SOIL SURVEY

Bexar County Texas

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
TEXAS AGRICULTURAL EXPERIMENT STATION

HOW TO USE THIS SOIL SURVEY REPORT

THIS SOIL SURVEY of Bexar County, Tex., contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

Locating soils

All the soils of Bexar County are shown on the detailed map at the back of this report. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown 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 in the report. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for the capability unit, range site, or any other group in which the soil has been placed.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soil in the soil descriptions and in the discussions of the interpretative groupings.

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

Community planners and others concerned with suburban development can read about the soil properties that affect the choice of homesites, industrial sites, schools, and parks in the section "Suburban Development."

Engineers and builders will find, under "Engineering," tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

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

Students, teachers, and others will find information about soils and their management in various parts of the text.

Newcomers in Bexar County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "Additional Facts About the County."

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Fieldwork for this survey was completed in 1962. Unless otherwise indicated, all statements in this report refer to conditions in the county at the time the survey was in progress. This survey of Bexar County was made cooperatively by the U.S. Department of Agriculture, the Texas Agricultural Experiment Station, and the city of San Antonio, Tex. It is part of the technical assistance furnished by the Soil Conservation Service to the Alamo Soil Conservation District.

Contents

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SOIL SURVEY OF BEXAR COUNTY, TEXAS

BY F. B. TAYLOR, R. B. HAILEY, AND D. L. RICHMOND, SOIL CONSERVATION SERVICE

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

BEXAR COUNTY is in the south-central part of Texas, in the land resource areas of the Rio Grande Plain, the Blackland Prairie, and the Edwards Plateau. The county covers 798,720 acres. It is irregularly pentagonal in shape and is about 45 miles from north to south and 43 miles from east to west (fig. 1).

The southern two-thirds of the county is a nearly level or undulating plain sloping upward from the southeast to the northwest and rising from about 500 feet to 1,000 feet in elevation. The northern third is an old eroded plateau that has been dissected by streams. It is strongly sloping to steep and rises from 1,000 feet to about 1,900 feet in elevation.

About a third of the county, or 266,240 acres, is cultivated, and some 28,000 acres is irrigated. Corn, grain sorghum, small grain, and cotton are the main dryland crops. Peanuts, watermelons, flax, and truck crops are grown under irrigation. A little more than a third of the county is used as range.

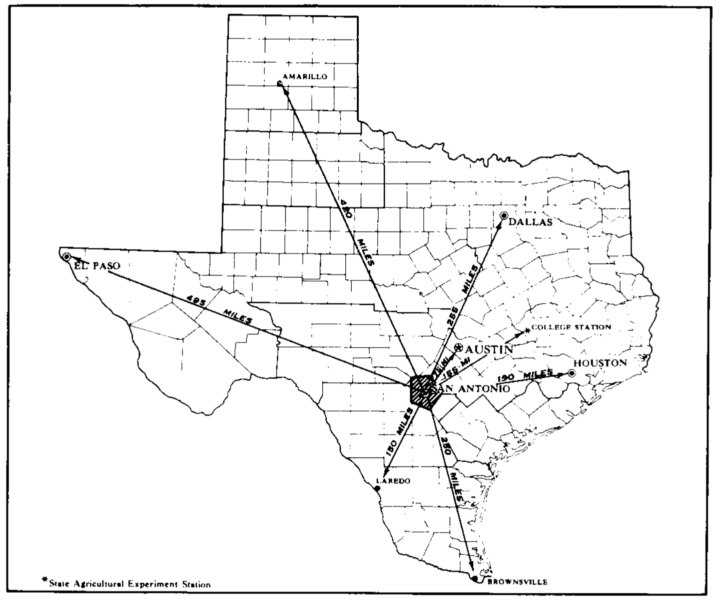

***Figure 1.*—Location of Bexar County in Texas.**

How This Soil Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Bexar County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; 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 to the rock material that has not been changed much by leaching or by 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. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, the major horizons of all the soils of one series 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. San Antonio and Crockett, 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 natural, undisturbed landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Duval fine sandy loam and Duval loamy fine sand are two soil types in the Duval series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Duval fine sandy loam, 1 to 3 percent slopes, is one phase of Duval fine sandy loam, a soil type that has a slope range of 1 to 5 percent.

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 in the back of this report was prepared from the aerial photographs.

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

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and occur in such small individual tracts that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Brackett-Austin complex, 1 to 5 percent slopes. On some detailed maps, the soil scientists show two or more soils as one mapping unit because the differences between the soils are not sufficient to justify separation for the purposes of the soil survey report. Such a mapping unit is called an undifferentiated group. Crawford and Bexar stony soils is an example. Another kind of mapping unit is the soil association. It consists of two or more soils that may differ from each other but are geographically associated in a consistent pattern and proportion too intricate for separate mapping. Brackett-Tarrant association, hilly, is an example. An association may also consist of different types or phases of one soil series. Tarrant association, gently undulating, is an example.

In most areas surveyed there are tracts that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These tracts are shown on the soil map, like other mapping units, but they are given descriptive names, such as Hilly gravelly land or Gullied land, and are called land types rather than soils.

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 kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way that it is readily useful to different groups of readers, among them farmers, ranchers, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in soil survey reports. The soil scientists set up trial groups based on the yield and practice tables and other data. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others; then they adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

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

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The nine soil associations in Bexar County, which are shown on the colored map at the back of this report, are described in the following pages.

1. *Tarrant-Brackett association*

Shallow and very shallow soils over limestone

This association is in the northern third of the county. Locally, this part of the county is referred to as the limestone prairie, the hill country, or the Edwards Plateau. It consists predominantly of soils that developed over limestone. Figure 2 shows the geographic association of Tarrant and Brackett soils, both of which occur in association 1, Crawford and Bexar soils in association 2, and Lewisville and Houston Black terrace soils in association 5.

The soils in association 1 are gently sloping to very steep, shallow or very shallow, dark colored or light colored, stony, and moderately permeable. They are underlain by Glen Rose limestone and Edwards limestone. The total extent of this association is 239,616 acres, or about 30 percent of the county.

Tarrant soils have a clayey, very dark grayish-brown, calcareous surface layer that ranges from a few inches to about 10 inches in thickness. On the surface and within the profile are various amounts of stones, flagstones, cobblestones, channery fragments, and gravel. The underlying material is hard, fractured limestone. About 65 percent of the association consists of Tarrant soils.

Brackett soils have a light-colored, highly calcareous surface layer. They are 4 to 16 inches thick over soft marl or limestone interbedded with hard limestone. There are stones, gravel, channery fragments, and cobblestones on the surface, and outcropping slabs of limestone give the landscape a "stairstep" appearance. The slopes range from hilly to very steep. The hills are cone

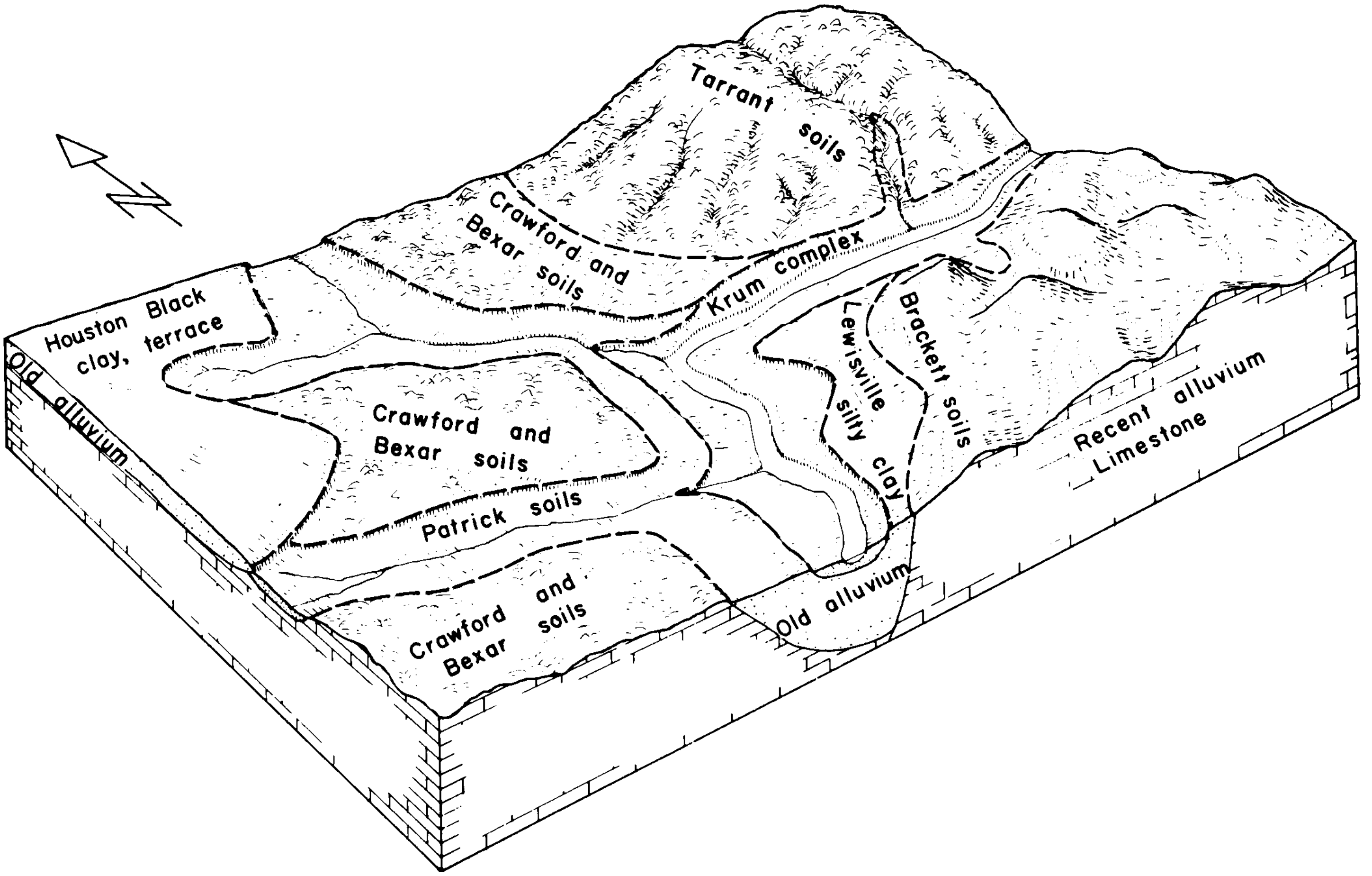

Figure 2.—**Representative pattern of soils in associations 1, 2, and 5.**

shaped, or nearly so, and have low saddles between the cones. About 20 percent of the association consists of Brackett soils.

Minor parts of this association consist of Crawford soils (3 percent), Bexar soils (3 percent), Krum soils (4 percent), Patrick soils (2 percent), and Lewisville soils (3 percent). Crawford soils are moderately deep, noncalcareous stony clays that occur mostly on narrow benches along large streams. Bexar soils, which occur mostly on ridgetops, have a clay loam surface layer. They are redder than Crawford soils and contain more chert and more limestone fragments. Krum soils are moderately deep, dark colored, and clayey. They developed from slope alluvium on old alluvial fans and in narrow, sloping valleys. Lewisville soils occur on terraces along streams. They are brown, deep, and moderately permeable. Patrick soils are less deep than Lewisville soils, and they have gravel within 3 feet of the surface.

This association is now occupied by large ranches, military reservations, and suburban homesites. Also, the city of San Antonio is expanding into this area. The soils are not suited to crops and are used principally as range. Stoniness and the topography make the use of machinery difficult. This part of the county is an excellent site for wildlife preserves and shooting leases. Deer and turkey are abundant. There are also suitable sites for dude ranches and other recreational enterprises. Homesites and locations for public utilities need to be carefully studied before construction is begun.

2. *Crawford-Bexar association*

Moderately deep, stony soils over limestone

This association occupies a broad, nearly level to gently sloping area in the northern third of the county. It is flanked by Tarrant soils, which are in association 1. The total extent of association 2 is 47,923 acres, or about 6 percent of the county.

Crawford soils are moderately deep. They have a very dark grayish-brown to dark reddish-brown, noncalcareous surface layer that is 12 to 16 inches thick. Their subsurface layer is blocky, reddish-brown clay that developed over broken limestone. These soils make up about 44 percent of this association. About 90 percent of this acreage has large fragments of chert and limestone both on the surface and within the profile. The rest is stone free and can be used for crops. Ordinarily, grain sorghum and small grain are grown. The post oak-blackjack oak savannah type of vegetation is characteristic of these soils.

Bexar soils also are moderately deep. They have a dark-brown to reddish-brown, noncalcareous surface layer that ranges from 6 to 14 inches in thickness and from cherty clay loam to stony clay loam in texture. This layer is underlain by blocky, reddish-brown to red cherty clay. The underlying material is soft, weathered limestone and hard, crystalline limestone. About 41 percent of the association consists of Bexar soils.

Minor parts of this association consist of Tarrant soils (10 percent), and of Lewisville and Houston Black soils (5 percent). Tarrant soils, which are similar to those in association 1, occur mainly in the more sloping areas that border the larger streams. Lewisville and Houston Black soils occur on narrow terraces along some streams.

Because of stoniness, most of this association is not suitable for cultivation and is used as range. The soils are fertile, and if well managed they are suited to good-quality pasture grass. Some selected areas can be used as wildlife preserves and for shooting leases. Deer, turkey, and other species of wildlife thrive on this association. Other areas are suitable as sites for dude ranches and other recreational enterprises. Some parts of this association are being developed for homesites. Homesites and locations for public utilities need to be carefully studied before construction is begun.

3. *Austin-Tarrant association*

Moderately deep and very shallow clayey soils over chalk and marl

This association is on the uplands in the northeastern, central, and west-central parts of the county. The general area, locally referred to as the Blacklands or the Blackland Prairie, is dissected by many creeks and streams. It consists predominantly of soils that developed over chalk and marl but contains some alluvial soils. Figure 3 shows the geographic association of Austin and Tarrant soils in association 3, Houston Black and Houston soils in association 4, and some of the alluvial soils that occur in associations 5 and 6.

The soils in association 3 are gently sloping and undulating to steep, moderately deep to very shallow, grayish brown, and moderately permeable. They are underlain by chalk and marl of the Austin and Anacacho formations. The total extent of this association is 63,898 acres, or about 8 percent of the county.

Austin soils have a dark grayish-brown, limy surface layer that is silty clay in texture and 16 to 30 inches thick. The subsoil is firm, pale-brown silty clay; it has fine, subangular blocky structure. About 50 percent of the association consists of Austin soils.

Tarrant soils have a dark-colored surface layer that is gravelly clay loam in texture and about 8 inches thick. The substratum is about 12 inches of fragmented, platy chalk. Cracks and crevices in this layer are filled with grayish-brown, fine-textured soil material. The underlying material consists of alternate beds of hard and soft, white chalk. About 30 percent of the association consists of Tarrant soils.

Minor parts of this association consist of Brackett soils (8 percent); Stephen soils (4 percent); Houston soils and Houston Black soils (6 percent); and Sumter soils (2 percent). Brackett soils are similar to Austin soils but are lighter colored, less clayey, and less deeply developed than those soils. Stephen soils are shallow and dark colored and are 12 to 24 inches thick over chalk rubble or bedrock. Houston soils are deep, moderately permeable, grayish-brown, calcareous clays. Houston Black soils are similar to Houston soils but have a dark-gray surface layer. Sumter soils are calcareous, are very shallow over yellowish, calcareous clays, and occur on steep slopes.

Residential areas are expanding northward into this association, most of which is now urban or is included in planned urban development. Small grain, grain sorghum, and corn are grown on the acreages that are cultivated, but the high lime content of the soils tends to tie up plant nutrients and consequently limits yields. Some selected areas can be used as wildlife preserves. Others are suitable for playgrounds, fishponds, or small-game farms. Sites for houses and industrial buildings and locations for public utilities need to be carefully studied before construction is begun.

4. *Houston Black-Houston association*

Deep clayey soils over calcareous clay and marl

This association occupies broad, nearly level to undulating uplands in the eastern and western parts of the county. The soils are deep, slowly permeable, dark colored, and clayey. Wide cracks form when they dry. These soils are underlain by calcareous clay and marl of the Taylor and Navarro formations. The total extent of this association is 79,872 acres, or about 10 percent of the county.

Houston Black soils have a black to dark-gray, noncrusty, calcareous surface layer that is clay or gravelly clay in texture, is 28 to 50 inches thick, and has fine, blocky structure. The substratum is light brownish-gray, calcareous clay or marl. About 65 percent of the association consists of Houston Black soils.

Houston soils have a grayish-brown to brown surface layer that is less deeply developed than that of Houston Black soils but is similar to it in other characteristics and qualities. The substratum is pale-yellow to olive-yellow, calcareous clay and contains some altered shale fragments. Houston soils are typically more sloping than Houston Black soils. About 20 percent of the association consists of Houston soils.

Minor parts of this association consist of Houston Black terrace soils (4 percent), Lewisville soils (4 percent), Patrick soils (2 percent), and Tarrant soils, Trinity soils, and Trinity and Frio soils, frequently flooded (5 percent). Houston Black terrace soils and Lewisville soils occupy low terraces along the major streams. Houston Black terrace soils differ from other Houston Black soils in position and in having a substratum that ranges from clay to loam in texture and from reddish yellow to gray in color. Lewisville soils are browner and more permeable than Houston Black soils and are likely to have some gravel near the base of the substratum. Patrick soils are closely associated with Lewisville soils but are less deeply developed and have gravel within 3 feet of the surface. Tarrant soils occur on high, narrow ridges and are similar to the Tarrant soils in association 3. Trinity soils are dark-gray, slowly permeable, calcareous clays on the flood plains of the larger streams. Trinity and Frio soils, frequently flooded, are on the bottom lands.

Most of this association is cultivated, and good yields are obtained of all crops commonly grown. Small grain, grain sorghum, corn, cotton, and flax are grown on soils that are dryfarmed. Irrigation is not commonly prac-

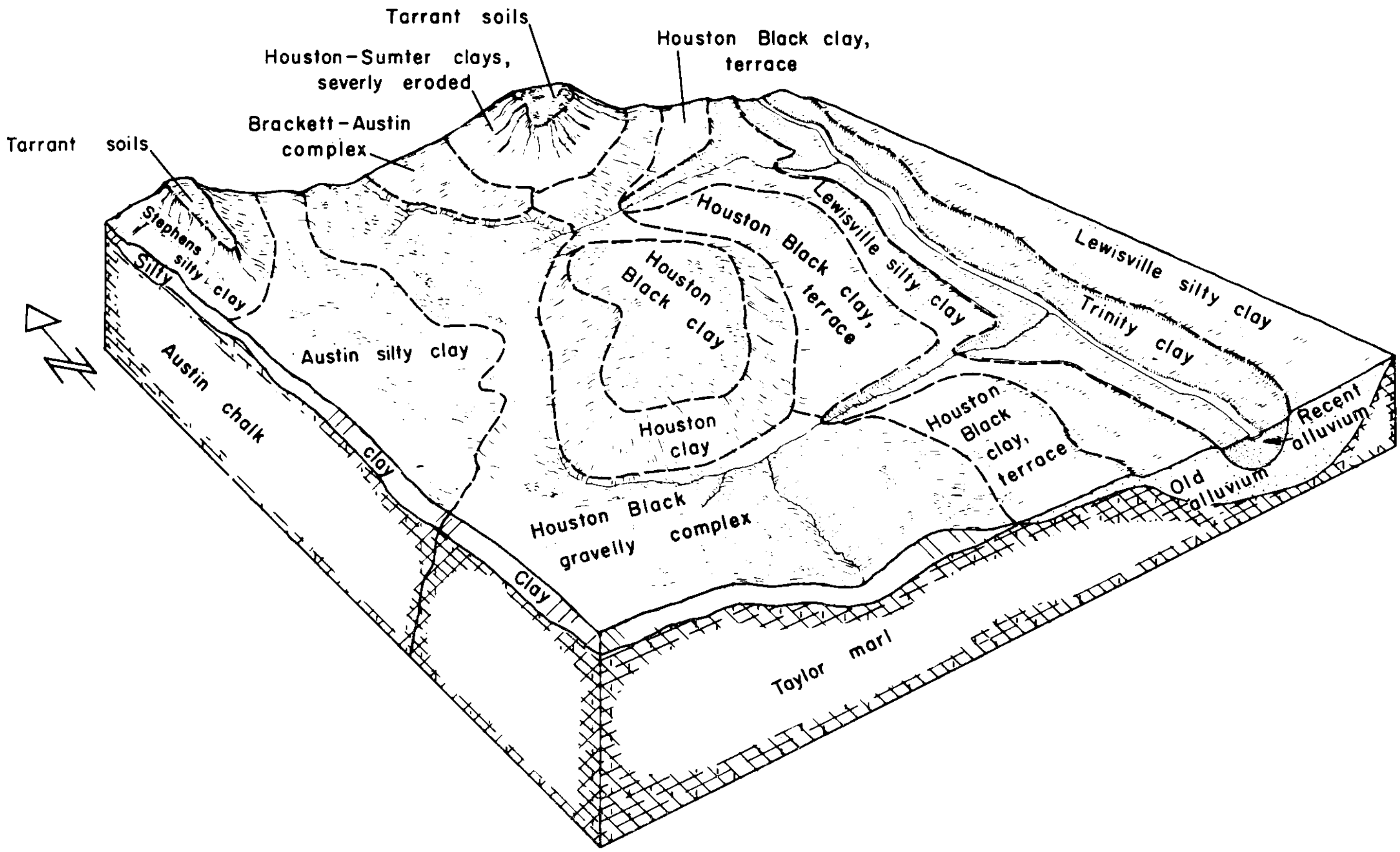

Figure 3.—**Representative pattern of soils in associations 3, 4, 5, and 6.**

ticed. Some small areas are still in native vegetation and are used as pasture. If well managed, these soils are productive of good pasture grass. Some selected areas can be used for recreational facilities, particularly fishponds and small-game farms.

5. *Lewisville-Houston Black, terrace, association*

Deep, calcareous clayey soils in old alluvium

This association occupies a large area in the central part of the county and small areas along the northern, northeastern, and western boundaries. It occurs where deposits of calcareous alluvium border the principal streams and intermittent drains and underlie old outwash plains. The lowest lying deposits, adjacent to the rivers and streams, have washed from surrounding uplands in recent geologic time. The thicker, higher lying deposits date back to the Pleistocene epoch. The thickest and most extensive deposits of Pleistocene alluvium are those in the valleys of Salado and Leon Creeks and the San Antonio and Medina Rivers, and those that underlie the outwash plains between Culebra Road and Mitchell Lake and the plain east of Salado Creek. Some of these deposits are as much as 45 feet thick. Figure 4 shows the geographic association of the alluvial soils in associations 5 and 6 with soils in other associations in the county.

The soils in association 5 are predominantly deep clays and silty clays that formed in calcareous alluvium. Most of the association is nearly level, but some areas along streams are gently sloping. The total extent of this association is 95,846 acres, or about 12 percent of the county.

Lewisville soils are deep, moderately permeable, dark-brown to dark grayish-brown, crumbly clays. The surface layer is about 25 inches thick. The subsurface layer ranges from dark brown to reddish brown; it has fine, blocky structure. In places the substratum contains beds of gravel. About 45 percent of the association consists of Lewisville soils.

The surface layer of Houston Black terrace soils consists of dark-gray to black, slowly permeable clay and is 45 to 60 inches thick. The substratum ranges from reddish yellow to light gray in color and contains some gravel below a depth of 6 feet. About 40 percent of the association consists of Houston Black terrace soils.

Minor parts of this association consist of Venus soils (4 percent), Patrick soils (4 percent), Frio soils (3 percent), Trinity soils (2 percent), and Houston soils (2 percent). Venus soils are grayish brown, friable, and high in lime content. They occur on high bottoms along the rivers and the major streams. Patrick soils are similar to Lewisville soils but are less deeply developed than those soils and have beds of gravel within 3 feet of the surface. Frio soils are similar to Venus soils but have a thicker, darker colored surface layer and are less friable than those soils. Trinity soils are similar to Houston Black terrace soils but occur on the flood plains

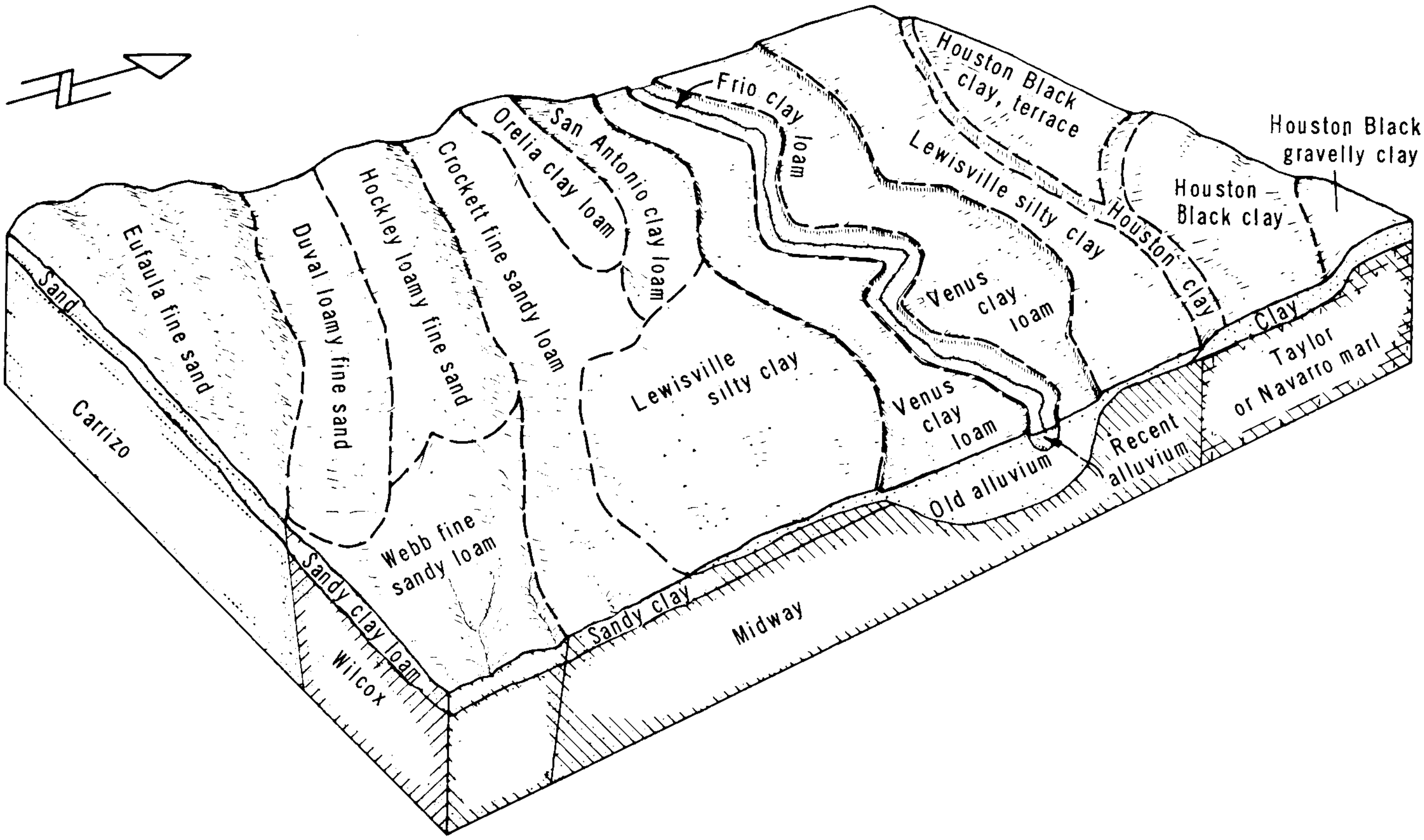

Figure 4.—**Parent material and representative pattern of soils in associations 5 and 6.**

along streams. Houston soils occupy the steeper areas; their slope is more than 3 percent.

A large part of this association is within the urban area of the county. The acreages that are cultivated are productive of all crops commonly grown. There are many irrigated vegetable farms, on which the principal crops are carrots, cabbage, potatoes, and sweet corn. Corn, small grain, grain sorghum, and cotton are grown on soils that are dryfarmed. Some selected areas can be used for recreational facilities, such as shooting farms, vacation farms, fishponds, parks, and playgrounds. Onsite determinations should be made before any construction is begun.

6. *Venus-Frio-Trinity association*

Deep, calcareous soils on bottom lands and terraces

This association occupies bottom lands and low terraces along the rivers and major streams and their tributaries. The soils are deep, calcareous clay loams and clays that are developing in alluvium. Most of the association is nearly level, but some areas along deeply entrenched streams are gently sloping. The total extent of this association is 27,955 acres, or about 3.5 percent of the county.

Venus soils have a friable, grayish-brown, strongly calcareous surface layer that is clay loam or loam in texture and 7 to 20 inches thick. The subsurface layer is light brownish gray to pale brown, is friable to firm, and has granular structure. The substratum consists of deep beds of old alluvium that ranges from light gray to very pale brown in color. These soils occur mostly as low terraces that are not subject to overflow. About 45 percent of the association consists of Venus soils.

Frio soils, which are flooded occasionally, have a friable, dark grayish-brown to grayish-brown, calcareous surface layer that is clay loam in texture and about 20 inches thick. The subsurface layer is clay loam or loam and is about 10 inches thick. Below a depth of 25 to 30 inches, the texture ranges from loam to stratified loam and clay loam. About 20 percent of the association consists of Frio soils.

Trinity soils are deep, dark-colored, calcareous, slowly permeable clays that are developing in clayey alluvium. These soils are ordinarily 48 to 60 inches thick. In some isolated areas there is a stratum of gravel within 4 feet of the surface. About 15 percent of the association consists of Trinity soil.

Minor parts of this association consist of Karnes soils (7 percent), Lewisville soils (5 percent), Gullied land (3 percent), and Patrick soils (5 percent). Karnes soils are similar to Venus soils, but they are more friable, less clayey, and lighter colored than those soils and contain more free lime. They occur as beveled slopes on the escarpments of the rivers. Lewisville soils occur mostly on low terraces with Venus soils. They are darker colored, more clayey, and more deeply developed than Venus soils. Gullied land occurs as very steep, severely eroded escarpments between the low terraces and the flood plains of the major rivers and streams. Patrick soils are similar to Lewisville soils, but they are less deeply developed than those soils and have beds of gravel within 3 feet of the surface. Patrick soils are also similar to Venus soils, but they are more sloping, less deeply developed, and lighter colored than Venus soils.

For the most part, the soils on low terraces are cultivated. They contain much free lime, which makes some plant nutrients unavailable, but they are fairly productive of small grain, grain sorghum, corn, and flax. Crops respond well to irrigation, and there are some vegetable farms. The bottom land is used mostly as native pasture or for pecan orchards. Selected areas can be used for wildlife habitats and recreational areas. The fact that some of the soils in this association are subject to occasional overflow must be considered.

7. *San Antonio-Crockett association*

Deep clay loams and sandy loams with claypan

This association is on the uplands in the eastern and southeastern parts of the county. The soil pattern is complex. The soils are mainly sandy clay, sandy clay loam, and sand, but alluvial soils occur along the Medina and San Antonio Rivers and their tributaries. Figure 5 shows the geographic association of San Antonio and Crockett soils in association 7; Hockley, Webb, and Crockett soils in association 8; Eufaula soils in association 9; and alluvial soils in associations 5 and 6.

The soils in association 7 have a moderately fine textured or fine textured subsoil. They developed from sandy clay and sandy clay loam that contains some interbedded sandstone of the Midway formation. These soils are mostly gently sloping, but along streams where erosion is moderate to severe, they are more strongly sloping. The total extent of this association is 19,968 acres, or about 2.5 percent of the county.

San Antonio soils have a dark grayish-brown to brown surface layer that is clay loam in texture and 6 to 14 inches thick. The subsoil is brown to reddish-brown, very firm, blocky clay or heavy sandy clay. About 50 percent of the association consists of San Antonio soils.

Crockett soils have a dark grayish-brown to brown surface layer that is sandy loam in texture and 8 to 14 inches thick. The subsoil consists of mottled heavy sandy clay loam or sandy clay, is very firm, and has blocky structure. About 30 percent of the association consists of Crockett soils.

Both San Antonio and Crockett soils are slow to very slow in permeability. They have a medium acid or slightly acid surface layer, a slightly acid or neutral subsoil, and a slightly alkaline substratum that contains moderate amounts of free lime.

Minor parts of this association consist of Webb soils (10 percent), Hockley soils (5 percent), Orelia soils, (3 percent), and Zavala and Gowen soils, frequently flooded (2 percent). Webb soils have a surface layer of brown to dark reddish-brown fine sandy loam and a subsoil of reddish-brown to red, blocky sandy clay. Hockley soils have a surface layer of pale-brown loamy fine sand and a subsoil of mottled, blocky sandy clay. Orelia soils have a dark-gray to dark grayish-brown, noncalcareous surface layer underlain by slowly permeable, calcareous clay. These soils are nearly level and occupy the highest positions in the landscape. Zavala and Gowen soils, frequently flooded, are on the flood plains of the larger creeks and drainageways.

Most of the soils in this association are cultivated and are fairly productive of all crops commonly grown in the area. Crops respond well to irrigation, but only a limited acreage in this part of the county is irrigated. Heavy mesquite, huisache, whitebrush, pricklypear, and annual weeds and grass grow on the acreages that are

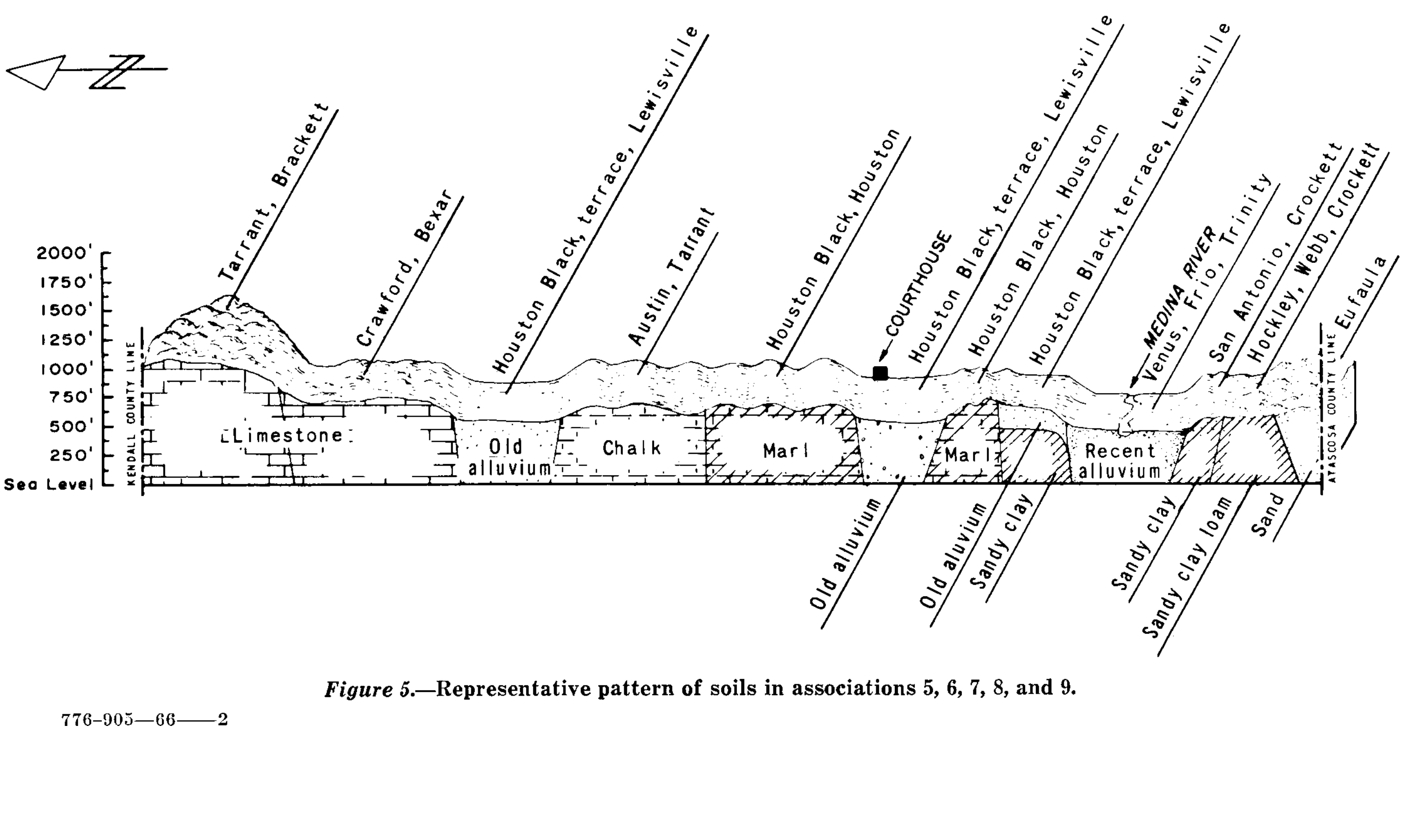

Figure 5.—**Representative pattern of soils in associations 5, 6, 7, 8, and 9.**

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not cultivated. Some selected areas can be used for wildlife, and many are suitable for vacation farms, shooting farms, fishponds, picnic and camping areas, parks, and playgrounds. On-site determinations should be made before any construction is begun.

8. *Hockley-Webb-Crockett association*

Deep loamy sands and sandy loams over loam, sandy clay, and interbedded sandstone

This association is in the southeastern, southern, and southwestern parts of the county. The soils are predominantly moderately deep loamy sands that have a moderately fine textured or fine textured subsoil and developed in sandy clay, thin-bedded sand, and sandstone of the Wilcox formation. Most areas are gently sloping to undulating; the more sloping ones are moderately to severely eroded. The total extent of this association is 159,744 acres, or about 20 percent of the county.

Hockley soils have a light-colored surface layer that is loamy fine sand in texture and about 12 to 15 inches thick. The subsoil is firm, blocky, mottled sandy clay loam. About 30 percent of the association consists of Hockley soils.

Webb soils have a brown to reddish-brown surface layer that is fine sandy loam in texture and about 8 to 18 inches thick. The subsoil is firm, red sandy clay to clay that has fine blocky structure. The substratum is slightly alkaline and contains moderate amounts of free lime. About 24 percent of the association consists of Webb soils.

Crockett soils occupy about 22 percent of the association. They are similar to the Crockett soils in association 7.

Minor parts of this association consist of Orelia soils (2 percent), Duval soils (8 percent), San Antonio soils (7 percent), and Gowen, Zavala, and Frio soils (7 percent). Orelia soils are closely associated with Crockett soils and are similar to the Orelia soils in association 7. Duval soils have a reddish-brown surface layer that is loamy fine sand or fine sandy loam in texture and about 10 to 26 inches thick. The subsoil is moderately permeable, reddish-brown to reddish-yellow sandy loam to sandy clay loam. San Antonio soils are closely associated with Webb soils and are similar to the San Antonio soils that occur in association 7. Gowen and Zavala soils occur on narrow terraces above the flood plains. Gowen soils are darker colored and more clayey than Zavala soils. Zavala and Gowen soils, frequently flooded, and Frio soils are on the flood plains of the larger creeks and drainageways.

Most of this association is in cultivation. The soils, for the most part, have only a moderate water-holding capacity; consequently, yields are somewhat limited. Crops respond well to irrigation, and there are some vegetable farms. Grain sorghum, small grain, and corn are the principal dryland crops. The number of acres planted to pasture grass is steadily increasing. The acreages not cultivated now consist of a heavy growth of thorny brush, cacti, and annual weeds and grass. Some selected areas can be used for recreational facilities such as shooting farms, riding stables, fishponds, and picnic and camping areas. Each site should be examined before any construction is begun.

9. *Eufaula association*

Deep fine sands with loamy subsoil

This association is in the extreme southern tip of the county. The soils are mostly deep, loose, slightly acid sands that formed in sandy and clayey material of the Carrizo formation. The total extent of this association is 63,898 acres, or about 8 percent of the county.

Eufaula soils have a light brownish-gray to pale-brown surface layer that is 48 to 72 inches thick. The subsoil is 12 to 22 inches thick and consists of pale-brown fine sand alternating with nearly continuous horizontal bands of yellowish-red sandy loam that range from one-fourth inch to one-half inch in thickness and are 2 to 4 inches apart. The substratum is red to yellowish-red sandy loam to sandy clay loam and is many feet thick. About 90 percent of the association consists of Eufaula soils.

Minor parts of this association consist of Hockley soils (5 percent) and Duval and Leming soils (5 percent). Hockley and Duval soils occur in the southeastern part of the association, in fairly low topographic positions. Leming soils are on nearly level, low terraces along the major drainageways.

Most of this association is still in the native vegetation, which consists of post oak, blackjack oak, hickory, switchgrass, little bluestem, sand dropseed, and annual weeds and grass. Small areas are cultivated, and they are planted mainly to peanuts and watermelons. All crops respond well to irrigation. The acreage under irrigation is steadily increasing. Some selected areas can be used for recreational facilities. There are few good roads.

Descriptions of Soils

This section describes the soil series and mapping units of Bexar County. The approximate acreage and the proportionate extent of each mapping unit are given in table 1.

A general description of each soil series is given, and it is followed by brief descriptions of the mapping units in that series. For full information on any one mapping unit, it is necessary to read the description of the soil series as well as the description of the mapping unit.

Following the name of the mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of the description of each mapping unit are the capability units, dryland and irrigated, and the range site in which the unit has been placed. The page on which each capability unit and each range site is described can be found readily by referring to the "Guide to Mapping Units" at the back of the report.

Soil scientists, engineers, students, and others who want detailed descriptions of soil series should turn to the section "Formation, Classification, and Morphology of Soils." Many terms used in the soil descriptions and other sections of the report are defined in the Glossary.

Austin Series

The Austin series consists of clayey soils that are moderately deep, moderately dark colored, and very strongly calcareous. These soils are on the uplands and

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

Symbol	Mapping unit	Acreage	Percent
AuB	Austin silty clay, 1 to 3 percent slopes	7, 316	0. 9
AuC	Austin silty clay, 3 to 5 percent slopes	8, 372	1. 1
BrE	Brackett soils, 12 to 30 percent slopes	24, 488	3. 1
BrD	Brackett soils, 5 to 12 percent slopes	5, 785	. 7
BpC	Brackett clay loam, 1 to 5 percent slopes	4, 960	. 6
BsC	Brackett-Austin complex, 1 to 5 percent slopes	9, 707	1. 2
BtE	Brackett-Tarrant association, hilly	19, 590	2. 5
Cb	Crawford and Bexar stony soils	35, 807	4. 5
Ca	Crawford clay	3, 575	. 5
CfA	Crockett fine sandy loam, 0 to 1 percent slopes	4, 163	. 5
CfB	Crockett fine sandy loam, 1 to 3 percent slopes	13, 902	1. 8
CkC2	Crockett soils, 2 to 5 percent slopes, eroded	3, 526	. 4
DnB	Duval fine sandy loam, 1 to 3 percent slopes	1, 929	. 2
DnC	Duval fine sandy loam, 3 to 5 percent slopes	565	. 1
DmC	Duval loamy fine sand, 1 to 5 percent slopes	5, 874	. 7
DsC2	Duval soils, 3 to 5 percent slopes, eroded	1, 017	. 1
EuC	Eufaula fine sand, 0 to 5 percent slopes	38, 903	4. 9
Fr	Frio clay loam	12, 765	1. 6
Go	Gowen clay loam	1, 499	. 2
Gu	Gullied land	4, 160	. 5
HgD	Hilly gravelly land	4, 132	. 5
HkB	Hockley loamy fine sand, 0 to 3 percent slopes	26, 979	3. 4
HkC	Hockley loamy fine sand, 3 to 5 percent slopes	12, 779	1. 6
HkC2	Hockley loamy fine sand, 3 to 5 percent slopes, eroded	8, 173	1. 0
HnB	Houston clay, 1 to 3 percent slopes	4, 527	. 6
HnC2	Houston clay, 3 to 5 percent slopes, eroded	4, 878	. 6
HnC3	Houston clay, 3 to 5 percent slopes, severely eroded	1, 085	. 1
HoD3	Houston-Sumter clays, 5 to 10 percent slopes, severely eroded	4, 892	. 6
HsA	Houston Black clay, 0 to 1 percent slopes	2, 316	. 3
HsB	Houston Black clay, 1 to 3 percent slopes	26, 289	3. 3
HsC	Houston Black clay, 3 to 5 percent slopes	4, 900	. 6
HtA	Houston Black clay, terrace, 0 to 1 percent slopes	33, 374	4. 2
HtB	Houston Black clay, terrace, 1 to 3 percent slopes	10, 503	1. 3
HuB	Houston Black gravelly clay, 1 to 3 percent slopes	27, 839	3. 5
HuC	Houston Black gravelly clay, 3 to 5 percent slopes	20, 284	2. 6
HuD	Houston Black gravelly clay, 5 to 8 percent slopes	6, 703	. 8

Symbol	Mapping unit	Acreage	Percent
KaB	Karnes loam, 1 to 3 percent slopes	1, 038	0. 1
KaC	Karnes loam, 3 to 5 percent slopes	1, 559	. 2
KcC2	Karnes clay loam, 3 to 5 percent slopes, eroded	680	. 1
Kr	Krum complex	14, 545	1. 8
LfB	Leming loamy fine sand, 0 to 3 percent slopes	5, 174	. 6
LvA	Lewisville silty clay, 0 to 1 percent slopes	46, 538	5. 8
LvB	Lewisville silty clay, 1 to 3 percent slopes	32, 474	4. 1
LvC	Lewisville silty clay, 3 to 5 percent slopes	760	. 1
OrA	Orelia clay loam, 0 to 1 percent slopes	955	. 1
OrB	Orelia clay loam, 1 to 3 percent slopes	2, 582	. 3
PaA	Patrick soils, 0 to 1 percent slopes	314	[1]
PaB	Patrick soils, 1 to 3 percent slopes	13, 612	1. 7
PaC	Patrick soils, 3 to 5 percent slopes	5, 782	. 7
Pt	Pits and Quarries	2, 691	. 3
SaB	San Antonio clay loam, 1 to 3 percent slopes.	18, 297	2. 3
SaC	San Antonio clay loam, 3 to 5 percent slopes.	4, 866	. 6
SaC2	San Antonio clay loam, 3 to 5 percent slopes, eroded.	4, 611	. 6
ScB	Stephen silty clay, 1 to 3 percent slopes.	193	[1]
ScC	Stephen silty clay, 3 to 5 percent slopes.	623	. 1
TaB	Tarrant association, gently undulating	62, 691	7. 8
TaC	Tarrant association, rolling	36, 689	4. 6
TaD	Tarrant association, hilly	32, 996	4. 1
Tb	Tarrant soils, chalk substratum, undulating.	8, 951	1. 1
Tc	Trinity clay	1, 258	. 2
Tf	Trinity and Frio soils, frequently flooded.	20, 947	2. 6
VaA	Venus loam, 0 to 1 percent slopes	1, 126	. 1
VaB	Venus loam, 1 to 3 percent slopes	2, 375	. 3
VcA	Venus clay loam, 0 to 1 percent slopes	10, 138	1. 3
VcB	Venus clay loam, 1 to 3 percent slopes	11, 508	1. 5
VcC	Venus clay loam, 3 to 5 percent slopes	1, 299	. 2
WbB	Webb fine sandy loam, 1 to 3 percent slopes.	15, 547	2. 0
WbC	Webb fine sandy loam, 3 to 5 percent slopes.	5, 679	. 7
WeC2	Webb soils, 3 to 5 percent slopes, eroded.	9, 158	1. 2
WeC3	Webb soils, 3 to 5 percent slopes, severely eroded	1, 064	. 1
WmA	Willacy loam, 0 to 1 percent slopes	1, 895	. 2
WmB	Willacy loam, 1 to 3 percent slopes	1, 432	. 2
Za	Zavala fine sandy loam	1, 199	. 2
Zg	Zavala and Gowen soils, frequently flooded.	5, 891	. 7
	Braunig Plant Lake	1, 320	. 2
	Mitchell Lake	707	. 1
	Total	798, 720	100. 0

[1] Less than 0.05 percent.

have gentle to undulating, convex slopes. They developed under grass, in material weathered from chalk or chalky marl.

The surface layer is dark grayish-brown silty clay. It is about 28 inches thick. To the depth normally plowed, the structure is granular, but below that depth, it is fine, subangular blocky.

The subsurface layer is about 18 inches thick. This layer is pale-brown silty clay and is somewhat more clayey than the surface layer. It has moderate, medium and fine, subangular blocky structure and is very hard when dry and firm but crumbly when moist.

The underlying material is chalky marl that contains much lime and many shale fragments and is firm but crumbly when moist. This layer is easily penetrated by roots.

The surface layer ranges from 16 to 30 inches in thickness and from very dark brown to grayish brown in color. The darker colored soils are ordinarily the more clayey. The subsurface layer ranges from 12 to 26 inches in thickness. The underlying material may be either chalk or chalky marl, and it ordinarily contains many small shale fragments. A profile of Austin silty clay is shown in figure 6.

Austin soils are lighter colored, less clayey, more calcareous, and more permeable than the nearby Houston Black soils. They are deeper, lighter colored, and more calcareous than Tarrant soils. They are more permeable and less clayey than Houston soils. Austin soils are similar to Lewisville soils, which developed from old alluvium and are typically less sloping. They are lighter colored and more deeply developed than the closely associated Stephen soils.

Austin soils are easy to work. They are well drained, and their capacity to hold water is good. Internal drainage is medium. Permeability is moderate. The large amount of free lime tends to make some plant nutrients unavailable and increases susceptibility to water erosion. Small grain, hay and pasture mixtures, and native grass are suitable crops. A large part of the acreage has been cultivated, but now most of it is in tame pasture or is used as sites for shopping centers, subdivisions, playgrounds, or parks.

Austin silty clay, 1 to 3 percent slopes (AuB).—This soil occupies low, broad ridgetops. It occurs mainly as large, irregularly shaped areas in the northeastern and central parts of the county. Included in the areas mapped are patches of other soils, particularly Stephen soils, which also developed over chalk but are darker gray and less deeply developed than this soil.

Associated soils include Houston soils, which are more clayey and less permeable than Austin soils and occur near the foot of the long gentle slopes, and Austin silty clay, 3 to 5 percent slopes, small areas of which occur as side slopes that extend toward the large streams.

This is a fairly productive soil that is suited to corn, small grain, and grain sorghum, and to both native grass and adapted varieties of perennial grass. It has a crusty surface and is susceptible to water erosion. Maintaining a balance between fertility and moisture is also a problem. Fertilization, terracing, contour tillage, and proper use of plant residues help to control erosion, conserve moisture, and maintain tilth and productivity. (Capability unit IIe–3, dryland; IIe–3, irrigated; Rolling Blacklands range site)

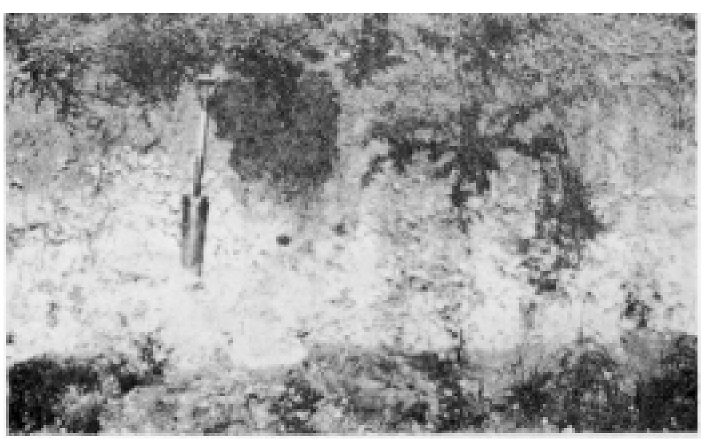

***Figure 6.*—Profile of Austin silty clay, showing chalky underlying material.**

Austin silty clay, 3 to 5 percent slopes (AuC).—The surface layer of this soil is about 16 inches thick, and the subsurface layer about 14 inches. Where the slope is strongest, spots of the lighter colored subsurface layer have been exposed by erosion. Where the associated soils are of a more clayey texture, the surface layer of this soil is more clayey than is typical. Small areas of undulating Tarrant soils, which occur as small narrow ridges, and small areas of Houston clay, 3 to 5 percent slopes, are included in the areas mapped.

This is a fairly productive soil that is suited to corn, small grain, grain sorghum, and sudangrass, as well as to hay and pasture or to native grass. It is droughty and susceptible to water erosion. Fertilization, terracing, contour tillage, and the proper use of plant residues help to control runoff and erosion, conserve moisture, and maintain tilth and productivity. (Capability unit IIIe–5, dryland; IIIe–5, irrigated; Rolling Blacklands range site)

Bexar Series

The soils of the Bexar series are shallow to moderately deep, noncalcareous, and dark colored. They occur as nearly level to gently undulating areas on the uplands. These soils are mainly in the northern and northeastern parts of the county.

The surface layer is dark reddish-brown clay loam and is about 18 inches thick. It has very fine, subangular blocky structure and is firm but crumbly when moist. An estimated 30 percent of it, by volume, is made up of chert fragments that range from half an inch to 5 inches in diameter.

The subsoil is about 12 inches thick. It is red to dark reddish-brown cherty clay. The structure is moderate, fine, blocky. Coarse fragments make up 15 to 60 percent of this layer, by volume. The reaction ranges from slightly acid to mildly alkaline.

The underlying material is white or pinkish-white limestone that is weakly fractured in the uppermost 2 or 3 inches. This material is partly weathered but becomes very hard with increasing depth.

The surface layer ranges from 14 to 22 inches in thickness and from cherty clay loam to gravelly loam in texture. The coarse angular fragments, which consist of chert and hard limestone, are as much as 10 inches in diameter and make up 15 to 50 percent of this layer, by volume. The subsoil is 40 to 55 percent clay and 15 to 60 percent coarse fragments. The depth to limestone ranges from 16 to 36 inches. Both the thickness of the soil and the number of coarse fragments vary considerably within short distances. Locally, a thin, discontinuous layer of carbonates in the form of soft concretions and lumps occurs above the limestone bedrock. Figure 7 shows chert and limestone fragments within the profile of Bexar cherty clay loam.

Bexar soils are ordinarily redder, less clayey, and more cherty in the surface layer than the closely asso-

Figure 7.—**Profile of Bexar cherty clay loam.**

ciated Crawford soils. They are deeper, redder, and less limy than Tarrant soils.

Bexar soils are well drained but have good capacity to hold water. Permeability is slow. These soils are nonarable because of the chert and limestone fragments, but they are high in natural fertility and are moderately to highly productive of forage. For the most part, they are used as pasture or range.

In this county Bexar soils are mapped only with the closely associated Crawford soils. The mapping unit, Crawford and Bexar stony soils, is described under the heading "Crawford Series."

Brackett Series

The Brackett series consists of very shallow and shallow, light-colored soils that developed over soft limestone interbedded with hard limestone. These soils occur as moderately sloping to steep, convex, cone-shaped hills. They are mainly in the northern and northwestern parts of the county but occur in a few places in the northeastern part. The alternate layers of hard and soft limestone give the slopes a "stairstep" appearance. The slope range is 2 to 30 percent.

The surface layer is grayish-brown gravelly clay loam and is about 4 inches thick. This layer has weak, granular structure and is friable when moist. It is very strongly calcareous. About 20 percent of it, by volume, consists of limestone fragments that range from about a quarter of an inch to as much as 6 inches in diameter.

The subsurface layer is light brownish-gray clay loam to silty clay and is about 8 inches thick. Soft limestone and lenses of chalky marl make up an estimated 30 percent of this layer, by volume. The structure is weak to moderate, fine, granular. This layer is hard when dry but friable when moist.

The underlying material is a thick bed of soft limestone that is interbedded with hard limestone and contains lenses of chalky marl or calcareous clay.

In uneroded areas the surface layer ranges from 4 to 12 inches in thickness. Excluding the gravel and stones, it ranges from clay loam to silty clay or light clay in texture. Some areas are free of stones. This layer ranges from light brownish gray to gray in color.

Brackett soils are lighter colored, less clayey, and less stony than the soils in the Tarrant associations and more limy than Tarrant soils that overlie chalk. They are lighter colored, less clayey, more limy, and less deeply developed than Crawford soils. They are less deeply developed and lighter colored than Stephen soils. They are lighter colored, less deeply developed, more limy, more crusty, and more sloping than Austin soils.

Brackett soils are well drained. Internal drainage is medium or slow. Erosion is active in most areas, even where there is a natural cover of vegetation. Natural fertility is low to moderate. These soils are best suited to pasture or range. The large amount of free lime makes some plant nutrients unavailable; consequently, the quality of the forage is poor. The better grasses include little bluestem, tall grama, seep muhly, sideoats grama, and tall dropseed. The poorer range plants are Ashe juniper, queensdelight, red grama, and annual weeds and grass.

Brackett soils, 12 to 30 percent slopes (BrE).—These soils are extensive. They cover 24,488 acres and are mainly in the northern and northwestern parts of the county. They occur as long slopes that range from hilly to steep, are strongly convex, and have a "stairstep" appearance. The hills are cone shaped or nearly so and have low saddles between the cones (fig. 8). The slope is typically about 24 percent. These are loamy and clayey soils that are light colored, very shallow, and strongly calcareous. They developed over soft limestone interbedded with hard limestone. There are stones, gravel, channery fragments, and cobblestones on the surface and in the surface layer. Patches of Tarrant association, of Krum complex, and of Trinity and Frio soils, frequently flooded, are included in the areas mapped.

These soils are nonarable and are best suited to native grass. Maintaining an adequate cover of native grass helps to control runoff and water erosion. Fencing, seeding, control of grazing, water development, and brush

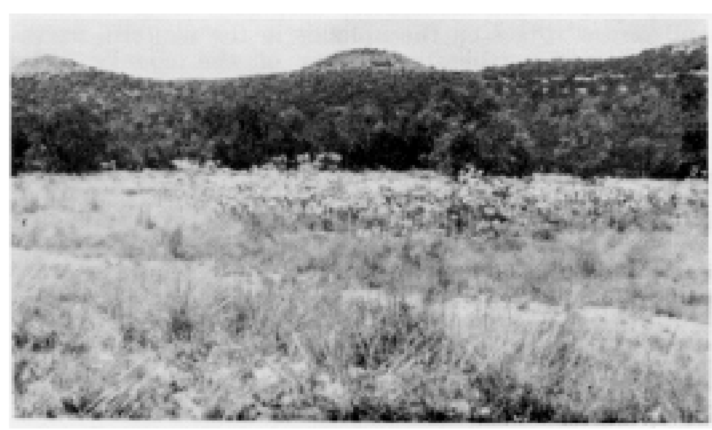

Figure 8.—**Brackett soils, 12 to 30 percent slopes.**

control are a few of the necessary management practices. (Capability unit VIIs–2, dryland; Steep Adobe range site)

Brackett soils, 5 to 12 percent slopes (BrD).—These soils occur on the tops and on the upper side slopes of meandering ridges. They are mainly in the western and northwestern parts of the county, but they also occupy a few scattered areas in the northern part. The slope generally is between 5 and 8 percent, but in places it is as much as 12 percent. These are light-colored, very shallow, and strongly calcareous soils that developed over chalk. They have stones, gravel, channery fragments, and cobblestones on the surface and in the surface layer. Patches of Austin soils and of Tarrant soils, chalk substratum, are included in the areas mapped.

These soils are nonarable and are best suited to native grass. Natural fertility is low. Runoff is rapid, and erosion is active, even where there is a natural cover of vegetation. Maintaining an adequate cover of native grass helps to control runoff and erosion. Fencing, seeding, controlled grazing, water development, and brush control are a few of the necessary management practices. (Capability unit VIIs–1, dryland; Adobe range site)

Brackett clay loam, 1 to 5 percent slopes (BpC).—This soil is mainly in the western and northwestern parts of the county but also occupies some small scattered areas in the northern and northeastern parts. On the landscape it is below Brackett soils, 5 to 12 percent slopes, and above the deeper, darker colored Austin silty clay, 3 to 5 percent slopes. Patches of both of these soils are included in the areas mapped. The slope generally is between 1 and 5 percent, but in a few areas it is as much as 7 percent.

The surface layer is about 6 inches thick. The subsurface layer is silty clay and is about 9 inches thick. The underlying material is white chalk that can be penetrated by roots (fig. 9). The profile is deeper than that of Brackett soils, 5 to 12 percent slopes.

This soil is used as pasture and is also cultivated. It is generally planted to small grain that can be grazed in winter. Cultivated areas are grayer in the surface layer than areas that are in native vegetation, because material in the subsurface and surface layer have been mixed during tillage. This soil is droughty and susceptible to water erosion. Fertilization, terracing, contour tillage, and proper use of plant residues help to control runoff and erosion, conserve moisture, and maintain tilth and fertility. (Capability unit IVe–7 dryland; Adobe range site)

Brackett-Austin complex, 1 to 5 percent slopes (BsC).—These shallow and moderately deep soils occur as knolls and narrow ridges on the uplands in the western, north-central, and northeastern parts of the county. The Brackett soils in this complex are similar to Brackett clay loam. The Austin soils are similar to those described under the heading "Austin Series" but are lighter colored in the surface layer, particularly in cultivated areas. They occur as slopes between the meandering ridges and the knolls. Both of these soils developed over chalk that is easy to dig into with an auger or a spade. Included in the areas mapped are patches of Tarrant soils, chalk substratum, which occur as "caps" on the higher lying knolls, and of Houston clay, which occurs as foot slopes.

These soils are used as pasture and are also cultivated. They are generally planted to small grain that can be grazed in winter. The large amount of free lime in these soils tends to tie up some plant nutrients and increases

***Figure 9.*—Profile of Brackett clay loam, 1 to 5 percent slopes, showing roots in chalky underlying material.**

susceptibility to water erosion. Droughtiness is also a limitation. Fertilization, terracing, contour tillage, seeding to hay and pasture mixtures, and proper use of crop residues help to control erosion, conserve moisture, and maintain productivity. (Brackett soils: capability unit IVe–7, dryland; Adobe range site. Austin soils: capability unit IVe–7, dryland; Rolling Blacklands range site)

Brackett-Tarrant association, hilly (8 to 30 percent slopes) (BtE).—These soils are extensive in the northern third of the county. Tarrant soils are on the tops and the upper side slopes of ridges, just above Brackett soils. Included in the areas mapped are patches of Krum, Crawford, Patrick, and Lewisville soils.

These soils are nonarable and are best suited to native grass. Maintaining an adequate cover of vegetation helps to control runoff and water erosion. Fencing, seeding, control of grazing, water development, and brush control are a few of the necessary management practices. (Brackett soils: capability unit VIIs–2, dryland; Steep Adobe range site. Tarrant soils: capability unit VIs–3, dryland; Low Stony Hill range site)

Crawford Series

The soils of the Crawford series are very dark grayish-brown to reddish-brown clay. They occur as broad, nearly level to gently undulating areas and are extensive in the northern part of the county.

The surface layer is noncalcareous, about 8 inches thick, and very dark grayish brown or very dark brown. It has fine, subangular blocky and granular structure. When moist, this layer is very firm but breaks easily to a mass of fine clods. When dry, it is very hard and contains many large cracks. There are few to many angular fragments of chert and limestone that range from a quarter of an inch to as much as 24 inches in diameter.

The subsurface layer is dense, angular blocky clay. It is browner or more reddish than the surface layer and has a coarser, wedge-shaped structure. This layer is neutral or slightly acid, but it may be limy in the lower part. It is about 26 inches thick and either overlies a thin layer of yellowish-red to pale-brown, limy clay or, if the limy layer is lacking, rests on hard, fractured limestone that is many feet thick.

The surface layer ranges from 6 to 10 inches in thickness. It ranges from clay through gravelly or cherty clay to stony clay in texture; stony clay is predominant. The reaction in the solum ranges from slightly acid to mildly alkaline. The depth to limestone bedrock ranges from 17 to 45 inches.

Crawford soils are deeper, redder, and less limy than Tarrant soils. They are more clayey and less red in the surface layer than Bexar soils. As compared with Brackett soils, they are deeper, darker colored, and less limy, and they developed over harder limestone.

Crawford soils are naturally well drained. Internal drainage and permeability vary according to moisture content; water moves rapidly when the soil is dry and cracked, but very slowly when the soil is wet. Most of the acreage is used as pasture or range. The soils are high in natural fertility and are moderately to highly productive of forage. Oats and other small grains are grown on a few small nonstony areas. The native vegetation ordinarily consists of Texas wintergrass, little bluestem, sideoats grama, and buffalograss, and scattered live oak, post oak, and mesquite trees.

Crawford and Bexar stony soils (0 to 5 percent slopes) (Cb).—These soils occur as large areas, generally several hundred acres in size, and form a nearly continuous belt extending westward from the northeastern part of the county to a little south of Helotes.

Crawford soils make up about 51 percent of the acreage. About 90 percent of this consists of soils that are stony clay in texture and are shallow to moderately deep over hard limestone. The surface layer is very dark gray to dark reddish-brown, noncalcareous clay and is 8 or 9 inches thick. From 10 to 40 percent of this layer consists of chert and limestone fragments. These fragments, which are on the surface and in the surface layer, range from a quarter of an inch to 24 inches in diameter. The subsurface layer generally contains a few chert fragments or small flags of cherty limestone.

Bexar soils make up 36 percent of the acreage. The surface layer of these soils ranges from cherty clay loam to gravelly loam in texture and from 14 to 22 inches in thickness. The subsoil is cherty clay and ranges from 6 to 14 inches in thickness.

Included in the areas mapped are small tracts of Tarrant soils and of a soil that is similar to Bexar soils except that it is very shallow. These inclusions make up 13 percent of the acreage.

For the most part, these soils are nonarable and are best suited to native grass. Maintaining an adequate cover of vegetation helps to control runoff and water erosion. Fencing, seeding, control of grazing, water development, and brush control are a few of the necessary management practices. (Crawford soils: capability unit VIs–1, dryland; Redland range site. Bexar soils: capability unit VIs–1, dryland; Redland range site)

Crawford clay (0 to 1 percent slopes) (Ca).—Patches of this soil are scattered throughout the hard limestone area. Most are in the uplands, but a few are in the valleys. The surface layer is dark brown or dark reddish brown, noncalcareous, and 8 to 10 inches thick. Wide cracks form when it dries. The subsurface layers are clay and are noncalcareous also. They are redder than the surface layer. During prolonged dry periods, the cracks in the surface layer are likely to extend into the subsurface layers. Limestone ordinarily occurs at a depth of 24 to 36 inches. In some places, however, there is a few inches of limy clay over the limestone. Included in the areas mapped are small tracts of Crawford stony clay, of Bexar cherty clay loam, of Lewisville clay loam, 0 to 1 percent slopes, and of Patrick clay, 1 to 3 percent slopes.

This is a productive soil that is suited to corn, small grain, grain sorghum, and sudangrass. Water intake is slow, and water erosion is a hazard. A plowpan is likely to form. Fertilization, terracing, contour tillage, and proper use of plant residues help to control erosion, conserve moisture, and maintain tilth and productivity. (Capability unit IIIe–2, dryland; IIIe–2, irrigated; Redland range site)

Crockett Series

The Crockett series consists of moderately deep, dark-colored, nearly level to gently sloping sandy loams. These soils are in the southern third of the county.

The surface layer is brown or dark brown, noncalcareous, easily worked, and about 10 inches thick. It has weak, granular structure or is structureless.

The subsoil is about 34 inches thick. It is brown with red and gray mottles, has medium, blocky structure, and is extremely hard when dry. This layer is noncalcareous.

The underlying material is sandy clay that has much free lime in the uppermost few inches and less with increasing depth. In places the sandy clay is interbedded with sandstone.

The surface layer ranges from 8 to 14 inches in thickness and from dark brown to dark grayish brown in color. The subsoil ranges from 25 to 40 inches in thickness, from brown to dark brown in color, and from sandy clay loam to sandy clay in texture. It has red, yellow, and gray mottles that range from few to many and from distinct to faint. Depth to the lime accumulation ranges from 35 to 50 inches.

Compared with Crockett soils, San Antonio soils have a browner surface layer and a redder, unmottled subsoil; Orelia soils are darker gray and more clayey in the surface layer and have a compact, unmottled subsoil; Webb and Duval soils are redder in the surface layer and have a less dense, more sandy, redder, blocky subsoil; and Hockley soils have a sandier, thicker, lighter colored surface layer and a sandier, more permeable, mottled subsoil.

Crockett soils are naturally well drained. Internal drainage is very slow but is adequate for field crops. The water-holding capacity is low in the surface layer but good in the subsoil. Natural fertility is moderate. Water erosion is a hazard. These soils are suited to small grain, grain sorghum, corn, and other dryland crops commonly grown in the area. They are also suited to native grass and to adapted varieties of introduced grass grown for tame pasture. Most of the acreage is cultivated. A few small areas are irrigated and planted to truck crops.

Crockett fine sandy loam, 0 to 1 percent slopes (CfA).—This soil occurs as small, scattered areas on the uplands in the southern third of the county. It differs from the soil described as typical of the series in that it is less sloping and has a thicker and darker colored surface layer. There is little surface runoff and consequently no hazard of water erosion. Included in the areas mapped are small tracts of Orelia clay loam, 0 to 1 percent slopes, of Leming loamy fine sand, 0 to 3 percent slopes, and of Crockett fine sandy loam, 1 to 3 percent slopes.

The surface layer is grayish brown or very dark grayish brown and is about 14 inches thick. The subsoil is dark grayish-brown to light olive-brown, blocky sandy clay and has red and dark yellowish-brown mottles. This layer is about 32 inches thick.

This soil is easily tilled, but if it is too wet when cultivated, it tends to crust and clod. Most of the acreage is cultivated and planted to small grain, grain sorghum, and corn. The acreage in tame pasture has been increasing steadily. Fertilization, crop rotation, and proper use of plant residues help to conserve moisture and maintain tilth and productivity. (Capability unit IIIs–1, dryland; IIIs–3, irrigated; Tight Sandy Loam range site)

Crockett fine sandy loam, 1 to 3 percent slopes (CfB).—This is the most extensive of the Crockett soils in this county; the areas shown on the map range from 20 acres to as much as 350 acres in size. The slopes are weakly convex, and the gradient ranges from 1 to 4 percent but is generally less than 2.5 percent. This soil has more runoff than Crockett fine sandy loam, 0 to 1 percent slopes, and is moderately susceptible to water erosion. Included in the areas mapped are small tracts of Hockley loamy fine sand, 1 to 3 percent slopes, of San Antonio clay loam, 1 to 3 percent slopes, and of Orelia clay loam, 1 to 3 percent slopes.

The surface layer is about 10 inches thick. It is easily worked, but if it is too wet when cultivated, it tends to crust and clod. The subsoil is noncalcareous sandy clay mottled with red and yellowish red. This layer is about 34 inches thick. It has a blocky structure and is very firm when moist.

This soil is moderately productive of most dryland crops. A large acreage is cultivated, and the acreage in tame pasture has been increasing steadily. Susceptibility to water erosion and lack of moisture are limitations. Fertilization, terracing, contour tillage, and proper use of plant residues are needed to help control erosion, conserve moisture, increase water intake, and maintain tilth and fertility. (Capability unit IIIe–1, dryland; IIIe–1, irrigated; Tight Sandy Loam range site)

Crockett soils, 2 to 5 percent slopes, eroded (CkC2).—These soils occur around the head of streams and on short, steep side slopes where the streams are deeply entrenched. They are mainly in the southeastern part of the county and are not extensive. They have more rapid runoff than the other Crockett soils. Rills and gullies have formed in most areas. The gullies are 3 to 6 feet wide, 12 to 18 inches deep, and 150 to 300 feet apart. The slope is generally between 3.5 and 4 percent. About 8 percent of the acreage mapped consists of small areas of Orelia soils, San Antonio soils, and other Crockett soils.

The surface layer ranges from dark grayish brown to brown. Except in the more eroded areas, where this layer has been mixed with the subsoil, the texture is fine sandy loam. The subsoil is similar to that described as typical of the series.

Most of the acreage is, or has been, cultivated. Because of erosion, however, these soils are not productive and are best suited to grass. They need to be fertilized and planted to native grass or adapted varieties of perennial grass. (Capability unit VIe–1, dryland; Tight Sandy Loam range site)

Duval Series

The Duval series consists of sandy upland soils that are deep, reddish, and nearly level to moderately sloping. These soils developed over calcareous sandy material and soft sandstone. They occur in the southeastern and southern parts of the county.

The surface layer is brown to reddish-brown, slightly acid fine sandy loam or loamy fine sand and is about 14 inches thick. It has weak, granular structure, is friable when moist, and is easily worked. Plowing tends to destroy the structure; consequently, in cultivated areas this layer appears structureless.

The subsoil is yellowish-red, slightly acid sandy clay loam and is about 40 inches thick. It contains more clay than the surface layer. This layer has weak, coarse, prismatic structure and is friable when moist.

The underlying material is very pale brown, slightly acid loam mixed with weakly consolidated sandstone. This material is massive and porous and is friable when moist. It extends to a depth of several feet.

The surface layer ranges from 10 to 26 inches in thickness, from dark reddish brown to dark brown in color, and from fine sandy loam to loamy fine sand in texture. The subsoil ranges from 20 to 44 inches in thickness, from reddish brown to yellowish red in color, and from heavy sandy clay loam to heavy loam in texture. The clay content in the subsoil ranges from 17 to 25 percent. Free lime seldom occurs within 60 inches of the surface.

Duval soils are more permeable and have a less clayey subsoil than the closely associated Webb soils, which have some accumulation of lime within 60 inches of the surface. They are less brown and less clayey in the surface layer and have a less clayey subsoil than San Antonio soils, which also have a zone of lime accumulation. They are more permeable and redder in the surface layer and have a less clayey subsoil than Hockley soils, which have a mottled subsoil.

Duval soils are moderately well drained or well drained. Internal drainage is medium or rapid. The soils take up water well but have moderate to low capacity to store water for plants. Natural fertility is moderate. Water erosion and wind erosion are hazards. These soils are well suited to small grain, grain sorghum, corn, and hay and pasture mixtures. If irrigated, they are suited to all types of truck crops. Most of the acreage is cultivated.

Duval fine sandy loam, 1 to 3 percent slopes (DnB).—This soil occurs as small areas, mostly as narrow ridgetops, in the southeastern part of the county. Runoff is medium or slow. Included in the areas mapped are small tracts of Webb fine sandy loam, 1 to 3 percent slopes, and of Crockett fine sandy loam, 1 to 3 percent slopes.

The surface layer is about 14 inches thick. This layer is easily worked, but if it is too wet when cultivated, a plowpan is likely to form. The subsoil consists of massive, porous sandy clay loam and is about 30 inches thick. Free lime seldom occurs within 60 inches of the surface.

This is a productive soil, and almost all of it is cultivated. Grain sorghum, corn, small grain, sudangrass, and cotton are suitable crops. Hay and pasture mixtures can be grown also. Water erosion is the main limitation. Fertilization, terracing, contour tillage, and proper use of plant residues are needed to help control erosion and maintain fertility and tilth. (Capability unit IIe–1, dryland; IIe–1, irrigated; Sandy Loam range site)

Duval fine sandy loam, 3 to 5 percent slopes (DnC).—This soil occurs as small, scattered areas, mainly in the southeastern and southern parts of the county. It has a thinner surface layer than Duval fine sandy loam, 1 to 3 percent slopes, and because it is steeper, has more rapid runoff. Nevertheless, runoff is only medium. Included in the areas mapped are small tracts of Webb fine sandy loam, 3 to 5 percent slopes, of Duval loamy fine sand, 3 to 5 percent slopes, and of Crockett fine sandy loam, 1 to 3 percent slopes.

The surface layer is about 10 inches thick. The subsoil consists of massive, porous material and is about 30 inches thick.

This is a fairly productive soil, and most of it is cultivated. It is suited to grain sorghum, small grain, sudangrass, corn, and cotton. It is also suited to tame pasture consisting of native and introduced grasses. Water erosion is a hazard. Also, a plowpan is likely to form, which will result in slow water intake. Fertilization, terracing, contour tillage, and proper use of plant residues are needed to help control erosion, conserve moisture, and maintain fertility. (Capability unit IIIe–4, dryland; IIIe–3, irrigated; Sandy Loam range site)

Duval loamy fine sand, 1 to 5 percent slopes (DmC).—This soil occurs as small, rounded hills or low, intermittent ridges. It is in the southern part of the county, just north of the sandier Eufaula soils. Runoff is slow. Included in the areas mapped are small tracts of Hockley loamy fine sand, 1 to 3 percent slopes, of Webb fine sandy loam, 3 to 5 percent slopes, and of Crockett fine sandy loam, 1 to 3 percent slopes.

The surface layer is loose and winnowed and is about 16 inches thick. The subsoil is about 44 inches thick. It consists of massive, porous sandy clay loam that is easily broken into fragments. Free lime seldom occurs within 60 inches of the surface.

This is a fairly productive soil. Most of it is either in cultivated crops or in tame pasture. Small grain, grain sorghum, corn, peanuts, watermelons, and sudangrass are suitable crops. Also suitable are native grass or adapted varieties of perennial grass grown for tame pasture. Wind erosion has damaged this soil to the extent that the surface layer in cultivated areas is now more sandy than it was before it was plowed. Water erosion is a hazard, and lack of fertility and of moisture is a limitation. Fertilization, wind stripcropping, and proper use of all plant residues are needed to help control erosion, conserve moisture, and maintain fertility. (Capability unit IIIe–9, dryland; IIIs–2, irrigated; Deep Sand range site)

Duval soils, 3 to 5 percent slopes, eroded (DsC2).—These soils occur mainly in the southern and southwestern parts of the county, within larger areas of the Duval fine sandy loams and the Duval loamy fine sands. Generally, they occur on knolls and low hills or at the head of drainageways. They have been seriously damaged by sheet and gully erosion. In some areas they have lost all of the original surface layer, but in others most of the original surface layer remains. Many tracts are dissected by gullies that are 10 to 50 feet apart. Included in the areas mapped are small tracts of Hockley loamy fine sand, 3 to 5 percent slopes, eroded, of Webb fine sandy loam, 3 to 5 percent slopes, and of Crockett fine sandy loam, 1 to 3 percent slopes.

These soils are best suited to native grass or adapted varieties of perennial grass. Most of the acreage is idle farmland or is used for tame pasture. Water erosion is a hazard, and lack of soil moisture is a limitation. Fertilizer and a protective cover of vegetation are needed to help control erosion, conserve moisture, and maintain fertility. (Capability unit IVe–5, dryland; IIIe–7, irrigated; Deep Sand range site)

Eufaula Series

The Eufaula series consists of undulating sandy soils that are deep, loose, light colored, and slightly acid. These soils occur in the extreme southern tip of the county.

The surface layer is noncalcareous, light brownish-gray fine sand about 7 inches thick. This layer is structureless and is very loose, even when moist.

The subsoil also is fine sand but is lighter colored than the surface layer. It ranges from about 35 inches to more than 72 inches in thickness. This layer is structureless.

The underlying material consists of pale-brown fine sand and nearly continuous, alternate horizontal bands of yellowish-red sandy loam. The bands are a quarter of an inch to half an inch thick and 2 to 4 inches apart. This layer ranges from 12 inches to more than 72 inches in thickness. It is structureless and is very friable when moist.

The substratum consists of massive, red sandy clay loam that is extremely hard when dry. The reaction is slightly acid. Few plant roots enter this layer.

The surface layer ranges from 4 to 7 inches in thickness and from grayish brown to light brownish gray in color. The subsurface layer ranges from 30 inches to more than 72 inches in thickness and from light gray to very pale brown in color. The substratum ranges from 12 inches to more than 72 inches in thickness. The lenses, or hardened bands, are an eighth of an inch to half an inch thick and half an inch to 6 inches apart.

Eufaula soils are sandier, thicker in the surface layer, and less clayey in the subsoil than Hockley soils. They are less red, sandier, thicker in the surface layer, and less clayey in the subsoil than Duval soils. They are more sloping, thicker and sandier in the surface layer, and less clayey in the subsoil than Leming loamy fine sand, which has a mottled gray and yellowish-brown subsoil that is within 30 inches of the surface.

These deep, sandy soils are naturally well drained. They absorb most of the precipitation but have poor capacity to hold water. Unless protected by a cover of vegetation, they are highly susceptible to wind erosion. Natural fertility is low to moderate. For the most part, these soils are not cultivated. A few areas have been cleared and planted to peanuts, watermelons, grain sorghum, corn, and small grain. Most of these areas are irrigated. The acreage planted to Coastal bermudagrass and used as tame pasture has been increasing. The native vegetation consists mainly of post oak, blackjack oak, and hickory trees; and switchgrass, little bluestem, sand dropseed, and Leavenworth vetch.

Eufaula fine sand, 0 to 5 percent slopes (EuC).—This soil occupies one large acreage at the southern tip of the county and a few other scattered, small acreages. The slope generally is between 0 and 5 percent, but in a few places it is as much as 7 percent. Included in the areas mapped are small tracts of Hockley loamy fine sand, 0 to 3 percent slopes, of Leming loamy fine sand, 0 to 3 percent slopes, and of Duval loamy fine sand, 1 to 5 percent slopes.

Nearly all of this soil is in native vegetation. If cultivated, it is highly susceptible to wind erosion. Deep plowing, which ordinarily helps to control wind erosion, is impractical; the surface layer is so thick that the clayey material in the subsoil cannot be plowed up and mixed with the surface layer. This soil should be kept in permanent vegetation. (Capability unit IVe–6, dryland; IIIs–4, irrigated; Sandy Savannah range site)

Frio Series

The Frio series consists of limy alluvial soils that are moderately deep, grayish brown or dark grayish brown, and nearly level. These soils occur on the flood plains along the San Antonio River and the Medina River and their main tributaries.

The surface layer is grayish-brown or dark grayish-brown clay loam and is about 20 inches thick. It has weak, granular structure, is friable, and is easily worked. This limy layer contains few to many worm casts and snail fragments.

The subsurface layer is light brownish gray. It is more loamy and more compacted than the surface layer; the texture is light clay loam or loam. This layer has weak, fine, granular structure. It is limy, firm but crumbly when moist, and about 5 inches thick.

The parent material is limy, friable, loamy alluvium that is easily penetrated by plant roots. In places it contains thin layers of more sandy or more clayey material. There are a few beds of water-rounded limestone gravel at a depth of 3 to 6 feet.

The surface layer of Frio soils ranges from 8 to 25 inches in thickness and from loam to clay loam and silty clay loam in texture. The finer textured soils are the darker colored. The subsurface layer is 5 to 20 inches thick. It has moderate, fine, granular and subangular blocky structure and is friable when moist. The underlying material ranges from sandy loam through light loam and stratified loam to clay loam in texture.

Frio soils are more clayey, darker colored, less limy, and less sloping than Karnes soils. They are more deeply developed and more limy than the darker colored Gowen soils. They are less brown, less clayey, and less deeply developed than Lewisville soils. Frio soils are similar to Venus soils, but they are stratified, occur on lower terraces, and have more accumulated calcium carbonate than those soils. They are also similar to Patrick soils, but Patrick soils have a bed of gravel within 3 feet of the surface and are less deeply developed than Frio soils.

Frio soils are poorly drained to moderately well drained. Internal drainage is medium. Permeability is moderate. The capacity to hold water is good. Natural fertility is moderate. Water erosion and occasional flooding are hazards. Most of the acreage is either in pecan orchards or in native pasture. The acreages that are cultivated are planted to corn, grain sorghum, small grain, or hay crops. Truck crops are grown on a small acreage that is irrigated.

Frio clay loam (0 to 1 percent slopes) (Fr).—This soil occurs mainly on the flood plains of the Medina River and the San Antonio River and their chief tributaries, or on low terraces bordering the flood plains. It is flooded occasionally. The surface is uneven and in a few places is dissected by partly filled old stream channels, in which water stands for short periods after floods. Except for the lowest depressions, however, all of this soil is well drained. Included in the areas mapped are small tracts of Patrick soils, 0 to 1 percent slopes, and of Karnes loam, 1 to 3 percent slopes.

The surface layer is about 20 inches thick. The subsurface layer is light brownish gray in color and is about 5 inches thick. Below a depth of 25 to 30 inches, the texture ranges from sandy loam through stratified loam to clay loam. The depth to water-rounded limestone gravel ranges from 3 to 6 feet or more. This soil is limy throughout.

This is a fairly productive soil that is well suited to pecan orchards and native grass. Some of it is cultivated. Corn, small grain, grain sorghum, and hay are the main crops. Truck crops are grown in irrigated areas. Some tame pastures are irrigated with "black water" from sewage effluent. Fertilization, brush control, seeding to native grass or adapted varieties of perennial grass and setting out pecan trees are effective measures for providing a cover of vegetation adequate to protect this soil during floods. (Capability unit IIw–1, dryland; IIw–1, irrigated; Loamy Bottomland range site)

Gowen Series

The Gowen series consists of deep, dark-colored, nearly level soils that formed in alluvium. These soils occur on flood plains in the eastern and southeastern parts of the county.

The surface layer is dark-brown or very dark grayish-brown clay loam and is about 7 inches thick. It has weak, granular structure and is friable and easy to work. This layer is noncalcareous.

The subsurface layer is noncalcareous, dark grayish-brown to very dark brown light clay loam. It is more compacted and a little more sandy than the surface layer.

This layer is massive but porous, friable when moist, and about 40 inches thick.

The parent material consists of noncalcareous, friable, loamy and clayey alluvium washed from the nearby uplands.

The surface layer ranges from 6 to 10 inches in thickness and from loam through clay loam to sandy clay in texture. The finer textured soils are the darker colored. The subsurface layer is 36 to 54 inches thick. In reaction it is neutral or slightly acid. The underlying material ranges from sandy clay that is mottled in places to stratified clay loam and sandy loam.

Gowen soils are lighter colored, less limy, and less clayey than Trinity soils and are darker colored and less sandy than Zavala soils. They are less limy, less gray, and less deeply developed than Frio soils, which occur on the flood plains of the larger rivers and streams and developed from older alluvium.

Gowen soils have slow surface drainage and slow to medium internal drainage. Their permeability is moderate. The capacity to hold water is good. Natural fertility is high. Occasional overflow is a hazard. These soils are cultivated and are also used as pasture. Grain sorghum, corn, and small grain are the main crops. Adapted varieties of introduced perennial grass make excellent pasture. The native vegetation consists of whitebrush; post oak, mesquite, elm, hackberry, and pecan trees; and bristlegrass, Canada wildrye, and buffalograss.

Gowen clay loam (0 to 1 percent slopes) (Go).—This soil is on short, narrow, nearly level flood plains that border the major creeks and streams in the eastern and southeastern parts of the county. It is flooded occasionally. Surface drainage is slow, and internal drainage is slow to medium. Included in the areas mapped are a few small tracts of Trinity and Frio soils, frequently flooded, and of Zavala and Gowen soils, frequently flooded. Also included are small tracts of Crockett fine sandy loam, which has received sediments washed from the surrounding uplands and consequently has a thicker surface layer than is typical.

If not flooded too frequently, this soil is well suited to pasture and is productive of cultivated crops. If cultivated when moist, it is susceptible to compaction, which reduces water intake and lowers production. The proper use of plant residues helps to maintain tilth and fertility. (Capability unit IIw–1, dryland; IIw–1, irrigated; Bottomland range site)

Gullied Land (Gu)

This land type occurs along rivers and streams, where high terraces break to flood plains. The topography is rough. The slope generally is between 12 and 20 percent, but in many places it is more than 50 percent. Gullying and sheet erosion are severe. An intricate network of shallow and deep gullies covers 80 to 90 percent of the area. The gullies are 5 to 75 feet wide, 4 to 30 feet deep, and 3 to 50 feet apart. The soil material consists of grayish-brown or light grayish-brown, strongly calcareous loam, clay loam, or silty clay derived from alluvium. It washes off the steep, exposed slopes so rapidly that there is not time for a soil profile to develop.

A typical area of Gullied land occurs in the southwestern part of the county, where Old Pearsall Road crosses the Medina River.

This land type has little value for agriculture. The vegetation consists of mesquite trees, lotebush, agrito, pricklypear, oakbrush, three-awn, and annual weeds and grass. The cover is inadequate as protection against further erosion. (Capability unit VIIs–3, dryland; Clay Loam range site)

Hilly Gravelly Land (HgD)

This land type occurs as knolls and narrow ridges throughout the county but mainly in the southern and western parts. These ridges and knolls are probably erosion-resistant remnants of old waterways. They rise about 30 to 40 feet above the surrounding Lewisville and Houston Black soils. The slope range is 5 to 25 percent. Also mapped as Hilly gravelly land are a few areas, mostly in the southern part of the county, of steep knolls and outcrops of calcareous sandstone. The average size of these areas is about 12 acres, and 75 percent of each area consists of outcrops and boulders. Many of the knolls have a hard caliche layer and a thin mantle of sandy loam.

Hilly gravelly land consists of beds of caliche or of gravelly, very strongly calcareous, loamy alluvium 10 to 20 feet or more in thickness. The upper 3 to 12 inches of the caliche layer is generally hard and platy. There are some nearly level areas 100 feet or so wide, and on these a 4- to 8-inch mantle of limy, dark grayish-brown loam or clay loam has formed. On the slopes, which are predominant in the landscape, there is very little soil; it is estimated that only 15 percent of this land type is actually soil. In places there is a 2- to 3-foot bed of weak conglomerate consisting of sediments cemented with calcium carbonates.

A typical area of Hilly gravelly land is just off Old Pearsall Road, half a mile southwest from Loop 13, which is near Kelly Air Force Base.

This land type is used mainly as pits and quarries. It provides excellent roadbed material. Some areas are used as native pasture. The native vegetation consists of mesquite trees, thorny brush, and mid and short grasses. (Capability unit VIIs–3, dryland; Shallow Ridge range site)

Hockley Series

The Hockley series consists of sandy soils that are deep, light colored, and nearly level to moderately sloping. These soils occur on the upland prairies, in the southern third of the county.

The surface layer is pale-brown, slightly acid loamy fine sand and is about 16 inches thick. It has weak, granular structure. This layer is very friable when moist and loose when dry and is easily worked.

The subsoil is about 24 inches thick and has blocky structure. The upper part is yellowish-brown sandy clay loam and has distinct mottles of yellow, red, and yellowish brown. It is very firm when moist and very hard when dry. The lower part is yellowish-red sandy clay loam and has faint mottles of red and yellowish brown. It is firm when moist and hard when dry.

The underlying material consists of reddish-yellow sandy clay loam interbedded with weakly consolidated sandstone.

The surface layer ranges from 12 to 25 inches in thickness and from pale brown to dark brown in color. The subsoil ranges from sandy clay to sandy clay loam in texture, from 17 to 30 inches in thickness, and from brown to yellowish red in color. It has red, yellow, and yellowish-brown mottles that range from faint to prominent.

Hockley soils are associated with Crockett, San Antonio, Eufaula, Duval, and Webb soils. They are sandier, less brown, and more sloping than Crockett soils, which have a well-defined layer of lime accumulation. They are lighter colored and are less clayey throughout than San Antonio soils, which have an unmottled subsoil. They have a thinner, less sandy, darker colored surface layer than Eufaula soils. They are less red throughout the profile and have a less loamy, less permeable subsoil than Duval soils, which have an unmottled, massive subsoil. They are more sandy and less red than Webb soils, which have an unmottled, red, blocky subsoil.

Hockley soils have medium or slow surface drainage and slow or very slow internal drainage. Drainage is adequate for crops. The water-holding capacity is low in the surface layer but good in the subsoil. Natural fertility is moderately low. Wind erosion and water erosion are hazards. For the most part, these soils are cultivated. Peanuts, corn, small grain, grain sorghum, and watermelons are the main crops. Only a small acreage is irrigated, chiefly permanent pastures that are seeded to Coastal bermudagrass.

Hockley loamy fine sand, 0 to 3 percent slopes (HkB).—This soil occurs throughout the southern third of the county. The slope is as much as 6 percent in places but is dominantly about 2 percent. This soil is typical of the series and is the most extensive of the Hockley soils in the county. The areas mapped range from 10 acres to several hundred acres in size. The larger areas are irregular, circular, or oblong in shape. The smaller ones are mostly long and narrow. Included in the areas mapped are small tracts of Webb fine sandy loam, 1 to 3 percent slopes, of Crockett fine sandy loam, 1 to 3 percent slopes. In the extreme southern part of the county, low, narrow ridges of Eufaula fine sand finger into large areas of this Hockley soil.

The surface layer is about 16 inches thick. The subsoil is sandy clay loam and is about 24 inches thick. Free carbonates ordinarily have been leached to a depth of 6 to 8 feet, but in some areas there is a weakly defined accumulation at a depth of about 4 feet.

Most of this soil is cultivated. Peanuts and watermelons are the main crops, but corn, grain sorghum, small grain, sudangrass, vetch, and hay and pasture mixtures are well suited. The sandy surface layer is low in both fertility and water-holding capacity. Cultivated fields are susceptible to wind erosion. In many places the finer soil particles have been removed and the surface layer is now fine sand. Along fence rows there are accumulations of soil material 1.5 to 3 feet high. Fertilization, proper use of plant residues, and wind stripcropping are needed to help control erosion, conserve moisture, maintain fertility, and supply organic matter. (Capability unit IIIe-8, dryland; IIIs-1, irrigated; Deep Sand range site)

Hockley loamy fine sand, 3 to 5 percent slopes (HkC).—This soil occupies both long, narrow slopes along the larger field drainageways and convex slopes that separate the nearly level Hockley soils from the higher lying Eufaula soils. It occurs throughout the southern third of the county. The surface layer is thinner than that of Hockley loamy fine sand, 0 to 3 percent slopes. It is thinner on the upper three quarters of the slope than on the lowest quarter, where deposition is heaviest. The areas range from 5 to 250 acres in size. Included in the areas mapped are small tracts of Duval loamy fine sand and Crockett fine sandy loam and small, narrow ridges of Eufaula soils that finger in from higher positions.

The surface layer is about 12 inches thick. The subsoil is sandy clay loam and has many fine, distinct mottles of red and yellowish brown. It is about 28 inches thick. Its structure is blocky. Permeability is slow. Lime seldom occurs above a depth of 72 inches.

About 75 to 80 percent of the acreage is cultivated. Peanuts, watermelons, small grain, and grain sorghum are the main crops. A small acreage is in tame pasture. In some areas gullies have formed where water has collected in various spots across the slope or at the head of draws. Fertilization, wind stripcropping, and proper use of plant residues are needed to help control erosion, conserve moisture, supply organic matter, and maintain fertility. (Capability unit IVe-5, dryland; IIIe-7, irrigated; Deep Sand range site)

Hockley loamy fine sand, 3 to 5 percent slopes, eroded (HkC2).—This soil occurs within larger areas of Hockley soils, mainly as long, narrow slopes along the larger drainageways and at the head of large draws. The soil has been severely eroded by wind and water. Shallow, saucer-shaped gullies that are crossable with farm machinery and deep, U-shaped gullies not crossable with farm machinery have divided and cut through fields and made cultivation difficult. The gullies are 8 to 15 feet wide, 1 foot to 8 feet deep, and 10 to 80 feet apart. Areae of this soil average about 52 acres in size. Included in the areas mapped are patches of other Hockley loamy fins sands, of Crockett soils, 3 to 5 percent slopes, eroded, and of Webb soils, 3 to 5 percent slopes, eroded.

The thickness of the surface layer ranges from 0 to 20 inches but is typically about 12 inches. The texture ranges from loamy fine sand in uneroded areas to fine sandy loam or sandy clay loam in eroded areas. The subsoil is essentially the same as the one described as representative of the series.

This soil is best suited to grass, and a good cover of grass is needed for protection against further erosion. Fertilization, seeding to native grass or adapted varieties of introduced grass, mowing or controlled grazing, brush control, and diversion of runoff are measures that help grass to become established. (Capability unit VIe-4, dryland; Deep Sand range site)

Houston Series

The Houston series consists of upland soils that are deep, moderately dark colored, and gently sloping to strongly sloping. These soils occur in the northeastern,

eastern, south-central, and southwestern parts of the county.

The surface layer is grayish brown to light olive brown, calcareous, clayey, and about 25 inches thick. Wide cracks form when it dries. The structure is weak, very fine, blocky to the depth normally plowed, but below that depth it is moderate, fine, blocky. This layer is extremely firm but crumbly when moist.

The subsurface layer is grayish-brown or light yellowish-brown clay and is about 18 inches thick. Cracks form in this layer also, when the soil is dry. This layer has moderate, fine, blocky structure and is extremely firm but crumbly when moist. The lime content is about 6 to 8 percent, by volume.

The underlying material consists of pale-yellow to olive-yellow, calcareous clay that contains much lime, some altered shale fragments, and many gypsum crystals.

The surface layer ranges from 12 to 38 inches in thickness and from very dark grayish brown to light olive brown in color. The darker colored soils are associated with Houston Black soils. The lighter colored ones are associated with Austin soils and with the Tarrant soils that have a chalk substratum. The texture is clay. Shrinking and swelling cause churning, or self mulching, within the soil profile. Locally, the surface layer may be noncalcareous, and there may be scattered pebbles on the surface. The subsurface layer ranges from 12 to 24 inches in thickness and from dark grayish brown to light yellowish brown in color. It contains small to large amounts of lime.

Houston soils have a thinner, lighter colored surface layer and are typically more sloping than Houston Black soils. They are less limy, somewhat darker colored, less sloping, and more deeply developed than Sumter soils. They are less limy, less granular, less permeable, and more clayey than Austin soils. They are lighter colored, less granular, less permeable, and more deeply developed than the Tarrant soils that have a chalk substratum.

Houston soils have slow to rapid surface drainage; runoff is very rapid after the surface soil is saturated. Internal drainage is slow or very slow. The capacity to hold water is good. Natural fertility is moderately high. Water erosion is a hazard. For the most part, these soils are cultivated. Grain sorghum and corn are the main crops. Also grown are small grain, cotton, other dryland crops, and native grass and adapted varieties of perennial grass. A small acreage is irrigated.

Houston clay, 1 to 3 percent slopes (HnB).—This soil occurs just above the flood plains of Martinez Creek and its main tributaries. It is inextensive and is mainly in the eastern part of the county. There is little or no hazard of water erosion. Included in the areas mapped are patches of Houston Black clay, 1 to 3 percent slopes, of Trinity clay, of Trinity and Frio soils, frequently flooded, and of Austin silty clay, 1 to 3 percent slopes.

The surface layer is grayish brown and is about 15 inches thick. The subsurface layer is light olive brown, is about 16 inches thick, has medium, blocky structure, and is extremely hard when dry.

Most of the acreage is dryfarmed. Grain sorghum and corn are the main crops. Fertilization, terracing, contour tillage, and proper use of plant residues are needed to help control erosion, conserve moisture, and maintain tilth and productivity. (Capability unit IIIe-2, dryland; IIIe-2, irrigated; Rolling Blacklands range site)

Houston clay, 3 to 5 percent slopes, eroded (HnC2).—This soil is on the uplands, mainly in the northeastern and south-central parts of the county. Most areas are rounded but irregular in shape, but some are long, narrow slopes along creeks or drainageways. Runoff is more rapid than on Houston clay, 1 to 3 percent slopes. The hazard of water erosion is moderate. Included in the areas mapped are patches of Houston clay, 3 to 5 percent slopes, severely eroded, of Houston Black clay, 3 to 5 percent slopes, and of Austin silty clay, 3 to 5 percent slopes.

The surface layer is grayish brown. It is about 25 inches thick in areas where this soil is associated with Houston Black soils and somewhat thinner where this soil is associated with Austin soils. The slope is as much as 7 percent in places but is generally less than 5 percent. There are some scattered pebbles, as much as 3 inches in diameter, on the surface.

Most of this soil is cultivated. Grain sorghum and corn are the main crops. Fertilization, terracing, contour tillage, and proper use of plant residues are needed to help control erosion, conserve moisture, and maintain tilth and productivity. (Capability unit IIIe-3, dryland; Rolling Blacklands range site)

Houston clay, 3 to 5 percent slopes, severely eroded (HnC3).—This soil is inextensive. It occurs as long, narrow areas, mainly in the northeastern and eastern parts of the county. It differs from Houston clay, 3 to 5 percent slopes, eroded, in that it has shorter, more sharply breaking slopes, a thinner surface layer, and moderately severe rill and gully erosion. In the more severely eroded areas, which make up about 12 to 15 percent of the acreage, the gullies are 8 to 10 feet across, 1.5 to 6 feet deep, and 50 to 200 feet apart. The deeper gullies have cut into the parent material. Most areas are about 30 acres in size. Included in the areas mapped are small tracts of Houston clay, 5 to 8 percent slopes, of Houston Black clay, 3 to 5 percent slopes, and of Houston Black gravelly clay, 3 to 5 percent slopes.

The surface layer is 10 to 20 inches thick. It is thinnest on the upper part of the slopes. It is somewhat lighter colored than is typical because of the loss of organic matter. The subsurface layers are essentially the same as those described for the series.

Most of this soil has been cultivated but is now idle or in permanent pasture. Converting the entire acreage to pasture and applying proper amounts of fertilizer would help to control erosion, conserve moisture, and maintain tilth and fertility. (Capability unit IVe-3, dryland; Rolling Blacklands range site)

Houston-Sumter clays, 5 to 10 percent slopes, severely eroded (HoD3).—These very shallow soils occupy long, narrow areas, mainly in the eastern part of the county. There are scattered pebbles on the surface in some places. The Houston soils in this association occur as strongly sloping areas that have been damaged by water erosion. Sumter gravelly clay is very shallow and occurs as strongly sloping to steep, narrow ridges. Houston soils make up about 75 percent of the association and Sumter soils about 20 percent. Included in the areas mapped are patches of Tarrant soils, chalk substratum, undulating, of Houston

Black gravelly clay, 5 to 8 percent slopes, and of Houston clay, 3 to 5 percent slopes, severely eroded.

The surface layer of Houston soils is 8 to 15 inches thick on the upper part of slopes and 16 to 30 inches thick on the lower part of slopes and on saddles. In the more severely eroded areas the surface layer is lighter colored than is typical because it has been mixed with the parent material during tillage. In the less severely eroded areas, the surface layer is thicker and generally darker colored. Sheet, rill, and gully erosion have been severe. The gullies are V shaped, 6 to 15 feet wide, 1.5 to 5 feet deep, and 15 to 40 feet apart.

The surface layer of Sumter soils is grayish brown and about 8 inches thick. The underlying material is pale-yellow, calcareous marl or clay. Plant roots enter this layer readily. The slope is as much as 20 percent in places but is ordinarily about 15 percent.

Because of the erosion hazard, the steep slopes, and the shallowness of the soils, this association is best suited to native grass or tame pasture. Most of the acreage is in native grass. Some of it was once cultivated but is now idle or in tame pasture. (Houston soils: capability unit VIe-2, dryland; Rolling Blacklands range site. Sumter soils: capability unit VIe-2, dryland; Shallow Ridge range site)

Houston Black Series

The Houston Black series consists of clayey soils that are deep, dark gray to black, and calcareous. These soils are nearly level to strongly sloping. They are on the uplands, mainly in the northeastern, south-central, and southwestern parts of the county.

The surface layer is very dark gray to black, mildly alkaline, and about 38 inches thick. When plowed, this layer has weak, very fine, blocky structure in the uppermost 8 inches. Below that depth, it has moderate, fine and very fine, blocky structure and is extremely firm but crumbly when moist. This layer cracks when dry and swells when wet. If tilled when too wet, it puddles and seals over.

The subsurface layer is about 12 inches thick. It is gray or dark-gray clay and has some grayish-brown or olive-brown streaks. It has moderate, medium, blocky structure and is extremely firm when moist. Like the surface layer, this layer cracks when dry and swells when wet.

The underlying material is very pale brown, calcareous clay or marl and has mottles of olive brown and gray. There are some shale fragments and gypsum crystals.

The surface layer ranges from 28 to 40 inches in thickness and from dark gray to black in color. Its texture is clay or gravelly clay. Nearly all Houston Black soils have some gravel on the surface and in the plowed layer. In Houston Black gravelly clay, for example, the amount of gravel in the plowed layer exceeds 8 percent, by volume. The subsurface layer ranges from 10 to 24 inches in thickness and from dark gray to grayish brown in color. Its texture is clay or, in some few areas, gravelly clay. The amount of gravel may be as much as 60 percent, by volume. This layer is discontinuous. It occurs most commonly in the gravelly phases.

Houston Black soils are darker colored, deeper, more clayey, less permeable, less granular, and less limy than Austin soils. They are less brown and more deeply developed than Houston soils. They are darker colored, more deeply developed, and typically less sloping than Sumter soils.

Houston Black soils have slow to rapid surface drainage. Internal drainage is slow to none. Rainfall is very rapidly absorbed when the soil is dry and cracked, but practically all of it runs off after the water content of the soil has reached field capacity. Most areas lack a permanent water table. The capacity to hold water is good. Natural fertility is high. Water erosion is a hazard. For the most part, these soils are cultivated. Grain sorghum and corn are the main crops. Small grain, cotton, other dryland crops, and native grass or adapted varieties of perennial grass are grown also. A moderately large acreage, mostly in the southern and southwestern parts of the county, is irrigated.

Houston Black clay, 0 to 1 percent slopes (HsA).—This soil occurs as small areas on the crests of low ridges, along narrow benches, and at the head of drainageways. It is mainly in the northeastern, south-central, and southwestern parts of the county. It is similar to Houston Black clay, terrace, 0 to 1 percent slopes, from which it differs mainly in that it is underlain by calcareous, shaly clay or calcareous marl. Houston Black terrace soils are underlain by old alluvial sediments and some gravel. Included in the areas mapped are patches of Houston Black clay, 1 to 3 percent slopes, and of Houston Black clay, terrace, 0 to 1 percent slopes.

The surface layer is very dark gray to black and is about 36 inches thick. The subsurface layer, about 15 inches thick, is dark-gray clay and contains a few scattered lime concretions. The underlying material is light brownish-gray, calcareous marl.

This soil is productive, and most of it is cultivated. It is suited to corn, cotton, grain sorghum, small grain, flax, sudangrass, and Hubam sweetclover, and to tame pastures consisting of native grass or of introduced varieties of perennial grass. Fertilization, crop rotation, and the proper use of plant residues are needed to increase water intake, help reduce evaporation, and maintain tilth and fertility. (Capability unit IIs-1, dryland; IIs-2, irrigated; Rolling Blacklands range site)

Houston Black clay, 1 to 3 percent slopes (HsB).—This soil occurs as long, smooth, gentle slopes. It is mainly in the northeastern, south-central, and southwestern parts of the county. The areas are large and are irregular in shape. Runoff is more rapid than on Houston Black clay, terrace, 0 to 1 percent slopes. Water erosion is one of the major hazards. Included in the areas mapped are small tracts of Houston clay, 1 to 3 percent slopes, of Austin silty clay, 1 to 3 percent slopes, of Houston Black clay, terrace, 1 to 3 percent slopes, and of Trinity and Frio soils, frequently flooded.

The surface layer is about 38 inches thick. The pebbles in the plowed layer may make up as much as 8 percent of this layer, by volume. The subsurface soil, about 12 inches thick, is clay. Wide cracks form when it dries. This layer contains some lime concretions and a few fine crystals of gypsum.

This is a fairly productive soil. A large acreage is cultivated, and some small areas are irrigated. Small grain, grain sorghum, corn, cotton, flax, sudangrass, and Hubam sweetclover are suitable crops. Also suitable are hay and pasture mixtures. Water erosion is a hazard, water intake is slow, and a plowpan is likely to form. Fertilization, terracing, contour tillage, and proper use of plant residues are needed to help control erosion, conserve moisture, and maintain tilth and fertility. (Capability unit IIIe-2, dryland; IIIe-2, irrigated; Rolling Blacklands range site)

Houston Black clay, 3 to 5 percent slopes (HsC).—This soil occurs as slopes from knolls or low ridges and as side slopes along the deeper drainageways. It is mainly in the northeastern, south-central, and southwestern parts of the county. As compared with Houston Black clay, 1 to 3 percent slopes, this soil is more sloping and consequently has more rapid runoff and is moderately susceptible to water erosion. Also, it is likely to have a browner, thinner surface layer. There is scattered gravel, both on the surface and within the soil. It makes up 2 to 7 percent of this layer, by volume. Included in the areas mapped are patches of Houston clay, 3 to 5 percent slopes, of Houston Black gravelly clay, 3 to 5 percent slopes, and of Trinity and Frio soils, frequently flooded.

The surface layer is very dark gray and is about 20 inches thick. The subsurface layer is about 18 inches thick and contains a few fine concretions of calcium carbonate.

This is a fairly productive soil. It is suited to the commonly grown crops, as well as to hay and pasture mixtures. Most of the acreage is cultivated, but some of it is still in native pasture. Water intake is slow and water erosion is a hazard. A plowpan is likely to form. Fertilization, terracing, contour tillage, and proper use of plant residues help to control erosion, conserve moisture, and maintain tilth and fertility. (Capability unit IIIe-3, dryland; Rolling Blacklands range site)

Houston Black clay, terrace, 0 to 1 percent slopes (HtA).—This soil occurs as broad areas of an old outwash plain and as broad, smooth terraces that parallel the major streams. It is mainly in the south-central and southwestern parts of the county. It is similar to Houston Black clay, 0 to 1 percent slopes, but has a thicker surface layer and is underlain by more friable, less compact material. A layer of water-bearing gravel commonly occurs near the base of the alluvial deposits. Included in the areas mapped are patches of Trinity clay, or Lewisville silty clay, 0 to 1 percent slopes, of Willacy loam, 0 to 1 percent slopes, and of Trinity and Frio soils, frequently flooded.

The surface layer is dark gray, about 40 inches thick, and calcareous. It has fine, blocky structure. The subsurface layer is gray clay and is about 15 inches thick. It has moderate, fine, blocky structure and is extremely firm but crumbly when moist. The underlying material varies. It ranges from clay loam to sandy loam in texture and from reddish yellow and dark brown to light gray in color.

Most of this soil is cultivated. Grain sorghum, corn, and small grain are the main crops. Pecans, alfalfa, other deep-rooted plants, and native grass and adapted varieties of perennial grass do well on this soil. Truck crops, such as potatoes, sweet corn, cabbage, and carrots, are grown on some irrigated areas. Lack of soil moisture is the main limitation. Fertilization, crop rotation, and proper use of crop residues increase the water intake and help to maintain tilth and productivity. (Capability unit IIs-1, dryland; IIs-2, irrigated; Rolling Blacklands range site)

Houston Black clay, terrace, 1 to 3 percent slopes (HtB).—This soil occurs as long, narrow slopes, generally adjacent to the larger drainageways. It is mainly in the south-central and southwestern parts of the county. The slope generally does not exceed 2 percent. This soil is more susceptible to water erosion than Houston Black clay, terrace, 0 to 1 percent slopes, and it generally has a thinner surface layer. The average size of the areas is about 95 acres. Included in the areas mapped are patches of Lewisville silty clay, 1 to 3 percent slopes, of Willacy loam, 1 to 3 percent slopes, and of Houston Black clay, 1 to 3 percent slopes.

The surface layer is dark gray and is about 34 inches thick. The subsurface layer is gray, is about 20 inches thick, and has blocky, crumbly structure. This layer may contain a few lime concretions.

This soil can be dryfarmed or irrigated. Most of it is cultivated. Small grain, grain sorghum, corn, cotton, flax, sudangrass, and Hubam sweetclover are suitable crops. Native grass and adapted varieties of perennial grass are grown also. Water erosion is a hazard, water intake is slow, and a plowpan is likely to form. Fertilization, terracing, contour tillage, and proper use of plant residues help to control erosion, conserve moisture, and maintain tilth and fertility. (Capability unit IIIe-2, dryland; IIIe-2, irrigated; Rolling Blacklands range site)

Houston Black gravelly clay, 1 to 3 percent slopes (HuB).—This soil is on the uplands, mainly in the northeastern, central, and southwestern parts of the county. Most of it occurs as long, smooth, convex slopes, but part of it occurs as shorter undulating slopes along drainageways. As compared with Houston Black clay, 1 to 3 percent slopes, this soil has more pebbles on the surface and within the profile, a thicker and darker colored surface layer, less lime, and a somewhat stronger and more apparent structure. The areas of this soil are irregular in shape and average about 130 acres in size. Included in the areas mapped are patches of Houston Black clay, 1 to 3 percent slopes, of Houston clay, 1 to 3 percent slopes, and of Trinity and Frio soils, frequently flooded.

The surface layer is black and is about 38 inches thick. Wide cracks form when it dries. Gravel ordinarily makes up 8 to 18 percent of this layer, by volume (fig. 10), and on small, narrow ridgetops, as much as 60 percent. The subsurface layer, about 12 inches thick, is clay or gravelly clay. The gravel is discontinuous, but where it occurs, it makes up 30 to 60 percent of this layer, by volume. The pebbles range from half an inch to 3 inches in diameter.

Runoff is medium or slow. The pebbles on the surface reduce the risk of water erosion somewhat, and the hazard is none to slight. Large tracts of this soil are cultivated. Corn, grain sorghum, and small grain are the main crops. A large acreage is still in native vegetation, and small tracts are in tame pasture. Fertilization, terracing, contour tillage, and proper use of plant residues help to conserve moisture and maintain fertility and tilth. (Capability unit IIIe-2, dryland; IIIe-2, irrigated; Rolling Blacklands range site)

Figure 10.—Gravel on Houston Black gravelly clay.

Houston Black gravelly clay, 3 to 5 percent slopes (HuC).—This soil occupies narrow, convex ridges and valley walls in an undulating or gently rolling landscape. It occurs mainly in the eastern and western parts of the county. It is more susceptible to water erosion than Houston Black gravelly clay, 1 to 3 percent slopes, and it has a thinner surface layer and a greater volume of pebbles on the surface and within the profile. Included in the areas mapped are small tracts of Houston Black gravelly clay, 1 to 3 percent slopes, of Houston clay, 3 to 5 percent slopes, of Trinity and Frio soils, frequently flooded, and of Houston clay, 3 to 5 percent slopes, severely eroded.

The surface layer is black and is about 36 inches thick. Typically, it is 10 to 18 percent gravel, by volume. On a few narrow ridgetops, less than 5 percent of the acreage, it is as much as 60 percent gravel. The subsurface layer is about 12 inches thick and is similar to that of Houston Black gravelly clay, 1 to 3 percent slopes.

This is a fairly productive soil. It is suited to most of the crops commonly grown in the area. Most of the acreage is cultivated, but part of it is still in pasture. Water intake is slow, and water erosion is a hazard. A plowpan is likely to form. Fertilization, terracing, contour tillage, and proper use of plant residues are needed to help control erosion, conserve moisture, and maintain tilth and fertility. (Capability unit IIIe-3, dryland; Rolling Blacklands range site)

Houston Black gravelly clay, 5 to 8 percent slopes (HuD).—This soil is inextensive. It occurs as convex slopes that parallel the higher narrow ridges or as concave slopes or basins at the head of major drainageways. It is mainly in the southwestern part of the county. This soil differs from Houston Black gravelly clay, 3 to 5 percent slopes, in that it is more sloping, has more rapid runoff, and is more susceptible to erosion. Also, its surface layer is thinner and more gravelly, particularly near the narrow ridgetops. The average size of the areas is about 26 acres. Included in the areas mapped are small tracts of Houston clay, 3 to 5 percent slopes, severely eroded, of Houston clay, 3 to 5 percent slopes, and of Houston Black gravelly clay, 3 to 5 percent slopes.

The surface layer is black and is about 34 inches thick. Wide cracks form in this layer when it dries. Gravel makes up 10 to 20 percent of this layer, by volume. The subsurface layer is clay or gravelly clay and is about 10 inches thick. Wide cracks form in this layer also, when the soil is dry.

This is a fairly productive soil. Small grain, grain sorghum, sudangrass, and Hubam sweetclover are suitable crops. Hay and pasture mixtures suited to the area are also grown. Water erosion and lack of soil moisture are the main limitations. Fertilization, terracing, contour tillage, and proper use of plant residues help to control erosion, conserve moisture, and maintain tilth and fertility. (Capability unit IVe-3, dryland; Rolling Blacklands range site)

Karnes Series

The Karnes series consists of calcareous, light-colored soils that have only moderate horizon development. These soils occur on flood plains and high terraces along the rivers and streams of the county.

The surface layer is light brownish-gray or grayish-brown, calcareous loam and is about 20 inches thick. It has weak, granular structure in the plow layer and moderate, medium, granular structure below the plow layer. This layer is friable and is easily worked.

The subsurface layer also is calcareous loam but is a little more clayey than the surface layer. It is brown, is about 18 inches thick, and has moderate, medium, granular structure.

The underlying material consists of sandy alluvium that is light yellowish brown in color, structureless, friable, strongly calcareous, and easily penetrated by roots. A profile of Karnes loam is shown in figure 11.

The surface layer ranges from 8 to 24 inches in thickness. It is predominantly loam in texture but ranges through silt loam to clay loam. In color it ranges from dark grayish brown to light brownish gray. The subsurface layer ranges from 10 to 25 inches in thickness, from light brownish gray to brown in color, and from light loam to light clay loam in texture. Gravel beds occur near the base of the alluvium, or at a depth of 4 to 10 feet. The pebbles are water rounded, are coated with lime carbonates, and range from a quarter of an inch to 2½ inches in diameter.

Karnes soils are more friable, lighter colored, and more calcareous than the nearby Frio soils. They are lighter colored and less clayey than Houston Black terrace soils. They are less brown, less clayey, and less deeply developed than Lewisville soils, and they have a less distinct horizon of lime accumulation. These soils have a lighter colored surface layer and are more limy than Venus soils. They are more deeply developed and lighter colored than Patrick soils, which have a bed of gravel within 3 feet of the surface.

Karnes soils are naturally well drained. Internal drainage is medium, permeability is moderate, and the water-holding capacity is moderate. Natural fertility is moderate. The high lime content of the soils tends to

Figure 11.—**Profile of Karnes loam to a depth of about 3 feet.**

tie up some plant nutrients, and consequently crops are likely to develop chlorosis, or yellowing of the leaves. The hazard of water erosion is slight to moderate. For the most part, these soils are cultivated. They are suited to corn, grain sorghum, and other dryland crops, and to adapted varieties of perennial grass for pasture. They are particularly well suited to cool-season crops, such as small grain. A small acreage is irrigated, and many kinds of truck crops are grown.

Karnes loam, 1 to 3 percent slopes (KaB).—This soil occurs as gentle, convex slopes. The slope is as much as 4 percent in places but is dominantly about 2 percent. Included in the areas mapped are patches of Lewisville silty clay, 1 to 3 percent slopes, of Frio clay loam, of Venus clay loam, 1 to 3 percent slopes, and of Patrick soils, 1 to 3 percent slopes.

The surface layer is light brownish gray and is about 20 inches thick. The subsurface layer is brown loam and is about 18 inches thick. It is friable and crumbly when moist. This layer contains a large amount of lime.

Most of this soil is cultivated. Corn, grain sorghum, small grain, other dryland crops, and hay and pasture mixtures are suitable. A small acreage is irrigated, and truck crops are grown. This soil is easily tilled and can be worked into a good seedbed. If not protected, it is susceptible to water erosion. Also, a thin crust, lighter colored than the surface layer, tends to form on the surface. Crops grown on the more limy areas are likely to develop chlorosis, or yellowing of the leaves. Fertilization, terracing, contour tillage, and use of plant residues help to control erosion, conserve moisture, prevent surface crusting, and maintain tilth and productivity. (Capability unit IIe-3, dryland; IIe-3, irrigated; Clay Loam range site)

Karnes loam, 3 to 5 percent slopes (KaC).—This soil occurs as convex slopes adjacent to Gullied land and to escarpments along rivers and streams. The slope is as much as 8 percent in places but is dominantly about 4.5 percent. Runoff from the higher lying soils has caused several deep gullies to form in unprotected cultivated areas. Included in the areas mapped are patches of Patrick soils, 3 to 5 percent slopes, of Lewisville silty clay, 3 to 5 percent slopes, and of Venus clay loam, 3 to 5 percent slopes.

The surface layer is about 15 inches thick. In spots the texture is fine sandy loam. The subsurface layer is about 20 inches thick. It is very pale brown loam, very friable when moist, and limy. Lime concretions make up about 15 percent of this layer, by volume.

A large part of the acreage is idle or is in native vegetation. The soil is best suited to cool-season crops, such as small grain, sudangrass, or native grass, and to adapted varieties of introduced grass. Fertilization, terracing, contour tillage, and proper use of plant residues help to control erosion, conserve moisture, and maintain tilth and fertility. (Capability unit IIIe-5, dryland; IIIe-5, irrigated; Clay Loam range site)

Karnes clay loam, 3 to 5 percent slopes, eroded (KcC2).—This soil occurs as short, convex slopes between terraces, and as either convex or concave slopes along deeply entrenched drainageways or streams. A few gullies have formed. They are widely spaced, about 15 to 20 feet wide, and 4 to 8 feet deep. Erosion has completely removed the surface layer for a distance of about 50 feet on each side of the gullies but otherwise has not affected areas between the gullies. This soil is more sloping than the soil described as representative of the series and has a lighter colored surface layer. The surface layer is as much as 20 inches thick in places but is generally about 15 inches. The areas average about 20 acres in size. Included in the areas mapped are patches of Frio clay loam, of Karnes loam, 3 to 5 percent slopes, and of Patrick soils, 3 to 5 percent slopes.

For the most part, this soil is either cultivated or used as pasture. It is not productive, because of the effects of erosion. Control measures would include terracing, contour tillage, fertilization, proper use of plant residues, and planting to tame pasture. (Capability unit IIIe-6, dryland; IIIe-5, irrigated; Clay Loam range site)

Krum Series

The Krum series consists of clayey soils that are moderately deep, dark colored, and gently sloping to sloping. These soils developed from slope alluvium of the limestone prairies. They occur in the northern and northwestern parts of the county.

The surface layer is dark grayish brown or very dark grayish brown, calcareous, and about 30 inches thick. It has weak to moderate, fine, granular structure to the depth normally plowed. Below that depth, the structure is strong, fine, granular. This layer is friable when moist and is easily worked.

The subsurface layer is brown or yellowish-brown, calcareous clay about 14 inches thick. It has strong, medium, granular structure.

The underlying material is white to yellowish-brown, strongly calcareous silty clay. It contains scattered, subrounded fragments of limestone and soft concretions of lime carbonate.

The surface layer ranges from very dark brown to brown in color, from 18 to 36 inches in thickness, and from clay to clay loam in texture. In places there are a few, scattered, large limestone rocks on the surface. The subsurface layer ranges from 10 to 20 inches in thickness and from brown to light yellowish brown in color. The texture is clay or clay loam. Depth to the subrounded fragments ranges from 3 to 7 feet or more.

Krum soils are lighter colored and deeper than Tarrant soils. They are more deeply developed, darker colored, and less limy than Brackett soils. They resemble Lewisville soils but are typically more sloping than those soils and are in different topographic positions. These soils are more deeply developed than Patrick soils, which have beds of gravel within 3 feet of the surface. They are more deeply developed and have stronger structure than Trinity and Frio soils, frequently flooded, which are stratified.

Krum soils are naturally well drained. Internal drainage is medium, permeability is moderate, and the capability to hold water is good. Natural fertility is high. Because of the topography, water erosion is a hazard. For the most part, these soils are inaccessible and far removed from farming operations. Consequently, a large part of the acreage is in native vegetation. Only about 30 percent of the total acreage is cultivated. Small grain is the main crop. Some grain sorghum, corn, and hay and pasture mixtures are grown also.

Krum complex (2 to 5 percent slopes) (Kr).—This complex consists of all the soils in the long, narrow valleys in the limestone areas of the northern and northwestern parts of the county. These soils occupy foot slopes below Tarrant and Brackett soils. Included are patches of Brackett and Tarrant soils and other soils, all of which make up 15 to 30 percent of the acreage. Trinity and Frio soils, frequently flooded, occur on the narrow flood plains and in the watercourses in the valleys or draws. These Trinity and Frio soils vary in depth, in content of fragments, and in the amount of stratification; they range from silty clay loam to gravelly clay in texture; and they have slopes of as much as 2.5 percent. Also, an unclassified shallow soil similar to Patrick soils is included in some of the areas mapped. It is brown to grayish-brown, calcareous clay loam, is 15 to 20 inches thick, and overlies limestone fragments. This soil generally occupies a higher position on the slope than Krum soils; it is adjacent to the very shallow Tarrant and Brackett soils.

These soils receive runoff and additional sediments from higher lying soils. If unprotected, they are highly susceptible to water erosion. Some gullies and rills have formed where water has been concentrated on unprotected fields. These can be partially obliterated by installing diversion terraces and by utilizing other conservation measures. (Capability unit IIIe–10, dryland; Valley range site)

Leming Series

The Leming series consists of deep, light-colored, nearly level to gently sloping loamy fine sands. These soils occur in the southern third of the county.

The surface layer is light brownish gray, slightly acid, and about 22 inches thick. This layer is structureless and is very friable when moist. It is easily worked.

The subsoil is about 20 inches thick. The upper part is grayish brown and has distinct yellowish-brown and gray mottles. It has blocky structure and is very firm when moist and extremely hard when dry. The lower part is light brownish gray and has a few distinct yellowish-brown, strong-brown, and gray mottles. It has blocky structure and is very firm and dense when moist.

The underlying material is light-gray sandy clay loam. Limy concretions ordinarily make up about 5 percent of the upper part of this material, by volume.

The surface layer ranges from 13 to 30 inches in thickness and from grayish brown to light brownish gray in color. The subsoil ranges from dense sandy clay loam to very firm sandy clay or light clay in texture and from grayish brown to light brownish gray or light gray in color. It has mottles of yellowish brown, strong brown, or pale olive. The underlying material is light colored. In places limy concretions make up as much as 10 percent of this material, by volume.

Leming soils are associated with Eufaula, Hockley, Crockett, and Orelia soils. They are less sandy than Eufaula soils, which consist of fine sand to a depth of more than 30 inches. They are more clayey and less permeable than Hockley soils, which have a weak, blocky or subangular blocky subsoil. They are lighter colored throughout than Crockett soils, which lack a light-colored subsurface layer. They are less gray and less loamy in the surface layer than Orelia soils, and are more mottled in the subsoil.

Leming soils have very little runoff, for water rapidly enters the sandy surface layer. Internal drainage is slow to very slow in the subsoil. The capacity to store water is low in the surface layer, but some water available to crops is stored in the subsoil. Natural fertility is moderately low. Wind erosion is a hazard. For the most part, these soils are cultivated. Peanuts, corn, small grain, grain sorghum, and watermelons are grown. Only a small acreage is irrigated, chiefly to grow Coastal bermudagrass for permanent pasture.

Leming loamy fine sand, 0 to 3 percent slopes (LfB).—This soil occurs as scattered, narrow, nearly level to gently sloping, low terraces along large drainageways and small streams. It is mainly in the southwestern part of the county. The areas range from 12 to 200 acres in size. Included in the areas mapped are small tracts of Crockett fine sandy loam, 0 to 1 percent slopes, of Hockley loamy fine sand, 1 to 3 percent slopes, of Eufaula fine sand, 0 to 5 percent slopes, and of Zavala and Gowen soils, frequently flooded.

Most of this soil is cultivated. Peanuts, watermelons, and grain sorghum are the main crops. Wind erosion can be a problem if fields are left unprotected. In a few areas the finer particles have been removed and the surface layer is now almost a fine sand. In some areas the soil accumulations along fence rows are 18 to 24 inches high. Wind stripcropping, proper use of plant residues, and fertilization are needed to help control erosion and maintain tilth and productivity. (Capability unit IIIe–8, dryland; IIIs–1, irrigated; Deep Sand range site)

Lewisville Series

The Lewisville series consists of moderately deep, dark-colored, nearly level alluvial soils. These soils occur mainly on terraces bordering the San Antonio and Medina Rivers and their main tributaries.

The surface layer is very dark grayish-brown to brown silty clay and is about 24 inches thick. It has fine subangular blocky or blocky structure, is firm and crumbly when moist, and is easily worked. This layer contains a few fine concretions of lime carbonate.

The subsurface layer is brown silty clay and is about 20 inches thick. It has fine, subangular blocky or blocky structure and is very firm but crumbly when moist. This layer is limy.

The underlying material is reddish-yellow silty clay. It has weak, blocky structure, is very firm when moist, and contains large amounts of lime. Beneath this layer, there may be deep beds of water-rounded limestone gravel.

The surface layer ranges from light clay to silty clay loam in texture; the clay content is 32 to 55 percent. This layer ranges from 14 to 28 inches in thickness and from reddish brown to pale brown in color. Depth to the underlying material ranges from 36 to 60 inches. This material ranges from silty clay to gravelly loam in texture and contains small to large amounts of lime. Beds of gravel may occur near the base of the alluvium.

Lewisville soils are deeper than Patrick soils, which have deep beds of gravel within 3 feet of the surface. They are browner, less clayey, and more friable than Houston Black soils. They are deeper and less clayey than Austin soils. They are less gray, less loamy, and less calcareous than Venus soils.

Lewisville soils have slow or medium surface drainage and medium internal drainage. Permeability is slow to moderate. The capacity to hold water is good. Natural fertility is high. The hazard of water erosion is serious on the more sloping parts but is very slight on the nearly level areas. These soils occupy large, smooth areas that are easily tilled. Most of the acreage is cultivated. Small grain, grain sorghum, corn, flax, and cotton are the main crops. Potatoes, cabbage, sweet corn, carrots, and a variety of other truck crops are grown on some acreages that are irrigated. Tame pastures of native grass or adapted varieties of perennial grass can be grown on these soils also.

Lewisville silty clay, 0 to 1 percent slopes (LvA).—This soil occurs as nearly level, broad terraces along rivers and creeks. It is in the northern, central, and western parts of the county. Included in the areas mapped are patches of Venus clay loam, 0 to 1 percent slopes, of Houston Black clay, terrace, 0 to 1 percent slopes, and of Patrick soils, 0 to 1 percent slopes.

The surface layer is either silty clay or light clay and is about 24 inches thick. The subsurface layer is brown silty clay that is very firm but crumbly when moist. It is 20 inches thick. This layer has a few worm casts and a few hard and soft lime concretions.

This is one of the most productive soils in the county. It is easily tilled, and except in areas not easily reached, most of it is cultivated. A large acreage is irrigated. There is no hazard of water erosion. Cotton, corn, grain sorghum, small grain, sudangrass, flax, and hay and pasture mixtures are suitable crops. Truck crops can be grown under irrigation. Lack of soil moisture is a limitation. Fertilization, crop rotation, and proper use of plant residues help to conserve moisture and maintain fertility. (Capability unit IIc–2, dryland; I–2, irrigated; Clay Loam range site)

Lewisville silty clay, 1 to 3 percent slopes (LvB).—This soil occurs in all areas where Lewisville soils are mapped in Bexar County. It generally occupies long, narrow, sloping areas that separate nearly level terraces from soils on the uplands. Part of it occupies slopes along the major drainageways. Each area is about 55 acres in size. Included in the areas mapped are patches of Patrick soils, 1 to 3 percent slopes, of Karnes loam, 1 to 3 percent slopes, and of Lewisville silty clay, 0 to 1 percent slopes.

The surface layer is dark grayish brown and is about 20 inches thick. The subsoil is limy, brown clay. It is firm but crumbly when moist and about 17 inches thick.

This is a productive soil that is easily tilled and can be worked into a good seedbed. If unprotected, however, it is susceptible to water erosion. Most of it is cultivated, and some small acreages are irrigated. The acreage in tame pasture has been increasing steadily. Terracing, contour tillage, fertilization, and proper use of plant residues help to control erosion, conserve moisture, and maintain tilth and fertility. (Capability unit IIe–3, dryland; IIe–3, irrigated; Clay Loam range site)

Lewisville silty clay, 3 to 5 percent slopes (LvC).—This soil is not extensive. It occurs in the same areas as other Lewisville soils, generally as long, narrow slopes along creeks and along the more deeply entrenched major field drainageways, but also as short, steeper slopes between terrace benches. The areas range from 8 to 80 acres in size. Included in the areas mapped are patches of Lewisville silty clay, 1 to 3 percent slopes, of Venus clay loam, 3 to 5 percent slopes, and of Karnes clay loam, 3 to 5 percent slopes, eroded.

The surface layer is light grayish brown and is about 15 inches thick. The subsurface layer, about 14 inches thick, is silty clay. The soil becomes more loamy with increasing depth.

Like all Lewisville soils, this soil is easily tilled and can be worked into a good seedbed. Except for areas not easily reached, most of it is cultivated. A few gullies, 14 to 20 inches wide and 30 to 40 inches deep, have formed where water has concentrated on unprotected fields. The surface layer in these areas is thinner, and some rills have formed. Terracing, contour tillage, and other conservation measures are needed to help control erosion. (Capability unit IIIe–5, dryland; IIIe–5, irrigated; Clay Loam range site)

Orelia Series

The Orelia series consists of deep, dark-colored, nearly level to gently sloping soils on the uplands. These soils occur in the eastern, southeastern, and southwestern parts of the county.

The surface layer is dark-gray, noncalcareous clay loam or sandy clay loam and is about 12 inches thick. This layer has moderate, fine, blocky structure and is firm when moist.

The subsoil, about 26 inches thick, is dark-gray, weakly calcareous sandy clay. It has dense, blocky structure, is very firm when moist, and is very slowly permeable.

The underlying material is gray, calcareous clay and has a few, faint, brownish-yellow mottles. It is massive and very firm when moist. There are some concretions of lime and crystals of gypsum.

The surface layer ranges from 7 to 17 inches in thickness, and from very dark gray to gray in color. It is sandy clay loam or clay loam in texture and has weak, granular to blocky structure. A crust is likely to form on the surface. The subsoil ranges from 28 to 48 inches in thickness, from sandy clay to light clay in texture, and from dark gray to gray in color. This layer has fine to coarse, blocky structure.

Orelia soils are darker colored and more clayey in the surface layer and more compacted in the subsoil than Crockett soils. They are less sloping and ordinarily are darker colored and less clayey than San Antonio soils. They are less clayey, less limy, less deeply developed, and more slowly permeable than Houston Black terrace soils.

Orelia soils have slow surface drainage and slow internal drainage. Permeability is very slow. The capacity to hold water is moderate. Natural fertility is moderately high. The hazard of water erosion is slight to moderately severe. Most of the acreage is cultivated, but there are still some areas in brushy vegetation. Corn, grain sorghum, small grain, and cotton are the main crops. Hay and pasture mixtures consisting of native grass or of adapted varieties of perennial grass are well suited. Small scattered acreages in the southwestern part of the county are irrigated.

Orelia clay loam, 0 to 1 percent slopes (OrA).—This soil occurs as small, scattered areas in the eastern, southeastern, and southwestern parts of the county. It occupies old alluvial flats and is topographically the highest soil in the vicinity. It has weakly convex slopes that are ordinarily less than 1 percent but in places are as much as 1.5 percent. Included in the areas mapped, and making up about 10 percent of the acreage, are small tracts of Crockett fine sandy loam, 0 to 1 percent slopes, and of San Antonio clay loam, 1 to 3 percent slopes. Also included are some small playas.

The surface layer is about 12 inches thick. The subsoil, about 26 inches thick, has medium to coarse, blocky structure and is very slowly permeable.

This soil is crusty. Moisture conditions need to be favorable for tillage if a good seedbed is to be prepared. If tilled when too wet, the soil puddles and becomes extremely hard and massive. It is not susceptible to water erosion. Fertilization, crop rotation, and proper use of plant residues help to conserve soil moisture and maintain tilth and productivity. (Capability unit IIIs–1, dryland; IIIs–3, irrigated; Hardland range site)

Orelia clay loam, 1 to 3 percent slopes (OrB).—This soil occurs in the eastern, southeastern, and southwestern parts of the county. It is inextensive but is the more extensive of the two Orelia soils mapped in the county. It occupies large, broad, gently sloping areas. The slope is weakly convex and is dominantly about 1.5 percent. The areas range from 8 to 120 acres in size. Included in the areas mapped are patches of San Antonio clay loam, 1 to 3 percent slopes, of Crockett fine sandy loam, 1 to 3 percent slopes, and of Orelia clay loam, 0 to 1 percent slopes.

The surface layer is about 8 inches thick. The subsoil, about 32 inches thick, has medium, blocky structure, is weakly calcareous in the lower part, and is very slowly permeable.

Most of the acreage is cultivated. Corn, grain sorghum, and small grain are the main crops. This soil has more rapid runoff than Orelia clay loam, 0 to 1 percent slopes, and a crust is likely to form on the surface. Consequently, water erosion is a moderate hazard. Terracing and other conservation measures are needed. (Capability unit IVe–1, dryland; IVs–1, irrigated; Hardland range site)

Patrick Series

The Patrick series consists of shallow, dark-colored, nearly level and gently sloping soils. These soils occur as terraces along streams that drain the limestone prairies of the county.

The surface layer is very dark grayish-brown to dark-brown, calcareous clay loam about 12 inches thick. It has strong, granular structure. This layer is friable and easily worked when moist.

The subsurface layer is brown, calcareous, granular clay loam. It is about 5 inches thick. This layer also is friable when moist.

The substratum consists of waterworn, lime-coated limestone gravel. A profile of Patrick clay loam is shown in figure 12.

The surface layer ranges from 10 to 16 inches in thickness and from dark grayish brown to dark brown in color. This layer ordinarily ranges from loam to gravelly clay loam in texture, but in places it is silty clay

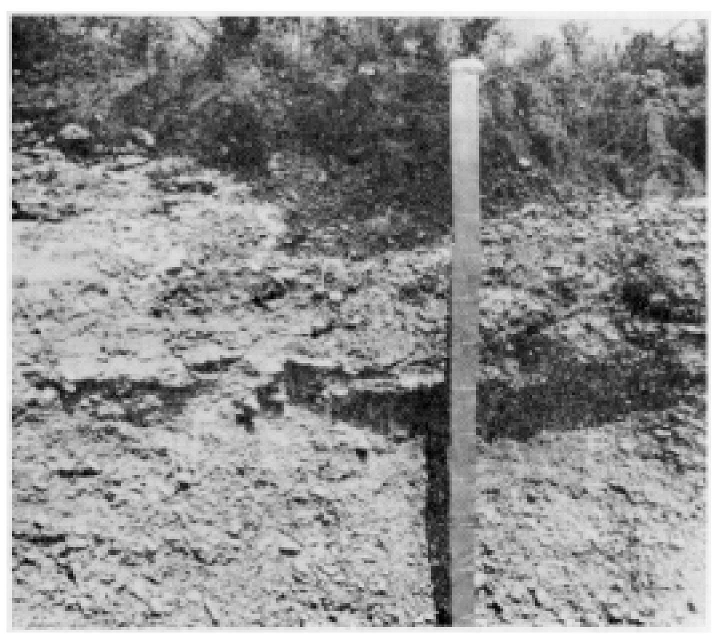

Figure 12.—**Profile of Patrick clay loam.**

or light clay. The subsurface layer ranges from 5 to 14 inches in thickness, from dark brown to brown in color, and from clay loam to loam in texture. The depth to the substratum ranges from 10 to 30 inches. The gravel is weakly to strongly cemented in the uppermost 6 to 8 inches of this layer, and below that there are alternate beds of porous gravel and of sandy sediments. In some places the gravel underlies a 2- to 3-foot layer of caliche, and in others it is interbedded with caliche.

Patrick soils are less deeply developed than Lewisville and Karnes soils. They are less clayey, less deeply developed, lighter colored, and more permeable than Houston Black terrace soils. They are more clayey, less friable, less limy, and less deeply developed than Venus and Frio soils. They are less clayey and less deeply developed than Krum soils, which occupy a higher topographic position.

Patrick soils have slow to rapid surface drainage and medium internal drainage. Because of shallowness, they have limited capacity to hold water. Permeability is moderate. Natural fertility is moderately high. In the more sloping parts, these soils are susceptible to water erosion. Most of the acreage is cultivated. Grain sorghum, small grain, native grass, and adapted varieties of introduced grass are the most suitable crops. Yields are low, as compared with yields obtained on deeper soils. Unless irrigated, these soils are poorly suited to cotton and to other deep-rooted plants. Even if irrigated, they are only moderately productive.

Patrick soils, 0 to 1 percent slopes (PaA).—These soils occur as small, scattered acreages, generally within larger acreages of Lewisville, Venus, and Karnes soils. The areas range from 15 to 50 acres in size. Included in the areas mapped are small tracts of nearly level Lewisville, Venus, and Frio soils.

The surface layer is about 14 inches thick. Its texture is clay loam, gravelly clay loam, loam, silty clay, or light clay. The subsurface layer, about 7 inches thick, is clay loam or light clay. This layer is granular, firm to friable when moist, and strongly calcareous. The underlying material is a deep bed of gravel, weakly or strongly cemented in the uppermost 10 inches. In places this material underlies a layer of white caliche, 2 to 3 feet thick.

Nearly all of the acreage is cultivated, and moderate yields of small grain and other dryland crops are obtained. A small acreage is irrigated. In some areas tillage has mixed the underlying gravel with material in the surface layer. Runoff is slow, and water erosion is not a problem. Fertilization, crop rotation, and proper use of plant residues help to conserve moisture and maintain tilth and productivity. (Capability unit IIIs–2, dryland; IIs–2, irrigated; Shallow range site)

Patrick soils, 1 to 3 percent slopes (PaB).—These soils make up the most extensive acreage of Patrick soils mapped in the county. They are in the northern part and occur as nearly level to gently sloping terraces along streams that drain the limestone prairies. The terraces are 3 to 30 feet above the present streambeds. Areas of these soils are mostly long and narrow, or from 200 to 1,500 feet in width. Included in the areas mapped are small tracts of nearly level to gently sloping Lewisville, Venus, and Karnes soils.

The surface layer is clay loam, gravelly clay loam, silty clay, or light clay and is about 12 inches thick. The subsurface layer, about 5 inches thick, is brown clay loam, loam, or light clay. This layer has granular structure. It is moderately permeable, firm to friable when moist, and calcareous.

These soils are easily tilled and can be worked into a good seedbed, but they are droughty. They are only fairly productive of most dryland crops. Unless protected, they are susceptible to water erosion. Fertilization, terracing, contour tillage, and proper use of plant residues help to control erosion, conserve moisture, and maintain tilth and productivity. (Capability unit IIIe–7, dryland; IIIe–6, irrigated; Shallow range site)

Patrick soils, 3 to 5 percent slopes (PaC).—These soils occupy escarpments between first- and second-level terraces, above the flood plains of streams that drain the limestone prairies in the northern part of the county. The slopes are moderate and convex. These soils have a slightly thinner and lighter colored surface layer than the soil described as representative of the series. They are more sloping than other Patrick soils mapped in the county and consequently are more susceptible to erosion. The areas are scattered and small, from 9 to 100 acres in size, and ordinarily are long and narrow. Some areas are only 150 feet wide. Included in the areas mapped are small tracts of sloping Lewisville, Karnes, and Venus soils.

The surface layer is clay loam, gravelly clay loam, or loam and is about 10 inches thick. The subsurface layer is clay loam or loam. It has granular structure. This layer is moderately permeable, friable when moist, and strongly calcareous.

Most of the acreage is still in native vegetation or permanent pasture. Part of it is cultivated. Small grain and grain sorghum are the main crops. Yields are low. (Capability unit IVe–7, dryland; Shallow range site)

Pits and Quarries (Pt)

This land type consists of gravel pits, clay pits, and sand pits, limestone quarries, chalk quarries, and rock quarries, and city dumps (sanitary land fills). Areas of this land type occur throughout the county and range from 3 acres to as much as 100 acres in size. Most of the acreage is not suitable for agriculture. Some of the abandoned areas could be reclaimed, seeded to grass or other suitable vegetation, and used for limited grazing or for wildlife. Some pits or quarries could be converted to ponds and then stocked with fish and used as recreational sites.

San Antonio Series

The San Antonio series consists of deep, moderately dark colored, nearly level and undulating soils on the uplands. hese soils occur in the eastern and southern parts of the county.

The surface layer is dark-brown, noncalcareous clay loam and is about 8 inches thick. It has weak, subangular blocky structure. This layer can be easily worked if moisture conditions are favorable. If it is tilled excessively, however, a crust tends to form on the surface.

The subsoil is noncalcareous, brown or dark reddish brown, about 20 inches thick, and more clayey in the upper part than in the lower part. The upper part is clay and has moderate, medium, blocky structure. The lower part is reddish-brown or brown light clay or heavy sandy clay and has weak, blocky structure.

The underlying material is light yellowish-brown or pale-brown clay loam interbedded with sandstone. It contains large lumps of limy material and weathered fragments of sandstone.

The surface layer ranges from 6 to 15 inches in thickness. It ranges from loam to clay loam in texture; the clay content is 18 to 32 percent. The subsoil ranges from heavy clay loam to clay, and the clay content is 35 to 50 percent. This layer ranges from brown to reddish brown in color and from 17 to 30 inches in thickness. The layer of calcium carbonate accumulation is at a depth of 26 to 45 inches. There are a few sandstone boulders within the profile.

San Antonio soils are more clayey in the surface layer than Crockett soils, and they have an unmottled subsoil. They are redder than Orelia soils. They are more clayey in the surface layer and denser and somewhat more clayey in the subsoil than Webb soils. They are darker colored and less sandy than Hockley soils, which have a mottled, more permeable subsoil.

San Antonio soils have slow surface drainage and very slow internal drainage. Permeability is very slow. The capacity to hold water is good. Natural fertility is moderately high. Water erosion is a hazard. About 35 percent of the acreage is still in native vegetation or permanent pasture. The rest is cultivated. Small grain, grain sorghum, corn, cotton, flax, and hay and pasture mixtures are suitable crops. A small acreage is irrigated.

San Antonio clay loam, 1 to 3 percent slopes (SaB).—This soil occurs as broad, gently undulating slopes and is ordinarily at the highest elevation in the immediate vicinity. It is in the eastern and southern parts of the county and makes up about three-fourths of the acreage of San Antonio soils. For the most part, this soil is surrounded by Webb and Crockett soils. The areas range from 15 to 200 acres in size. Included in the areas mapped are small tracts of Webb fine sandy loam, 1 to 3 percent slopes, of Crockett fine sandy loam, 1 to 3 percent slopes, and of Orelia clay loam, 1 to 3 percent slopes.

The surface layer is dark brown or dark grayish brown and is 10 inches thick. The lower part of this layer is browner and more clayey than the upper part but is clay loam in texture. The subsoil, about 28 inches thick, is dense, blocky clay and is very slowly permeable.

This soil is moderately productive of the crops commonly grown in the area, and most of the acreage is cultivated. If unprotected, cultivated fields are susceptible to water erosion. Along some shallow drains where the slope is stronger, the surface layer has been thinned by sheet and rill erosion. Terracing, contour farming, fertilization, and proper use of plant residues help to control erosion, conserve moisture, and maintain tilth and productivity. (Capability unit IIIe-1, dryland; IIIe-1, irrigated; Hardland range site)

San Antonio clay loam, 3 to 5 percent slopes (SaC).—For the most part, this soil occurs along small drainage channels and at the head of drainageways. In a few places it is on the crests of ridges. It is mainly within larger areas of San Antonio clay loam, 1 to 3 percent slopes, but differs from that soil in having a thinner and somewhat lighter colored surface layer, stronger slopes, and a more serious hazard of erosion. The areas are ordinarily long and narrow. They range from 10 to 185 acres in size. The slopes are short and fairly smooth. Included in the areas mapped are small tracts of Webb fine sandy loam, 3 to 5 percent slopes, of Crockett soils, 2 to 5 percent slopes, eroded, and of other San Antonio soils.

The surface layer is about 6 inches thick. The subsoil is essentially the same as that described as representative of the series.

Erosion is a hazard unless this soil is protected during heavy rains. Terraces, contour tillage, and other conservation measures help to reduce or control erosion. (Capability unit IVe-2, dryland; Hardland range site)

San Antonio clay loam, 3 to 5 percent slopes, eroded (SaC2).—This soil occurs as slopes at the head of draws and along the main drainage channels. It is within larger areas of uneroded San Antonio soils. The surface layer is lighter colored and 2 to 4 inches thinner than that of the soil described as representative of the series. Runoff from unprotected fields has caused sheet and gully erosion. The gullies are 3 to 4 feet wide, 1.5 to 3 feet deep, and 150 to 200 feet apart. Except for shallow rills in places, the areas between gullies have been little affected by erosion. Included in the areas mapped are small tracts of Webb soils, 3 to 5 percent slopes, eroded, of Crockett soils, 2 to 5 percent slopes, eroded, and of other San Antonio soils.

The surface layer ranges from 0 to 8 inches in thickness and from sandy clay loam to sandy clay in texture. The subsoil, about 20 inches thick, is light clay. It has blocky structure, is weakly calcareous, and is very slowly permeable. Most of this soil is in permanent pasture or is idle. Only a small acreage is cultivated. The soil is well suited to native grass and to adapted varieties of perennial grass. An adequate cover of vegetation, the most important management need, increases the water intake and helps to control erosion and maintain fertility. An adequate cover can be established by such practices as brush control, fertilization, seeding to native grass or to adapted varieties of introduced grass, and mowing or controlled grazing. (Capability unit VIe-1, dryland; Hardland range site)

Stephen Series

The Stephen series consists of clayey soils that are moderately dark colored, shallow, crumbly, and calcareous. These soils developed over chalk. They are gently sloping to undulating and occur on the uplands in the northeastern, central, and northwestern parts of the county.

The surface layer is very dark grayish brown and is about 18 inches thick. It has moderate, fine, granular structure and is friable when moist and slightly sticky when wet. This layer is calcareous.

The subsurface layer is about 6 inches thick. It consists of platy fragments of hardened chalk, several inches in diameter and stained both top and bottom. Dark grayish-brown fine earth fills the cracks and crevices between the hardened chalk fragments. Plant roots enter this layer.

The underlying material, or substratum, is white chalk. It consists of a massive, hard layer at the top and then alternate soft and hard layers. The top layer is the

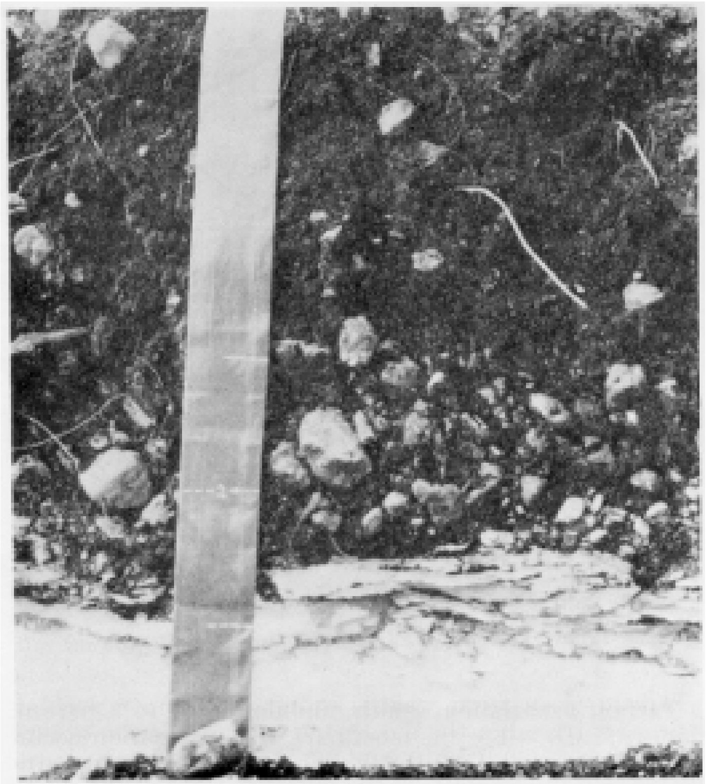

Figure 13.—**Profile of Stephen silty clay.**

hardest. A profile of Stephen silty clay is shown in figure 13.

The surface layer ranges from 12 to 22 inches in thickness and from very dark grayish brown to dark grayish brown in color. It ranges from light silty clay to heavy clay loam in texture; the clay content is 35 to 45 percent. The lime content ranges from 5 to 40 percent. Chalk fragments make up as much as 15 percent of this layer, by volume. The subsurface layer, which is rubble consisting of chalk fragments and fine earth, ranges from 2 to 12 inches in thickness.

Stephen soils are associated with Austin, Brackett, and Houston Black soils, and with some of the Tarrant soils. All of these soils formed over chalky materials. Stephen soils are shallower than Austin soils and deeper than Tarrant soils. They are darker colored than Brackett soils. They are browner, less clayey, more limy, and less deeply developed than Houston Black soils.

Stephen soils are naturally well drained. The capacity to hold water is low. Permeability is moderately slow in both the surface and subsurface layers. Unless fractured, the chalk substratum is nearly impervious. Natural fertility is moderate. Water erosion is a hazard. For the most part, these soils are not cultivated. They are best suited to native grass or adapted varieties of introduced grass. If cultivated, they are best suited to a cool-season crop, such as small grain. Many fields that were once cultivated are now idle or are in permanent pasture. These soils are not irrigated.

Stephen silty clay, 1 to 3 percent slopes (ScB).—This soil occurs mainly in the northeastern and northwestern parts of the county. Included in the areas mapped are patches of Tarrant soils, chalk substratum, undulating, which occurs as low, narrow ridges, and of Houston Black soils, which occur as foot slopes.

Runoff is slow. The hazard of erosion is slight to moderate. There are spots in cultivated areas where chalk rubble is on the surface and within the soil and the surface layer is lighter colored. The high lime content of the soil tends to tie up some plant nutrients, and crops are likely to develop chlorosis, or yellowing of the leaves. Yields are low to moderate. Cool-season crops do best. An example is small grain planted for winter grazing or native grass, or adapted varieties of perennial grass planted for permanent pasture. Terracing, fertilization, contour tillage, and proper use of plant residues help to control erosion, conserve moisture, and maintain tilth and fertility. (Capability unit IIIe–7, dryland; IIIe–6, irrigated; Shallow Ridge range site)

Stephen silty clay, 3 to 5 percent slopes (ScC).—This soil is inextensive but is the more extensive of the two Stephen soils mapped in the county. It occurs mainly in the northeastern part. In places the slope is as much as 7 percent. Although the areas range from 25 to 240 acres in size, they average about 80 acres. This soil is more sloping than Stephen silty clay, 1 to 3 percent slopes, and consequently has more rapid runoff, is more susceptible to erosion, and in cultivated areas has a thinner surface layer. Rill erosion is evident in many areas, and there are a few shallow gullies, widely spaced.

Most of the acreage either is still in native vegetation or has been cultivated and is now idle or used as permanent pasture. Good conservation practices are needed to help prevent further erosion. (Capability unit IVe–7, dryland; Shallow Ridge range site)

Sumter Series

The Sumter series consists of clayey soils that are very shallow, moderately dark colored, and calcareous. These soils are moderately sloping to steep. They occur on the uplands in the northeastern, eastern, and central parts of the county.

The surface layer is grayish-brown gravelly clay and is about 8 inches thick. It has moderate, medium, granular structure and is friable when moist. This layer is calcareous.

The underlying material is pale-yellow, calcareous marl or clay that contains many hard and soft limy concretions.

The surface layer ranges from 5 to 12 inches in thickness. It ranges from dark grayish brown to light olive brown in color; the darker colors occur on the more gentle slopes. The amount of gravel on the surface and within the soil ranges from less than 2 percent to as much as 15 percent of this layer, by volume. The pebbles range from a quarter of an inch to 3 inches in diameter. The underlying material may extend to a depth of many feet. It is capable of helping to support plant life, and numerous roots extend into this calcareous clay or marly clay.

Sumter soils are lighter colored and less deeply developed than the slowly permeable Houston soils. They are more clayey and lighter colored than the Tarrant soils that developed over chalk or chalk rubble. They are less deeply developed, lighter colored, and typically more sloping than Stephen soils. They are less deeply developed, lighter colored, less clayey, and typically more sloping than Houston Black soils.

Sumter soils have rapid surface drainage and slow internal drainage. Permeability is slow. The capacity to hold water is limited by the rapid runoff and a thin surface layer. Natural fertility is low. Water erosion is a hazard. These soils are used mainly as pasture and are best suited to native grass or to adapted varieties of perennial grass. A few small areas that occur within larger acreages of other soils are cultivated with the rest of the field. These cultivated areas are susceptible to erosion and are likely to have thin spots and gullies.

In this county Sumter soils are mapped with the closely associated, eroded Houston soils. The mapping unit, Houston-Sumter clays, 5 to 10 percent slopes, severely eroded, is described under the heading "Houston Series."

Tarrant Series

The Tarrant series consists of stony soils that are very shallow, dark colored, and gently undulating to steep. These soils occur on the limestone prairies in the northern third of the county.

The surface layer is very dark grayish-brown, calcareous clay loam and is about 10 inches thick. It has moderate, fine, subangular blocky structure. This layer is crumbly and friable when moist. Limestone fragments that range from a quarter of an inch to 24 inches in diameter cover about 35 percent of the surface, and angular limestone fragments of similar size make up an estimated 20 percent of this layer, by volume.

The subsurface layer, about 8 inches thick, is hard, fractured limestone. The cracks and spaces are filled with dark grayish-brown clay loam, which makes up approximately 8 to 10 percent of this layer, by volume (fig. 14).

The bedrock is hard limestone. Explosives or air hammers are needed to excavate both this material and the fractured limestone in the subsurface layer.

The surface layer ranges from black to very dark grayish brown in color, and from 5 to 12 inches in thickness. Limestone fragments that range from a quarter of an inch to 25 inches in diameter cover 15 to 50 percent of the surface and make up 10 to 60 percent of the surface layer, by volume. Excluding these fragments, the texture of this layer is heavy clay loam to clay. The subsurface layer is 8 to 10 inches thick. The fine earth that fills the cracks and voids in the fractured limestone makes up 5 to 14 percent of this layer, by volume.

Tarrant soils are darker colored, more clayey, and less limy than Brackett soils, and they developed over harder limestone. They are less deeply developed than the clayey, noncalcareous Crawford soils. They are shallower and less red than Bexar soils.

Tarrant soils have rapid surface drainage and good internal drainage. The capacity to hold water is low. Natural fertility is high. Water erosion is a hazard. These soils are nonarable and are best suited to pasture or range. They are capable of supporting good stands of mid grass and tall grass, including little bluestem, feathery bluestem, sideoats grama, plains lovegrass, green sprangletop, Texas cupgrass, indiangrass, hairy dropseed, buffalograss, and Texas wintergrass. Woody vegetation consists of live oak, shin oak, and Ashe juniper.

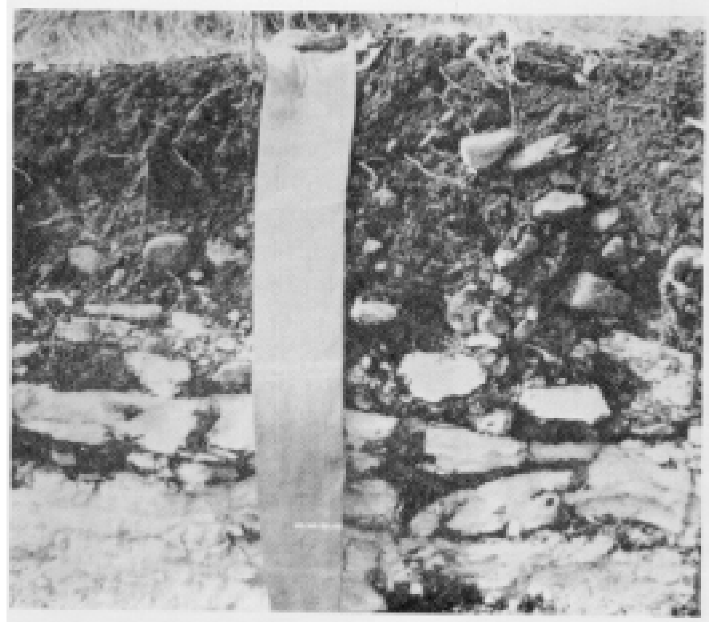

Figure 14.—**Profile of Tarrant stony clay loam.**

Tarrant association, gently undulating (1 to 5 percent slopes) (TaB).—For the most part, this association occurs as nearly level and gently sloping areas of typical prairie and plateau topography, in the northern third of the county. The slope is as much as 12 percent in places, and these moderately steep slopes are associated with the deeper canyons and draws. About 8 percent of the county is in this association. Some areas are several hundred acres in size.

About 70 percent of the acreage consists of Tarrant soils. These soils are dark colored, very shallow, calcareous, and clayey. They developed over hard limestone and have scattered stones, gravel, channery fragments, cobblestones, and flagstones on the surface and within the surface layer. About 12 percent of the acreage consists of associated soils that are 10 to 24 inches deep, and about 3 percent of the acreage consists of soils that are 24 to 45 inches deep. Also included in the areas mapped are small tracts of Crawford and Bexar stony soils, of Krum complex, of Brackett soils, 5 to 12 percent slopes, and of Valera soils. Valera soils, which were not mapped separately in Bexar County, are more deeply developed than Tarrant soils and are almost free of stones. They occur on benches or on the flood plains of small streams.

This association is best suited to native grass and is used mainly as range. Some areas have been subdivided for suburban homesites. Water erosion and lack of soil moisture are the main limitations. Brush control, fencing, water development, range seeding, and controlled grazing are needed to establish an adequate cover of vegetation. (Capability unit VIs–2, dryland; Rocky Upland range site)

Tarrant association, rolling (5 to 15 percent slopes) (TaC).—This association occurs in the northern third of the county. The slopes are complex, strongly convex or rounded, and fairly smooth. The gradient is as much as 20 percent in places but is typically about 10 percent. There are many draws and a few deep canyons. This association has fewer pockets of deeper soils than Tarrant association, gently undulating, and is typically more stony. About 5 percent of the county is in this association.

Tarrant soils make up about 90 percent of this association. These soils are dark colored, very shallow, clayey, and weakly calcareous. They developed over hard limestone and have scattered stones, gravel, channery fragments, cobblestones, and flagstones on the surface and within the surface layer. Included in the areas mapped are small tracts of Tarrant association, gently undulating, or Krum complex, and of Crawford and Bexar stony soils.

This association is best suited to native grass and is used mainly as range. Water erosion and lack of soil moisture are the main limitations. Brush control, fencing, water development, range seeding, and controlled grazing are needed to establish an adequate cover of vegetation. (Capability unit VIs-3, dryland; Low Stony Hill range site)

Tarrant association, hilly (15 to 30 percent slopes) (TaD).—For the most part, this association occurs as ridgetops and hilly to steep slopes in the northern third of the county. In some small areas outcrops of hard limestone form steep escarpments, and there are also draws and deep canyons. Included in the areas mapped are small tracts of Tarrant association, rolling, of Brackett soils, 12 to 30 percent slopes, and of Krum complex.

This association consists mostly of Tarrant soils. Outcrops of bedrock make up about 15 to 20 percent of the association.

The Tarrant soils in this association are moderately productive of native grass and are used mainly as range. Runoff is rapid because of the steep slopes and exposed bedrock. Conservation measures, such as proper range use, deferred grazing, brush control, fencing, water development, and reseeding are needed to help prevent water erosion. (Capability unit VIs-3, dryland; Steep Rocky range site)

Tarrant soils, chalk substratum, undulating (1 to 8 percent slopes) (Tb).—These soils occur as nearly level and gently sloping areas on broad ridgetops and as the surrounding, more strongly sloping, convex side slopes. Runoff is medium or rapid, depending on the gradient. These soils are mainly in the northeastern, north-central, and west-central parts of the county. Included in the areas mapped are patches of Austin silty clay, 3 to 5 percent slopes, and of Stephen silty clay, 1 to 5 percent slopes.

Unlike the other Tarrant soils, which are underlain by hard limestone, these soils have a substratum of white chalk. This substratum consists of a hard, massive layer at the top and below that, alternate soft and hard layers. The top layer is the hardest.

These soils are very shallow and droughty. Agriculturally they are unimportant. They are used mainly as pasture or for suburban housing developments. Water erosion is a hazard. Maintaining an adequate cover of native grass is the most important management problem. Brush control, fencing, water development, range seeding, and controlled grazing are a few of the measures needed to help control runoff and erosion. (Capability unit VIs-2, dryland; Rocky Upland range site)

Trinity Series

The Trinity series consists of alluvial soils that are deep, dark colored, and nearly level. These soils are on the bottom land in the eastern and southwestern parts of the county.

The surface layer is dark-gray, calcareous clay and is about 50 inches thick. It has medium, subangular blocky structure and is firm when moist.

The subsurface layer is gray, calcareous clay and is about 15 inches thick. This layer has weak, subangular blocky structure.

The underlying material is recent clayey alluvium washed from the clayey, upland soils. A profile of Trinity clay is shown in figure 15.

The surface layer ranges from black to grayish brown in color and from 40 to 70 inches in thickness. It is generally clay in texture. The subsurface layer ranges from 4 to 20 inches in thickness and from gray to light grayish brown in color. The depth to strata of water-worn gravel ranges from 4 to 12 feet.

Trinity soils are more clayey, more slowly permeable, and more calcareous than Gowen soils. They are less sandy, less permeable, and more calcareous than Zavala soils. They occupy lower terraces than Houston Black terrace soils, and they are flooded occasionally. They vary less in texture, are less stratified, and are flooded less frequently than Trinity and Frio soils, frequently flooded, which are subject to deposition and scouring.

Trinity soils have slow surface drainage and slow internal drainage. Permeability is slow. The capacity to hold water is good. Natural fertility is high. Occasional flooding is a hazard. For the most part, these soils are cultivated. Corn is the main crop. Also suitable are

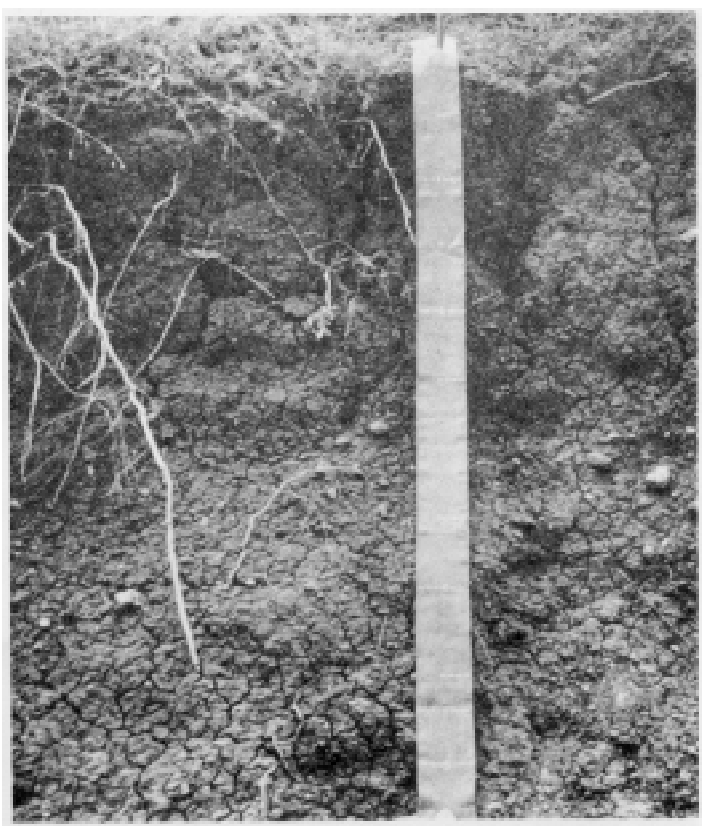

Figure 15.—**Profile of Trinity clay.**

dryland crops grown in the county and hay and pasture mixtures.

Trinity clay (0 to 1 percent slopes) (Tc).—This soil occurs as small, scattered areas on narrow, low-lying terraces just above the flood plains of Salatrillo, Martinez, and Rosillo Creeks. It is mainly in the eastern and southwestern parts of the county. The areas are 200 to 1,000 feet wide and 15 to 180 acres in size. Included in the areas mapped are small tracts of Houston Black clay, terrace, 0 to 1 percent slopes, of Trinity and Frio soils, frequently flooded, and of Trinity clay on slopes of more than 1 percent.

The surface layer is dark-gray clay. It is calcareous, about 50 inches thick, and slowly permeable. The subsoil is slowly permeable clay. It varies in thickness. Strata of gravel occur intermittently at a depth of 4 to 12 feet.

This soil is fertile. It is not subject to water erosion but is flooded occasionally. Corn, grain sorghum, cotton, and small grain are the main crops. Corn and grain sorghum may be washed out or lodged if flooding occurs late in spring. Water management is essential. (Capability unit IIw–2, dryland; Bottomland range site)

Trinity and Frio soils, frequently flooded (0 to 1 percent slopes) (Tf).—These soils occur as narrow, long, and irregularly shaped areas on the flood plains of small streams and the larger field drainageways. They are mostly in the northern and central parts of the county. These soils are flooded at least once a year, generally after a heavy rain. Some areas are subject to a thin deposition of sediments, and others to scouring or shifting. Channels in these areas are poorly defined and of small capacity (fig. 16).

Of the areas of this unit, about 60 percent consist entirely of Trinity soils. These soils are 3 to 5 feet deep. The surface layer ranges from clay loam to gravelly clay in texture. Ordinarily, the subsurface layer is clay, but in places it contains thin loamy strata. About 20 percent of the areas consist of Frio soils. These soils are 3 to 4 feet deep and are somewhat more clayey and darker colored than the Frio clay loams that occur on the flood plains of the larger streams and rivers. The other 20 percent of the areas consist of both Trinity and Frio soils.

Most of the acreage is in native vegetation and is used as pasture. A few areas are cultivated. Small grain, vegetables, and hay are the main crops. These soils support a heavy cover of vegetation, which generally consists of elm, hackberry, oak, huisache, mesquite, and other thorny shrubs, and of Texas wintergrass, johnsongrass, buffalograss, bermudagrass, and annual weeds. (Trinity soils: capability unit Vw–1, dryland; Bottomland range site. Frio soils: capability unit Vw–1, dryland; Loamy Bottomland range site)

Figure 16.—Area of Trinity and Frio soils, frequently flooded.

Venus Series

The Venus series consists of nearly level and gently sloping soils that are deep, moderately dark colored, and limy. These soils developed in loamy earths. They occur on terraces or alluvial fans along the main rivers and streams of the county.

The surface layer is dark grayish-brown, moderately alkaline loam or clay loam and is about 14 inches thick. It has weak, granular structure in the plow layer and stronger granular structure below the plow layer. There are a few worm casts and numerous fine pores. This layer is easily worked.

The subsurface layer is brown, limy loam or clay loam and is about 16 inches thick. It has moderate, very fine and fine, subangular blocky structure and fine, granular structure and is firm but crumbly when moist.

The underlying material is light yellowish-brown or very pale brown loam, sandy clay loam, or clay loam. This material may be many feet thick. Roots readily enter this layer (fig. 17).

The surface layer ranges from loam to clay loam in texture, from dark brown to grayish brown in color, and from 7 to 20 inches in thickness. A very thin, light-colored crust tends to form on the surface. The subsurface layer ranges from loam to sandy clay loam or clay loam in texture. Limy concretions or lumps of limy material make up about 10 percent of this layer, by volume. The underlying material consists of deep beds of loamy earths that range from loam to sandy clay loam or clay loam in texture. There are a few beds of gravel below a depth of 36 inches.

Venus soils are grayer, less clayey, and more permeable than Lewisville soils. They are more clayey, less limy, and less sloping than Karnes soils. They have more lime accumulations than the Frio soils that occur on the flood plains, but they are not stratified. Venus soils are lighter colored, less clayey, and more permeable than the terrace phases of Houston Black clay. They are more deeply developed than Patrick soils, which have beds of gravel within 3 feet of the surface.

Venus soils are well drained. Internal drainage is medium. Permeability is moderate. The capacity to hold water is good. Natural fertility is moderately high. Water erosion is a hazard. Most of the acreage is cultivated. Small grain, corn, grain sorghum, and hay are the main crops. Some areas are irrigated, and truck crops, such as carrots, potatoes, sweet corn, and cabbage are grown.

Venus loam, 0 to 1 percent slopes (VaA).—This soil occurs mainly on low terraces along the larger rivers and streams of the county. It also occurs as narrow bands where old watercourses once cut through large, smooth areas of Lewisville silty clay. The areas range from 8 to 130 acres in size. Included in the areas mapped are

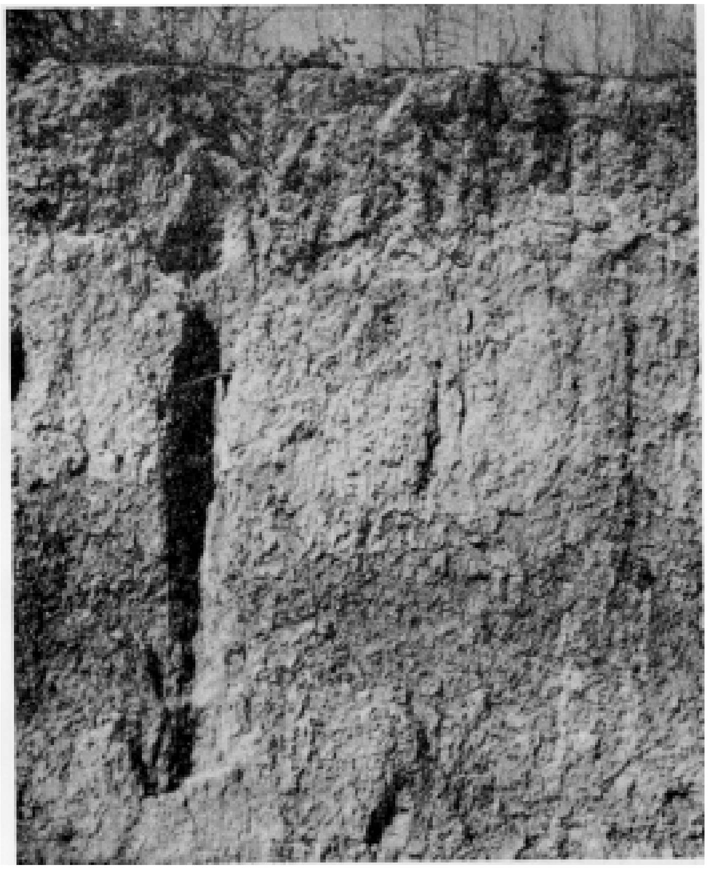

***Figure 17.*—Profile of Venus clay loam. This soil is approximately 20 feet deep.**

small tracts of Lewisville silty clay, and of Patrick soils, 0 to 1 percent slopes.

The surface layer is about 14 inches thick. The subsurface layer, about 16 inches thick, is loam but contains more clay than the surface layer. It is firm but crumbly when moist and contains much lime.

Most of the acreage is cultivated. Small grain, grain sorghum, and corn are the main crops. Some areas are irrigated, and truck crops are grown. The soil is easily tilled and can be worked into a good seedbed, but if it is plowed and cultivated to the same depth each time, a plowpan forms. Both surface drainage and internal drainage are good. The hazard of water erosion is only slight. Fertilization, crop rotation, and proper use of plant residues help to conserve moisture and maintain tilth and productivity. (Capability unit IIc–2, dryland; I–2, irrigated; Clay Loam range site)

Venus loam, 1 to 3 percent slopes (VaB).—This soil occupies small, narrow terraces that are parallel to and slope toward the major watercourses. It occurs in the same areas as Venus loam, 0 to 1 percent slopes. The slopes are weakly convex, and in some small areas the gradient is as much as 5 percent. The areas range from 6 to 125 acres in size. Included in the areas mapped are small tracts of Lewisville silty clay, 1 to 3 percent slopes, and of Patrick soils, 1 to 3 percent slopes.

The surface layer is brown and is about 12 inches thick. The subsurface layer, about 15 inches thick, is pale-brown loam or heavy loam. It is firm but crumbly when moist.

This soil is moderately productive of most dryland crops. It is easily tilled and can be worked into a good seedbed. Unprotected fields are subject to water erosion. The effects of rill and sheet erosion are noticeable at the head of drains, and in most areas part of the surface layer has been removed. Fertilization, terracing, contour tillage, and proper use of plant residues help to control rill and sheet erosion and prevent the formation of gullies. (Capability unit IIe–3, dryland; IIe–3, irrigated; Clay Loam range site)

Venus clay loam, 0 to 1 percent slopes (VcA).—This soil occurs as smooth terraces 20 to 40 feet above the flood plains of the San Antonio and Medina Rivers and their main tributaries. It is in the southern and southwestern parts of the county. Included in the areas mapped are a few small tracts of Lewisville silty clay, 0 to 1 percent slopes, of Patrick soils, 0 to 1 percent slopes, and of Frio clay loam.

This soil is limy and contains many snail shells, worm casts, and fine pores. The surface layer is about 16 inches thick. The subsurface layer, about 20 inches thick, is clay loam in texture but is less clayey than the surface layer.

This is a productive soil that is easily worked. Nearly all of it is cultivated. Corn, grain sorghum, small grain, sudangrass, and cotton are the main crops. Truck crops are grown under irrigation. Runoff is medium or slow. Crusting and lack of soil moisture are the main limitations. Establishing a balance between fertility and moisture is also a problem. Fertilization, crop rotation, and proper use of plant residues are needed to conserve moisture and maintain tilth and fertility. (Capability unit IIc–2, dryland; I–2, irrigated; Clay Loam range site)

Venus clay loam, 1 to 3 percent slopes (VcB).—This soil occurs as gentle slopes, either between the terraces and the upland soils or between the terraces and the flood plains. It has a thinner surface layer, stronger slopes, and more rapid runoff than Venus clay loam, 0 to 1 percent slopes. Included in the areas mapped are small tracts of Patrick soils, 1 to 3 percent slopes, of Venus clay loam, 0 to 1 percent slopes, and of Lewisville silty clay, 1 to 3 percent slopes.

The surface layer is about 14 inches thick. The subsurface layer, about 20 inches thick, is clay loam in texture but is less clayey than the surface layer.

This is a fairly productive soil. Most of it is cultivated, and part of it is irrigated. Small grain, sudangrass, grain sorghum, corn, and cotton are well suited, and truck crops can be grown under irrigation. A crust readily forms on the surface. The hazard of sheet and gully erosion is moderate. Terracing, fertilization, contour tillage, and proper use of plant residues are needed to help control runoff and erosion, conserve moisture, and maintain tilth and fertility. (Capability unit IIe–3, dryland; IIe–3, irrigated; Clay Loam range site)

Venus clay loam, 3 to 5 percent slopes (VcC).—This soil is inextensive. It occurs either as side slopes along creeks and along the more deeply entrenched field drainageways, or as short, steeper slopes between terrace benches. It is in the same areas as other Venus clay loams but is lighter colored and more loamy and friable in the surface layer than those soils. Included in the areas mapped are patches of Karnes loam, 3 to 5 percent slopes, of Patrick soils, 3 to 5 percent slopes, and of Lewisville silty clay, 1 to 3 percent slopes.

The surface layer is grayish brown and is about 14 inches thick. The subsurface layer is very pale brown, limy light clay loam and is about 18 inches thick. This layer is firm but crumbly when moist.

This soil is easily tilled and can be worked into a good seedbed. It is susceptible to water erosion. Terracing, contour tillage, and other conservation practices are needed to help protect the soil from erosion and to maintain tilth and fertility. (Capability unit IIIe–5, dryland; IIIe–5, irrigated; Clay Loam range site)

Webb Series

The Webb series consists of sandy loams that are moderately deep, moderately dark colored, and nearly level to gently sloping. These soils are in the southern third of the county.

The surface layer is reddish brown, noncalcareous, and about 12 inches thick. It has weak, fine, granular structure and is friable when moist and hard when dry. This layer is easily worked.

The subsoil, about 16 inches thick, is reddish-brown sandy clay. It has moderate, medium, blocky structure, is firm or very firm when moist, and is hard to extremely hard when dry. This layer is ordinarily noncalcareous, but locally there are a few lime concretions in the lower part.

The underlying material consists of yellowish-red to yellow sandy clay interbedded with weakly consolidated sandstone.

The surface layer is generally fine sandy loam in texture, and it ranges from 5 to 18 inches in thickness and from dark brown to reddish brown in color. In places there is a 4- to 6-inch transitional layer between the surface layer and the subsoil. The subsoil ranges from 14 to 32 inches in thickness, from red to dark reddish brown in color, and from sandy clay to clay in texture. The layer of lime accumulation in the underlying material ranges from weak to prominent.

Webb soils have a more clayey subsoil than Duval soils, which developed over similar parent material. They are less clayey, less dense, and lighter colored in the surface layer than San Antonio soils. They are lighter colored throughout the profile than Crockett soils, which have a clayey, mottled subsoil. They are darker colored, less sandy, and thinner in the surface layer than Hockley soils, which have a mottled, more permeable subsoil.

Webb soils are naturally well drained. Internal drainage is slow but is adequate for crops. Permeability is slow. The capacity to hold water is only fair in the surface layer but is good in the subsoil. Natural fertility is moderate. Water erosion is a hazard. For the most part, these soils are cultivated. Small grain, grain sorghum, corn, and hay and pasture mixtures are the main crops. Some areas are irrigated and are used for truck crops.

Webb fine sandy loam, 1 to 3 percent slopes (WbB).—This soil occurs as broad, gently sloping areas on the uplands in the southern third of the county. The slopes are generally convex but are concave in a few places at the head of streams. The areas are oval or irregularly oblong in shape and range from 15 to 160 acres in size. Included in the areas mapped are patches of Webb fine sandy loam that have slopes of less than 1 percent, of San Antonio clay loam, 1 to 3 percent slopes, of Crockett fine sandy loam, 1 to 3 percent slopes, and of Hockley loamy fine sand, 0 to 3 percent slopes.

The surface layer is reddish or dark brown and is about 12 inches thick. The subsoil is reddish-brown, blocky sandy clay and is about 16 inches thick. It is slowly permeable. In most places this layer is noncalcareous, but locally it contains a few lime concretions.

This soil is moderately productive of most dryland crops, and much of it is cultivated. It is easily tilled and can be worked into a good seedbed if moisture conditions are favorable. If it is tilled when too wet, it clods and crusts. Runoff is medium to slow. Water erosion is the main limitation. Fertilization, terracing, contour tillage, and proper use of plant residues are needed to help control erosion, conserve moisture, and maintain tilth and productivity. (Capability unit IIe–1, dryland; IIe–1, irrigated; Tight Sandy Loam range site)

Webb fine sandy loam, 3 to 5 percent slopes (WbC).—This soil occurs as side slopes along drainageways throughout the southern third of the county. It has smooth, convex or wavy slopes, and in places the gradient is as much as 7 percent. This soil has a thinner surface layer, stronger slopes, and slightly more rapid runoff than Webb fine sandy loam, 1 to 3 percent slopes; it also has more inclusions of San Antonio and Hockley soils. The areas are long and moderately wide and range from 15 to 137 acres in size. Included in the areas mapped are patches of San Antonio clay loam, 3 to 5 percent slopes, of Hockley loamy fine sand, 3 to 5 percent slopes, and of Crockett soils, 2 to 5 percent slopes, eroded.

The surface layer is about 8 inches thick. The subsoil, about 18 inches thick, is sandy clay. It has blocky structure and is firm when moist. This layer is noncalcareous and is slowly permeable.

A large acreage of this soil is cultivated and is planted to the dryland crops commonly grown in the area. Water erosion is a hazard. Terracing, contour tillage, and other conservation practices are needed to help control erosion. (Capability unit IIIe–4, dryland; IIIe–3, irrigated; Tight Sandy Loam range site)

Webb soils, 3 to 5 percent slopes, eroded (WeC2).—These soils occur as side slopes along the major field drainageways and streams and to a small extent, at the head of streams. They are mainly in the southeastern parts of the county and within larger areas of uneroded Webb soils. In places the slope is as much as 8 percent. Rills and gullies have formed. The surface layer is thinner than that of Webb fine sandy loam, 3 to 5 percent slopes, and is ordinarily redder because it has been mixed with the subsoil during tillage. The areas are narrow and some are several hundred feet long. Included in the areas mapped are patches of San Antonio clay loam, 3 to 5 percent slopes, eroded, of Crockett soils, 2 to 5 percent slopes, eroded, and of Hockley loamy fine sand, 3 to 5 percent slopes, eroded.

The surface layer ranges from 0 to 10 inches in thickness, depending on the type and severity of erosion. The thicker parts occur between the rills and gullies. This layer ranges from fine sandy loam to sandy clay loam in texture. The sandy clay loams occur in the gullied or eroded spots and make up an estimated 20 to 25 percent of the acreage. The subsoil is essentially the same as that described as representative of the series.

For the most part, these soils are now idle or in tame pasture. They are not productive of cultivated crops, because of the effects of erosion. A terrace system and other conservation measures, such as contour tillage, fertilization, and proper use of plant residues help to control erosion. (Capability unit IVe-4, dryland; Tight Sandy Loam range site)

Webb soils, 3 to 5 percent slopes, severely eroded (WeC3).—These soils occur as small, widely scattered areas within larger areas of Webb fine sandy loam. They occur as areas about 5 acres in size, on small, narrow ridgetops or as narrow slopes, as much as 15 acres in size, where water has washed away most of the unprotected soil. Runoff is more rapid than on other Webb soils. Sheet and gully erosion have removed most of the surface layer and in places part of the subsoil. The parent material, which is exposed in places, is noticeable because of the predominance of a material locally called iron rock and by the whitish color of the concretions of calcium carbonate. In small areas between gullies, the surface layer has been only slightly affected by erosion and is about 4 to 8 inches thick.

These soils ordinarily are not cultivated. Small spots that are within larger areas of uneroded soils and are cultivated with the surrounding soils generally can be distinguished in the field by the scantiness of the stand of crops. Diversion terraces on the slopes would stabilize the gullies, and the areas could then be reseeded to grass. Applications of nitrogen and phosphorus would encourage the growth of the grass. Until the grass is established, only light grazing or none should be permitted. (Capability unit VIe-1, dryland; Tight Sandy Loam range site)

Willacy Series

The Willacy series consists of deep, dark-colored, nearly level soils. These soils are on old alluvial outwash plains or terraces in the south-central part of the county.

The surface layer is very dark grayish brown, noncalcareous, and about 15 inches thick. It has weak, granular structure in the plow layer and weak, subangular blocky structure below the plow layer. This layer is easily worked.

The subsoil is about 40 inches thick. It contains more clay and is more compact than the surface layer. The upper part is dark-brown sandy clay loam. It is mostly noncalcareous but may contain a few concretions of calcium carbonate. The lower part, a yellowish-brown sandy clay loam, is calcareous. This layer has moderate to weak, fine, subangular blocky structure and is friable to firm when moist.

The underlying material is very pale brown loam. This material is strongly calcareous and is estimated to be 20 to 25 percent hard concretions of calcium carbonate.

The surface layer ranges from 12 to 20 inches in thickness, from very dark grayish brown to dark brown in color, and from loam to sandy clay loam in texture. The subsoil ranges from 25 to 44 inches in thickness and from loam to sandy clay loam in texture. The sloping soils have a thinner subsoil and loamier parent material. The color in both the subsoil and parent material ranges from dark grayish brown to yellowish brown. Depth to the accumulation of calcium carbonate ranges from 35 to 56 inches.

Willacy soils are darker colored, less friable, and less permeable than the strongly calcareous Frio soils. They are typically less clayey than Lewisville soils and are noncalcareous. They are lighter colored, less clayey, less deeply developed, and more permeable than the terrace phases of Houston Black soils. They are less loamy, less permeable, and less friable than the strongly calcareous Karnes soils.

Willacy soils have slow or medium surface drainage and slow internal drainage. Permeability is moderate. The capacity to hold water is good. Natural fertility is high. Water erosion is no problem on the nearly level soils but is a moderate hazard on the gently sloping soils. For the most part, these soils are cultivated. Corn and grain sorghum are the main crops. Also suitable are small grain, cotton, and other dryland crops commonly grown in the area. A large acreage is in tame pasture. A small acreage is irrigated.

Willacy loam, 0 to 1 percent slopes (WmA).—This soil occurs mainly in the south-central part of the county. The areas are long and broad and range from 40 to 280 acres in size. Included areas of an unclassified soil make up as much as 15 percent of the total acreage.

The surface layer of the Willacy soil is very dark grayish brown, about 15 inches thick, and noncalcareous. The subsoil is dark brown to yellowish brown and is about 40 inches thick. The upper part contains a few lime concretions, but the lower part is estimated to be 3 to 5 percent concretions of calcium carbonate. This layer is friable to firm when moist. The included unclassified soil is sandy clay loam or fine sandy loam in texture and is noncalcareous. The surface layer is very dark grayish brown and about 9 inches thick. It has weak, fine, granular structure. The subsoil is dark reddish-brown to dark reddish-gray clay. It has moderate, medium, blocky structure. This layer is mostly noncalcareous. The parent material is pale-brown sandy clay and contains many concretions of calcium carbonate.

This soil is highly productive of the dryland crop commonly grown in the area. It is easily tilled and can be worked into a good seedbed. If it is plowed and cultivated to the same depth each time, a plowplan readily forms. Water erosion is not a hazard. Fertilization, contour tillage, and proper use of plant residues will help to increase water intake and maintain fertility and tilth. (Capability unit IIc-1, dryland; I-1, irrigated; Clay Loam range site)

Willacy loam, 1 to 3 percent slopes (WmB).—This soil generally occurs as slopes between the nearly level Willacy loams and the lower lying Frio and Karnes soils. It is associated with other Willacy soils in the county. Besides being more sloping than Willacy loam, 0 to 1 percent slopes, this soil contains a smaller acreage of the unclassified soil previously described. The areas are generally long and moderately narrow and range from 20 to 160 acres in size. Included in the areas mapped are small tracts of Venus clay loam, 1 to 3 percent slopes, of Karnes loam, 1 to 3 percent slopes, of Lewisville silty clay, 1 to 3 percent slopes, and of an unclassified soil.

The surface layer is 14 inches thick and is noncalcareous. The subsoil is about 30 inches thick. The upper part is dark-brown sandy clay loam and has fine, subangular blocky structure. The lower part is yellowish-brown sandy clay loam. It has moderate, fine and very fine, subangular blocky structure and is firm but crumbly when moist. Fine concretions of calcium carbonate make up 3 to 5 percent of the lower part of the subsoil, by volume.

This is a moderately productive soil that is easily tilled and can be worked into a good seedbed. Water erosion is a hazard in unprotected fields. Terracing, contour farming, and proper use of plant residues help to prevent the formation of gullies. (Capability unit IIe-2, dryland; IIe-2, irrigated; Clay Loam range site)

Zavala Series

The Zavala series consists of deep, moderately dark colored, nearly level alluvial soils. These soils are in the southern third of the county.

The surface layer is grayish-brown, noncalcareous fine sandy loam and is about 16 inches thick. It has granular structure and is very friable when moist. This layer is easily worked.

The subsurface layer is gray to grayish brown fine sandy loam and is about 8 inches thick. It has granular structure and is very friable when moist. This layer is also noncalcareous.

The underlying material is noncalcareous loamy alluvium, in places stratified with sandy clay, clay loam, and loamy fine sand. This layer is many feet thick.

The surface layer ranges from dark grayish brown to brown in color, from 14 to 25 inches in thickness, and from loam through fine sandy loam to loamy fine sand in texture. The subsurface layer ranges from grayish brown to gray in color, from 7 to 20 inches in thickness, and from fine sandy loam to loamy fine sand in texture. The underlying material is mostly recent loamy alluvium washed from the closely associated Webb, Duval, Hockley, Crockett, San Antonio, and Eufaula soils. It is noncalcareous and in places is stratified with layers of loam, clay loam, or light sandy clay.

Zavala soils are less clayey, lighter colored, and more permeable than Gowen soils, and they are lighter colored, less clayey, and less deeply developed than the limy Trinity soils.

Zavala soils have medium surface drainage and medium internal drainage. Permeability is moderate. The capacity to hold water is only fair. Natural fertility is moderate. Water erosion is only a slight problem. For the most part, Zavala soils are cultivated. They are well suited to peanuts, watermelons, and other dryland crops of the area. Native grass and adapted varieties of perennial grass can be grown also. Yields are moderate.

Zavala fine sandy loam (0 to 1 percent slopes) (Za).—This soil occurs as long, narrow areas on the high bottoms, or terraces, that border Calaveras Creek, Hondo Creek, Chupaderas Creek, and Elm Creek in the southern part of the county. It is 8 to 20 feet above the flood plains of the streams. This soil is seldom flooded, but during heavy rains it receives runoff from upland soils. Included in the areas mapped are a few small tracts of Crockett fine sandy loam. This Crockett soil has a thicker surface layer than is typical because it receives sediments washed from higher lying loamy and sandy loam soils.

This is a moderately to highly productive soil that is well suited to peanuts, watermelons, other dryland crops, hay and pasture mixtures, and pecan orchards. This soil should be cultivated when moisture conditions are favorable, because when moist it is susceptible to compaction, which reduces water intake and lowers production. Fertilization and the proper use of plant residues increase water intake and help to conserve moisture and maintain tilth and productivity. (Capability unit IIw-1, dryland; IIw-1, irrigated; Loamy Bottomland range site)

Zavala and Gowen soils, frequently flooded (0 to 1 percent slopes) (Zg).—These soils are in the southern part of the county where sandy and loamy soils are predominant. They occur as long, narrow, and irregularly shaped areas on the flood plains of small creeks and large field drainageways, the channels of which have been filled, or partially filled, with sediments or erosional debris. These soils are flooded after each heavy rain and at least once a year. After each overflow, a very thin deposit is left on the surface or a thin layer is scoured off. This deposition and reworking of the soils results in an uneven surface.

About 65 percent of this unit consists entirely of Zavala soils, which are noncalcareous, are 4 to 6 feet deep, and range from fine sandy loam to loamy fine sand in texture. Their surface layer is generally darker colored than that of Zavala fine sandy loam, which occurs on low terraces. The subsurface layers are structureless and are generally stratified with sandy clay loam or loamy fine sand.

About 25 percent of the areas consist of Gowen soils. These soils are noncalcareous, are 3 to 5 feet deep, and range from clay loam to sandy clay loam in texture. The subsurface layer ranges from loam to clay loam and in places is stratified with fine sandy loam or loamy fine sand. The rest of the areas consist of both Zavala and Gowen soils.

These soils support a heavy cover of vegetation that ordinarily consists of cottonwood and willow trees and an understory of johnsongrass, bermudagrass, and annual weeds. Nearly all the acreage is in native vegetation and is used mainly as brushy pasture. Good pastures of common bermudagrass or Coastal bermudagrass can be established. Small areas are cultivated. (Zavala soils: capability unit Vw-2, dryland; Loamy Bottomland range site. Gowen soils: capability unit Vw-2, dryland; Bottomland range site)

Use and Management of Soils

This section describes the major uses of the soils and the limitations and management needs of the soils for each of these uses. The capability groupings used by the Soil Conservation Service are explained, and the soils of the county are grouped according to their suitability for crops. Also, predicted yields of the major crops are listed. Next the soils are grouped according to the kinds and amounts of forage they can produce if used as range. Then the relative suitability of soils for highways and other engineering structures are discussed. Next is information about urban uses of soils, which is of interest to builders, homeowners, and city planners, and then a discussion of recreation facilities.

Management of Cultivated Soils

Control of erosion, conservation of moisture, and maintenance of fertility are the main objectives of the management practices that are described briefly in the following paragraphs. Erosion is one of the chief hazards in Bexar County. In more than three-fourths of the county, the slope is more than 1 percent. Consequently, all of the soils except the coarse-textured ones are subject to accelerated water erosion if cultivated. The sandy soils are subject to wind erosion.

The type and intensity of management needed vary according to the kind of soil and the type of farm. Local representatives of the Soil Conservation Service, the Extension Service, and the Texas Agricultural Experiment Station are available to help determine management needs and plan the application of practices on specific farms and ranches.

Control of water erosion

Whenever the soil is laid bare by cultivation, it is subject to erosion caused by rainfall and runoff. The degree of erosion depends on the force with which raindrops stir up the soil and on the amount and speed of runoff. These depend, in turn, on the vegetation, the texture and structure of the soil, and the length and steepness of slopes(*6*).[1]

To control water erosion, it is necessary to reduce runoff and increase water intake. Contour farming, terracing, proper use of crop residues, and establishing grassed waterways help to accomplish these objectives.

Contour farming.—Contour farming consists of plowing, planting, and tilling across the slope, at a constant elevation. The objective is to hold water where it falls and thus to help control erosion and conserve soil moisture. All terraced fields should be farmed on the contour. Nearly level fields do not need to be terraced, but they benefit from contour farming. Some fields that are irrigated by sprinkler systems need to be terraced and farmed on the contour, for protection against erosion.

Terrace ridges serve as guidelines for contour farming. Where there are no terraces, contour lines can be laid out with an engineer's level.

Terracing.—Terraces can be designed to reduce runoff and thus control erosion and conserve moisture, or to divert surplus water from cropland or other areas that need protection. Sloping fields that are cultivated need to be protected by channel-type terraces (fig. 18) that will divert water to a pasture or a protected waterway. Such terraces should be either on the contour or parallel to each other and should have a uniform grade. For protection of the terrace system, terraced fields should be farmed on the contour or parallel to the terraces.

Contour lines for terraces should be laid out by means of an engineer's level. Technical assistance can be obtained from a local representative of the Soil Conservation Service.

Grassed waterways.—Grassed waterways carry outside or surplus water across a farm in such a way that it will not cause erosion.

Design and preparation of a waterway takes a year or two. After the course of a waterway is selected, the channel must be shaped to the proper dimensions, then seeded or sodded with a suitable grass, and fertilized. Examples of suitable grasses are King Ranch bluestem, Medio bluestem, and bermudagrass. The grass can be grazed or it can be harvested for hay or for seed. It is necessary to control the height of the vegetation by means of mowing, shredding, or grazing. Waterways should never be used as roadways or as livestock lanes.

[1] Italic numbers in parentheses refer to Literature Cited, p. 122.

***Figure 18.*—New diversion terrace, showing water flowing in the channel.**

If the slope is slight and the soils are suitable, drilled small grain or sorghum can be planted in a waterway instead of grass. Such crops should not be allowed to make seed but should be cut before maturity and used as a litter crop.

Technicians of the Soil Conservation Service and other agencies can give advice and assistance in the planning of grassed waterways.

Management of residues.—A good litter of crop residues left on the surface protects the surface soil against packing rains, reduces crusting, decreases runoff, increases water intake, and reduces evaporation of soil moisture. It shades the soil, thus reducing soil temperature. In addition, it adds organic matter to the soil, improves the tilth of the surface soil, and reduces packing by farm machinery. Applying nitrogen fertilizer to the crop residues causes the organic matter to decay more quickly.

Crop residues should be protected from grazing and burning. Tillage equipment that keeps the residues on the surface should be used.

Tillage.—The soil should be tilled only enough to prepare a good seedbed and to control weeds. Excessive tillage and tillage when the soil is wet destroy the soil structure and cause a plowpan to form. Poor structure limits water intake and reduces the air space in the soil. A plowpan restricts the growth of roots. It also slows water penetration and consequently causes an increase in runoff. Proper tillage equipment is important also.

Control of wind erosion

The wind erosion hazard in Bexar County is less serious than the water erosion hazard. Wind erosion damages only those soils that have a surface layer of fine sandy texture. Such soils occur mainly in the southern third of the county. Effective control of wind erosion involves a combination of practices, including crop rotation, proper tillage, and residue management.

Management of residues.—Residues from previous crops can be used to help control soil blowing. They slow down the wind at the ground surface. Standing stubble reduces wind force more than flattened stubble. Close-spaced stubble is more effective than wide-spaced stubble.

The proper use of crop residues not only protects the soil against blowing but also helps to conserve moisture, retard evaporation, increase water intake, maintain the organic-matter content, and improve soil tilth. The amount of residue needed for adequate protection varies, depending on the nature of the soil. None should be grazed or burned.

Tillage.—Tilling with equipment that leaves the surface of the soil rough and cloddy is a temporary means of controlling wind erosion. Deep plowing is another common method. It brings up 3 to 6 inches of the finer textured material from the subsoil, mixes it with the sandy surface soil, and thus makes the surface layer more resistant to blowing. It is only a temporary measure. Usually it is resorted to to help establish vegetation that will provide permanent protection.

Stripcropping.—Stripcropping is the practice of growing protective crops in alternate strips or bands with other crops. It provides protection against wind erosion for entire fields. The strips should be narrow and of uniform width, and they should be crosswise to the direction of the prevailing wind. Suitable protective crops include small grain, grain sorghum, sudangrass, native or introduced grasses, and vetch or a mixture of vetch and rye.

Cropping systems.—A good cropping system maintains or improves the physical condition of the soil, protects the soil during the periods when erosion is most likely, aids in the control of weeds, insects, and diseases, and provides an adequate economic return.

Basically, a cropping system consists of growing crops in a sequence or in a rotation in which soil-improving crops balance soil-depleting crops in their effect on the soil. Soil-improving crops are those that leave large amounts of residue.

Each year, about 50 percent of the cultivated land in Bexar County is planted to row crops, mainly corn, cotton, peanuts, and grain sorghum. In soils that have been used for row crops for a long time, soil structure has deteriorated, the organic-matter content has been depleted, and fertility has declined. A cropping system in which soil-improving crops (fig. 19) are grown at suitable intervals helps to supply organic matter, improve the structure, maintain fertility, and protect the soil from erosion.

Fertility management

Most of the soils in Bexar County that have been cropped intensively for a long time need nitrogen and phosphorus, and some need potassium. These elements can be supplied by applying commercial fertilizer and barnyard manure.

The use of commercial fertilizer should be based on needs determined by soil tests. The amount and type needed vary according to the nature of the soil, the crop to be grown, the previous crop, the season of the year, and the amount of available moisture. For row crops, it is usually best to band the fertilizer below and to the side of the seed.

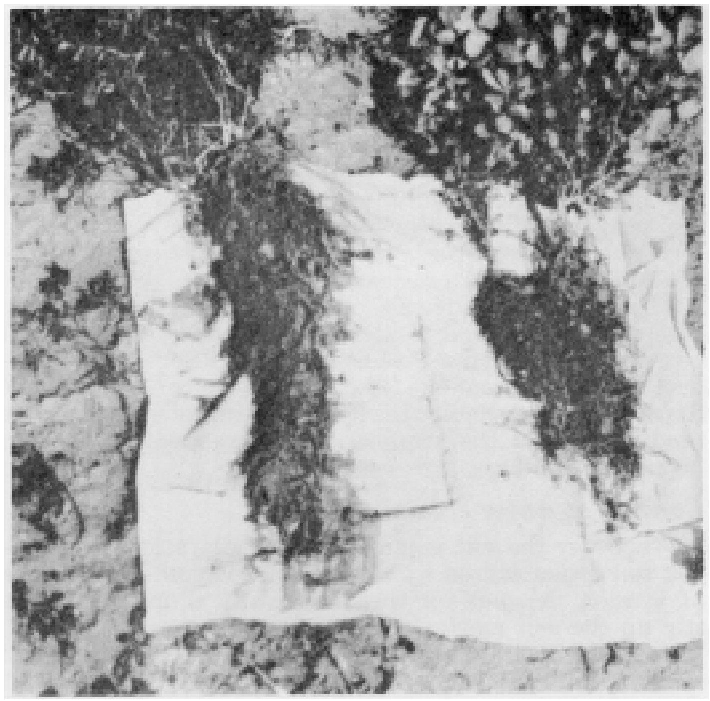

Figure 19.—**Two soil-improving crops. Vetch is on the left, and Brabham peas on the right. Both are legumes.**

Barnyard manure conditions the soil, in addition to supplying plant nutrients. It is especially beneficial if applied to cut areas or to spots where the soils are high in lime or very erodible.

Fertilizer is not generally used on dryland soils, because the lack of moisture limits the response. Field tests have shown, however, that when moisture conditions are favorable, most soils in Bexar County do respond to fertilization.

Irrigation

In the early 1700's, the Spanish settlers in Bexar County built dams and canals and irrigated the soils around the missions. Now, more than 28,000 acres in the county is irrigated, and the irrigated acreage is likely to increase. Water for irrigation is obtained from wells, rivers, creeks, and lakes. Wells in the Edwards formation range in depth from 485 feet in the northern part of the county to more than 1,800 feet in the southern part. Wells in the Carrizo formation range in depth from 250 to 400 feet. An irrigation district in the southwestern part of the county receives water from Medina Lake, which is some 30 miles to the northwest in Bandera County. The water is distributed through a network of canals and ditches, and much is lost through seepage unless the ditches are lined (fig. 20). Irrigation water for other areas is pumped from rivers and streams onto the adjoining soils.

The quality of the water ranges from good to poor. Some well water is high in dissolved solids and contains hydrogen sulfide in amounts that exceed 1,000 parts per

***Figure 20.*—Concrete-lined ditch. The lining will prevent loss of water.**

***Figure 21.*—Furrow irrigation on Lewisville silty clay, 0 to 1 percent slopes.**

million. This water is not suitable for irrigation. It is classed as undrinkable and is satisfactory for livestock only.

Among the factors to be considered in designing an irrigation system are the following: The quality and quantity of water available, the rate of intake and the water-holding capacity of the soil, the water requirements of the plants to be grown, and the topography of the area to be irrigated.

An irrigation system must be so designed as to distribute water evenly without causing erosion, excessive leaching of plant nutrients, waterlogging, or accumulation of harmful salts. The amount of water applied should be no more than can be retained in the root zone. In Bexar County, irrigation water is applied by both sprinkler and surface-flow systems. Surface-flow systems (fig. 21 and fig. 22) are generally used on the finer textured soils. They provide an even distribution of water only if the grade is uniform and level or nearly level. For sandier soils or for soils that cannot be leveled economically, a sprinkler system is preferable.

Capability Groups of Soils

The capability classification is a grouping that shows, in a general way, how suitable soils are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the country, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it are subject to little or no erosion but have other limitations that restrict their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils 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 identified by numbers assigned locally, for example, IIe-1 or IIIe-2.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their

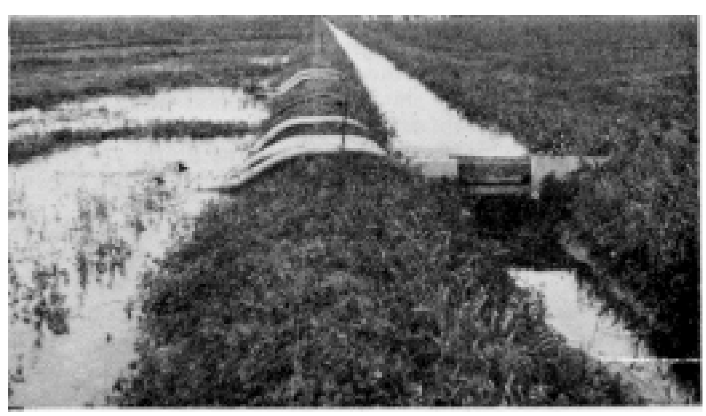

***Figure 22.*—Border irrigation.**

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permanent limitations, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil, and without consideration of possible but unlikely major reclamation projects.

Many of the soils in Bexar County are suitable for irrigation, and some of these can be assigned to a more favorable capability unit if irrigated than if dryfarmed. All of the soils in the county are classified according to their capacity when dryfarmed, and those suitable for irrigation and for which water is now available are classified according to their capacity when irrigated. The eight classes in the capability system, and the subclasses and units in Bexar County are described in the list that follows.

Class I. Soils that have few limitations that restrict their use. (No subclasses)

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

- Subclass IIc. Soils that have some limitations because of climate.
  - Unit IIc–1, dryland; I–1, irrigated.—Deep, nearly level, noncalcareous loams; moderately permeable subsoil.
  - Unit IIc–2, dryland; I–2, irrigated.—Deep, nearly level, strongly calcareous, medium-textured to fine-textured soils; slowly permeable to moderately permeable subsoil.
- Subclass IIe. Soils subject to moderate erosion if they are not protected.
  - Unit IIe–1, dryland; IIe–1, irrigated.—Deep, nearly level fine sandy loams; slowly permeable to moderately permeable subsoil.
  - Unit IIe–2, dryland; IIe–2, irrigated.—Deep, nearly level loams; moderately permeable subsoil.
  - Unit IIe–3, dryland; IIe–3, irrigated.—Deep, nearly level, strongly calcareous, medium-textured to fine-textured soils; slowly permeable to moderately permeable subsoil.
- Subclass IIs. Soils that have moderate limitations of moisture capacity or tilth.
  - Units IIs–1, dryland; IIs–2, irrigated.—Deep, nearly level, slowly permeable, very hard, calcareous clays that crack when dry.
- Subclass IIw. Soils that have moderate limitations because of excess water.
  - Unit IIw–1, dryland; IIw–1, irrigated.—Deep, nearly level, moderately permeable fine sandy loams and clay loams on flood plains.
  - Unit IIw–2, dryland.—Deep, nearly level, calcareous clays on flood plains along creeks and major streams and in depressions on the uplands.

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

- Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.
  - Unit IIIe–1, dryland; IIIe–1, irrigated.—Deep, nearly level fine sandy loams and clay loams; very slowly permeable subsoil.
  - Unit IIIe–2, dryland; IIIe–2, irrigated.—Deep nearly level, slowly permeable, calcareous clays and gravelly clays that crack when dry.
  - Unit IIIe–3, dryland.—Deep, gently sloping, slowly permeable, calcareous clays and gravelly clays that crack when dry.
  - Unit IIIe–4, dryland; IIIe–3, irrigated.—Deep, gently sloping fine sandy loams; slowly permeable or moderately permeable subsoil.
  - Unit IIIe–5, dryland; IIIe–5, irrigated.—Deep, gently sloping, strongly calcareous loams, clay loams, and silty clays; moderately permeable subsoil.
  - Unit IIIe–6, dryland; IIIe–5, irrigated.—Moderately deep, gently sloping, moderately permeable, strongly calcareous clay loams; eroded.
  - Unit IIIe–7, dryland; IIIe–6, irrigated.—Shallow to moderately deep, nearly level, moderately permeable clay loams and silty clays.
  - Unit IIIe–8, dryland; IIIs–1, irrigated.—Level and nearly level, thick loamy fine sands; dense, slowly permeable or very slowly permeable subsoil.
  - Unit IIIe–9, dryland; IIIs–2, irrigated.—Deep, nearly level and gently sloping, thick loamy fine sands; crumbly, moderately permeable subsoil.
  - Unit IIIe–10, dryland.—Deep to shallow, gently sloping and sloping, slowly permeable to moderately permeable clays on old alluvial fans and in narrow valleys.
- Subclass IIIs. Soils that have severe limitations of moisture capacity or tilth.
  - Unit IIIs–1, dryland; IIIs–3, irrigated.—Deep, nearly level fine sandy loams and clay loams; very slowly permeable subsoil.
  - Unit IIIs–2, dryland; IIs–2, irrigated.—Shallow, nearly level, moderately permeable clay loams, clays, or loams.

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

- Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
  - Unit IVe–1, dryland; IVs–1, irrigated.—Deep, nearly level, dark-colored clay loams; very slowly permeable subsoil.
  - Unit IVe–2, dryland.—Deep, gently sloping, dark-colored, noncalcareous clay loams; very slowly permeable subsoil.
  - Unit IVe–3, dryland.—Deep, gently sloping and sloping, dark-colored, calcareous clays and gravelly clays; slowly permeable subsoil.
  - Unit IVe–4, dryland.—Deep, gently sloping fine sandy loams; eroded; slowly permeable subsoil.
  - Unit IVe–5, dryland; IIIe–7, irrigated.—Gently sloping loamy fine sands; eroded; moderately slowly permeable to very slowly permeable subsoil.
  - Unit IVe–6, dryland; IIIs–4, irrigated.—Deep, nearly level and gently sloping, loose fine sands underlain by sandy clay loam at a depth of 42 to 100 inches or more.

Unit IVe–7, dryland.—Shallow and deep, nearly level and gently sloping, moderately permeable clay loams and silty clays.

Class V. Soils that are not likely to erode but have other limitations, impractical to remove without major reclamation, that limit their use largely to pasture or range, woodland, or wildlife food and cover.

Subclass Vw. Soils too wet for cultivation; drainage or protection not feasible.

Unit Vw–1, dryland.—Deep, nearly level, dark-colored, calcareous clays or clay loams on flood plains; frequently flooded.

Unit Vw–2, dryland.—Deep, somewhat granular, noncalcareous fine sandy loams and clay loams on flood plains; frequently flooded.

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

Sublcass VIe. Soils severely limited, chiefly by risk of erosion, if protective cover is not maintained.

Unit VIe–1, dryland.—Deep, gently sloping fine sandy loams and clay loams; eroded; slowly permeable or very slowly permeable subsoil.

Unit VIe–2, dryland.—Deep to very shallow, strongly sloping clays; eroded; slowly permeable subsoil.

Unit VIe–4, dryland.—Deep, gently sloping loamy fine sands; eroded; slowly permeable subsoil.

Subclass VIs. Soils generally unsuitable for cultivation and limited for other uses by low moisture capacity, stones, or other soil features.

Unit VIs–1, dryland.—Moderately deep and shallow, noncalcareous stony clays and cherty clay loams; slowly permeable subsoil.

Unit VIs–2, dryland.—Very shallow, dark-colored stony clays and stony clay loams over chalk and hard limestone bedrock.

Unit VIs–3, dryland.—Very shallow, rolling and hilly, dark-colored stony clays and stony clay loams over hard limestone bedrock.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation, and that restrict their use largely to grazing, woodland, or wildlife.

Subclass VIIs. Soils very severely limited by moisture capacity, stones, or other soil features.

Unit VIIs–1, dryland.—Very shallow, sloping and strongly sloping, light-colored, calcareous gravelly to stony clay loams over soft limestone bedrock interbedded with hard limestone.

Unit VIIs–2, dryland.—Very shallow, hilly or moderately steep, light-colored, calcareous gravelly to stony clay loams over soft limestone bedrock interbedded with hard limestone.

Unit VIIs–3, dryland.—Deep gullies, hilly gravelly land, and outcrops of caliche.

Class VIII. Soils and landforms that, without major reclamation, have limitations that preclude their use for commercial production of plants and restrict their use to recreation, wildlife, water supply, or esthetic purposes. (There are no class VIII soils in Bexar County.)

In the following pages each capability unit is described, the soils in each are listed, and some suggestions for use and management are given.

Capability unit IIc–1, dryland; I–1, irrigated

The one soil in these units, Willacy loam, 0 to 1 percent slopes, is deep and noncalcareous. It has a moderately permeable subsoil that ordinarily permits easy movement of water, air, and roots. This soil is mainly in the south-central part of the county and occupies less than 1 percent of the acreage. About 90 percent of it is cultivated.

This soil holds moderately large amounts of water available for plants and loses little water as runoff. If it is cultivated when it is too moist, it is susceptible to compaction and a plowpan is likely to form. Both compaction and formation of a plowpan interfere with water intake and root growth.

This soil is well suited to cultivation. Corn and grain sorghum are the chief crops. Small grain, cotton, and flax are grown also, but less extensively. An example of a suitable cropping system is 1 year of small grain or grain sorghum and 3 years of cotton. Occasional crops of Hubam sweetclover or winter peas increase the supply of organic matter and help to improve tilth.

Insufficient rainfall is the chief hazard in dryland farming. In order to keep these soils highly productive and in good tilth, it is important to conserve moisture and to utilize crop residues. The cropping system should provide enough residues to maintain the organic-matter content of the soil and to keep the surface layer in good tilth. For best results, residues should be kept on the surface.

This soil is suited to either surface or sprinkler irrigation. The amount of fertilizer to be applied to irrigated soils is best determined through soil tests.

This soil produces excellent grass. Suitable for pasture are Rhodesgrass, Kleberg bluestem, Gordo bluestem, blue panicgrass, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Sudangrass, sorghum almum, johnsongrass, and small grain provide good supplemental pasture. Pastures need liberal applications of nitrogen and phosphate fertilizers.

Capability unit IIc–2, dryland; I-2, irrigated

These units consist of deep, nearly level, strongly calcareous loamy and clayey soils that have a slowly permeable to moderately permeable subsoil. These soils are—

Lewisville silty clay, 0 to 1 percent slopes.
Venus clay loam, 0 to 1 percent slopes.
Venus loam, 0 to 1 percent slopes.

These soils occur on high, smooth terraces in all parts of the county. Their total acreage is about 7 percent of the county. About 75 percent of their acreage is cultivated.

Moderately large amounts of water are available to plants, and little water is lost as runoff. The surface layer is susceptible to compaction when wet and to crusting when dry, both of which reduce water intake and root growth. The Venus clay loam is somewhat high in lime in some areas, and crops in these limy places are likely to develop chlorosis, or yellowing of the leaves.

These soils are productive, easy to manage, and well suited to the crops commonly grown in the area. Corn and grain sorghum are the chief crops. Cotton, flax, wheat, and oats are grown also, but less extensively. A suitable cropping system would include grain sorghum or small grain at least once every 3 years, or grass and legumes once every 4 years.

Insufficient rainfall is the chief hazard in dryland farming. In order to keep these soils highly productive and in good tilth, it is important to conserve moisture and to utilize crop residues. If kept on the surface, residues improve tilth, help to maintain the supply of organic matter, and prevent crusting. Barnyard manure reduces the risk of chlorosis.

A row system of irrigation is best for these soils. The amount of fertilizer to be applied to irrigated soils is best determined through soil tests.

These soils produce excellent grass. Suitable for pasture are Kleberg bluestem, Gordo bluestem, Medio bluestem, blue panicgrass, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Sudangrass, small grain, sorghum almum, and johnsongrass provide good supplemental pasture. Pastures need liberal amounts of nitrogen and phosphate fertilizers.

Capability unit IIe–1, dryland; IIe–1, irrigated

These units consist of deep, nearly level fine sandy loams that have a slowly permeable to moderately permeable subsoil. These soils are—

Duval fine sandy loam, 1 to 3 percent slopes.
Webb fine sandy loam, 1 to 3 percent slopes.

These soils occur mainly in the southern third of the county. Their total acreage is about 2.5 percent of the county. About 68 percent of their acreage is cultivated.

These soils have good capacity to hold water but lose some water through runoff and are consequently susceptible to erosion.

These soils are productive and are well suited to cultivated crops. They are also suitable for tame pasture. Close-growing crops and crops that leave large amounts of residue, such as small grain and grain sorghum, should be grown once every 3 years. Part of the acreage could be planted to such crops every year.

Controlling erosion and maintaining fertility are the chief management requirements. Terracing and contour tillage help to reduce the amount of runoff. Tillage practices that keep crop residues on the surface are desirable. If kept on the surface, residues not only increase the supply of organic matter and improve tilth but also help to control erosion.

These soils can be farmed satisfactorily without terraces if they are stripcropped to small grain and grain sorghum or if they are used for hay or pasture crops. If the soils are stripcropped, the strips should be about equal in width and should be moved occasionally. The amount of fertilizer to be applied is best determined through soil tests.

These soils are suitable for either sprinkler or row irrigation. With a row system, results are best if the soils are leveled. The cropping system should provide enough residues to supply organic matter and keep the surface layer in good tilth. An example of a suitable system is 1 year of small grain or grain sorghum and then 3 years of corn. Residues should be kept on the surface as long as possible. If a sprinkler system is used, the cropping system should include small grain or grain sorghum every other year or a hay or pasture crop every third year. The amount of fertilizer to be applied to irrigated soils is best determined through soil tests.

Suitable for pasture are weeping lovegrass, blue panicgrass, Medio bluestem, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Small grain, sorghum almum, sudangrass, and johnsongrass provide good supplemental pasture. Pastures need to be fertilized with nitrogen and phosphate.

Capability unit IIe–2, dryland; IIe–2, irrigated

The one soil in these units, Willacy loam, 1 to 3 percent slopes, is deep and noncalcareous and has a moderately permeable subsoil. This soil occurs mainly in the south-central part of the county and occupies less than 1 percent of the acreage. About 90 percent of it is cultivated.

This soil has a moderately high capacity to hold water and plant nutrients. It has good water intake but is susceptible to compaction when moist. Runoff and erosion are hazards.

This soil is well suited to cultivation. It is productive of crops commonly grown in the area and of native grass and adapted varieties of introduced grass. The cropping system should include high-residue crops, which supply organic matter and help to control erosion and conserve moisture. If terracing and contour tillage are used, a suitable cropping system would be 1 year of grain sorghum and then 2 years of cotton or corn. Winter peas or Hubam sweetclover should be grown occasionally. For best results, residues should be kept on the surface.

If irrigated, this soil is highly productive. It is suited to sprinkler irrigation and, if leveled, to surface irrigation. Under surface irrigation, an example of a suitable cropping system is 1 year of small grain or grain sorghum, or of a cover crop, or of a hay or pasture crop, and then 3 years of cotton or corn. Under sprinkler irrigation, a good crop rotation consists of 1 year of grain sorghum or small grain and then 2 years of cotton or corn. Residues need to be kept on the surface. The amount of fertilizer to be applied to irrigated soils is best determined through soil tests.

Suitable for pasture are Rhodesgrass, Kleberg bluestem, Gordo bluestem, blue panicgrass, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Small grain, sudangrass, johnsongrass, and sorghum almum provide good supplemental pasture. Pastures need liberal applications of nitrogen and phosphate fertilizers.

Capability unit IIe–3, dryland; IIe–3, irrigated

These units consist of loamy and clayey soils that are deep, nearly level, and strongly calcareous and have a slowly permeable to moderately permeable subsoil. These soils are—

Austin silty clay, 1 to 3 percent slopes.
Karnes loam, 1 to 3 percent slopes.
Lewisville silty clay, 1 to 3 percent slopes.
Venus clay loam, 1 to 3 percent slopes.
Venus loam, 1 to 3 percent slopes.

These soils occur in all parts of the county. Their total acreage is about 6 percent of the county. About 65 percent of their acreage is cultivated.

The soils in these units are used and managed in about the same way as those in capability unit IIc-2. They lose more water through runoff than those soils and consequently are more likely to erode. Locally, some of the Austin, Karnes, and Venus soils are somewhat high in lime, and crops in these limy places are likely to develop chlorosis, or yellowing of the leaves.

These soils are well suited to cultivated crops. Corn and grain sorghum are the main crops. Tame pasture does well also. If the soils are dryfarmed, the cropping system should include high-residue crops. An example of a suitable system is 1 year of small grain or grain sorghum and then 2 years of cotton or corn. Another example is 1 year of grass or legumes and 3 years of cotton or corn. A cover crop, such as winter peas, should be grown occasionally.

Controlling erosion, conserving moisture, and maintaining fertility are the chief management requirements. Terracing and contour tillage help to reduce runoff. Residues should be kept on the surface as long as possible. Barnyard manure reduces the risk of chlorosis.

If irrigated, these soils are highly productive. They are suited to sprinkler irrigation and well suited to row irrigation. The cropping system should include high-residue crops, which supply organic matter and help to keep the surface layer in good tilth. An example of such a system is 1 year of small grain or grain sorghum and then 3 years of cotton or corn. Residues should be kept on the surface. The amount of fertilizer to be applied to irrigated soils is best determined through soil tests.

Suitable for pasture are Rhodesgrass, Kleberg bluestem, Gordo bluestem, blue panicgrass, Medio bluestem, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Small grain, sudangrass, johnsongrass, and sorghum almum provide good supplemental pasture. Pastures need liberal applications of nitrogen and phosphate fertilizers.

Capability unit IIs–1, dryland; IIs–2, irrigated

These units consist of deep, nearly level, slowly permeable, calcareous clays that harden and crack severely when dry. These soils are—

Houston Black clay, 0 to 1 percent slopes.
Houston Black clay, terrace, 0 to 1 percent slopes.

These soils occur as large areas, mainly in the northeastern, central, and southwestern parts of the county. Their total acreage is about 3 percent of the county. The terrace phase is the more extensive. About three-fourths of their acreage is cultivated.

Preparing a good seedbed is difficult because the surface layer dries slowly after a rain. If the soils are too wet when they are worked, their structure breaks down and a plowpan forms.

These are productive soils. Corn and grain sorghum are the main crops. Cotton, flax, and small grain are grown also, but less extensively. Grass grows well. An example of a suitable cropping system is 1 year of small grain, sudangrass, or grain sorghum and then 3 years of row crops. Another example is 1 year of grass or legumes and 3 years of row crops.

Increasing the water intake, maintaining tilth and fertility, and reducing the loss of moisture by evaporation are the chief management requirements. Growing perennial grass or a legume, such as sweetclover, helps to prevent the formation of a plowpan. Utilizing the residues increases water intake, reduces loss of moisture by evaporation, and prevents crusting.

These soils are suitable for irrigation, particularly to a row system of irrigation. The cropping system should include broadcast crops and high-residue row crops, both of which help to prevent crusting. All residues should be kept on or near the surface as long as possible. The amount of fertilizer to be applied to irrigated soils is best determined through soil tests.

Suitable for pasture are King Ranch bluestem, Rhodesgrass, Kleberg bluestem, Gordo bluestem, Medio bluestem, blue panicgrass, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Small grain, sudangrass, sorghum almum, and johnsongrass provide good supplemental pasture. Applications of nitrogen and phosphate fertilizers are needed.

Capability unit IIw–1, dryland; IIw–1, irrigated

These units consist of deep, nearly level, moderately permeable fine sandy loams and clay loams on flood plains. These soils are—

Frio clay loam.
Gowen clay loam.
Zavala fine sandy loam.

These soils occur along the major rivers and streams and the larger drainageways. They are flooded occasionally.

These soils are easy to manage. They lose little water through runoff. The use of some areas is limited because, as a result of dissection by meandering streams, the surface is uneven and the fields are irregularly shaped. Occasionally, flooding harms crops and also damages the soils by scouring and by leaving deposits of fresh sediments.

All crops commonly grown in the area are moderately well suited. Grain sorghum and corn are the main crops. Native grass and adapted varieties of introduced grass can be grown also. An example of a suitable cropping system is 1 year of small grain or grain sorghum and then 3 years of row crops. Another example is 1 year of grass or legumes or of a cover crop and 3 years of row crops. Winter peas or Hubam sweetclover should be grown occasionally.

Managing floodwater and maintaining fertility are the chief management requirements. A cropping system that includes high-residue plants is important. The residues should be left on or near the surface.

Surface or sprinkler systems of irrigation are suitable. The amount of fertilizer to be applied to irrigated soils is best determined through soil tests. All residues should be kept on or near the surface.

Suitable for pasture are johnsongrass, Rhodesgrass, Medio bluestem, blue panicgrass, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Sudangrass, sorghum almum, small grain, and johnsongrass provide good supplemental pasture. Pastures need regular applications of nitrogen and phosphate fertilizers.

Capability unit IIw–2, dryland

The one soil in this unit, Trinity clay, is deep, nearly level, and calcareous. It is on flood plains along creeks and major streams and in depressions on the uplands. This soil occurs as narrow areas crossed by meandering streams and as low-lying terraces. It is flooded occasionally.

Preparing a good seedbed is difficult because the surface layer dries slowly after rains or flooding. If the soil is too wet when it is worked, its structure breaks down and a plowpan forms. Permeability is slow. The narrow, uneven shape of the areas and the risk of flooding limit the use of the soil for crops.

This soil is well suited to native grass and to hay and pasture mixtures and is moderately well suited to most cultivated crops grown in the county. Corn is the main crop. Grain sorghum, cotton, and some truck crops are grown also. The cropping system should include high-residue crops, such as grain sorghum, small grain, or Hubam sweetclover. Perennial grass and legumes in the rotation help to prevent the formation of a plowpan, and broadcast crops or high-residue crops help to prevent surface crusting.

Managing the excess water and maintaining tilth and productivity are the chief management requirements. The amount of fertilizer to be applied is best determined through soil tests. Keeping large amounts of organic matter or plant residues on the surface or partially working them into the surface improves tilth and water intake. It also supplies organic matter and helps to prevent crusting.

Suitable for pasture are johnsongrass, King Ranch bluestem, Rhodesgrass, and Kleberg bluestem, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Sudangrass, sorghum almum, johnsongrass, and small grain provide good supplemental pasture. Pastures need applications of nitrogen and phosphate fertilizers.

Capability unit IIIe–1, dryland; IIIe–1, irrigated

These units consist of deep, nearly level fine sandy loams and clay loams that have a very slowly permeable subsoil. These soils are—

Crockett fine sandy loam, 1 to 3 percent slopes.
San Antonio clay loam, 1 to 3 percent slopes.

These soils occur mainly in the southern third of the county. Their total acreage is about 4 percent of the county. About 65 percent of their acreage is cultivated.

A crust forms on the surface of these soils. The subsoil is a stiff, blocky clay that impedes the movement of water, air, and roots.

These are moderately productive soils. They are moderately well suited to small grain, grain sorghum, corn, cotton, summer peas, winter peas, flax, sudangrass, Hubam sweetclover, and perennial grass. If these soils are terraced, an example of a suitable cropping system is 1 year of broadcast crops, such as small grain and sudangrass, and then 2 years of cotton or corn. Another suitable system consists of 1 year of grain sorghum planted in rows and then 1 year of cotton. Winter peas or vetch should be planted occasionally. If these soils are not terraced, they should be in close-growing crops continuously, or in a rotation in which grass or legume crops, close-growing crops, and row crops are grown on equal acreages each year. Row crops should be followed by winter cover crops.

Controlling water erosion, increasing water intake, reducing loss of moisture by evaporation, and supplying organic matter are the chief management requirements. Terracing and contour tillage help to protect the soils from water erosion. The terraces need protected outlets for removal of excess water. The outlets should empty into a pasture or into a prepared waterway. The cropping system should include crops that supply organic matter, increase water intake, and prevent surface crusting. All crop residues should be left on or near the surface. The amount of fertilizer to be applied is best determined through soil tests.

These soils are suitable for either row or sprinkler irrigation. Irrigated areas need a crop sequence that provides enough residue to supply organic matter and maintain tilth. Residues should be kept on or near the surface. The amount of fertilizer to be applied to irrigated soils is best determined through soil tests.

Suitable for pasture are Gordo bluestem, blue panicgrass, weeping lovegrass, Medio bluestem, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Small grain, sudangrass, sorghum almum, and johnsongrass provide good supplemental pasture. Pastures need liberal applications of nitrogen and phosphate fertilizers.

Capability unit IIIe–2, dryland; IIIe–2, irrigated

These units consist of deep, nearly level, slowly permeable, calcareous clays and gravelly clays that crack severely when dry and are very sticky and plastic when wet. These soils are—

Crawford clay.
Houston Black clay, 1 to 3 percent slopes.
Houston Black clay, terrace, 1 to 3 percent slopes.
Houston Black gravelly clay, 1 to 3 percent slopes.
Houston clay, 1 to 3 percent slopes.

These soils occur mainly in the northeastern, central, and southwestern parts of the county. Their total acreage is about 11 percent of the county. About 80 percent of their acreage is cultivated.

It is important to till these soils when moisture conditions are favorable. The soils dry slowly after rains. If they are tilled when too wet, the surface crusts and a plowpan forms.

These are productive soils. They are well suited to small grain, grain sorghum, corn, cotton, flax, sudangrass, Hubam sweetclover, summer peas, winter peas, and perennial grass. Corn and grain sorghum are the main crops. If these soils are terraced, a close-growing crop every third year maintains tilth and helps to control erosion. An occasional crop of grass and legumes helps to prevent the formation of a plowpan. If these soils are not terraced, a broadcast crop should be grown each year.

Controlling erosion, increasing water intake, preventing the formation of a plowpan, and maintaining fertility and tilth are the chief management requirements. Terracing and contour tillage help to protect the soils from water erosion if row crops are planted. The terraces need protected outlets for removal of excess water. The outlets should empty into a pasture or into a prepared waterway. The cropping system should include close-growing crops and perennial grass and legumes. All crop residues should be kept on or near the surface. The amount of fertilizer to be applied is best determined through soil tests.

A row system of irrigation is best for these soils. Leveling is necessary. Residues should be kept on or near the surface. The amount of fertilizer to be applied to irrigated soils is best determined through soil tests.

Suitable for pasture are King Ranch bluestem, Rhodesgrass, Kleberg bluestem, Gordo bluestem, Medio bluestem, blue panicgrass, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Pastures need liberal applications of nitrogen and phosphate fertilizers.

Capability unit IIIe-3, dryland

This unit consists of deep, gently sloping, slowly permeable, calcareous clays and gravelly clays that crack severely when dry and are sticky and plastic when wet. These soils are—

- Houston Black clay, 3 to 5 percent slopes.
- Houston Black gravelly clay, 3 to 5 percent slopes.
- Houston clay, 3 to 5 percent slopes, eroded.

These soils occur on uplands, mainly in the northeastern, central, and southwestern parts of the county. Their total acreage is about 2 percent of the county. About 70 percent of their acreage is cultivated.

Preparing a good seedbed is difficult. The soils must be tilled when they are neither too wet nor too dry. If they are too wet when tilled, the structure breaks down and a plowpan forms. Natural fertility is moderate to high. The capacity to hold water and plant nutrients is good. Permeability to water, air, and roots is slow.

Native grass, hay and pasture mixtures, and most crops suited to the area are grown. Corn and grain sorghum are the main crops. If these soils are terraced, half the acreage needs to be in drilled crops each year. If the soils are not terraced, an example of a suitable cropping system is 3 years of drilled crops and then 1 year of a row crop. Another example is 3 years of grass or legumes and 1 year of a row crop.

Moderate to severe water erosion, slow water intake, plowpan formation, low fertility, and poor tilth are the main risks in managing these soils. If the soils are used for row crops, terracing and contour tillage are needed. The terraces need protected outlets for removal of surplus water. Including grass and legumes in the crop rotation prevents the formation of plowpans. Keeping plant residues on the surface or working them into the surface improves tilth and makes preparation of a seedbed easier. It also helps to control erosion, increase water intake, and supply organic matter.

Suitable for pasture are King Ranch bluestem, Rhodesgrass, Kleberg bluestem, Gordo bluestem, Medio bluestem, blue panicgrass, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Small grain, sudangrass, sorghum almum, and johnsongrass provide good supplemental pasture. Pastures need applications of nitrogen and phosphate fertilizers.

Capability unit IIIe-4, dryland; IIIe-3, irrigated

These units consist of deep, gently sloping fine sandy loams that have a slowly permeable or moderately permeable subsoil. These soils are—

- Duval fine sandy loam, 3 to 5 percent slopes.
- Webb fine sandy loam, 3 to 5 percent slopes.

These soils occur mainly in the southern third of the county. Their total acreage is about 1 percent of the county. About 70 percent of their acreage is cultivated.

The capacity to hold water and plant nutrients is moderate. Water intake is slow, and water erosion is a moderate or severe hazard in cultivated areas.

These soils are suited to most crops commonly grown in the area and are well suited to native grass and adapted varieties of introduced grass. Corn, grain sorghum, and small grain are the main crops. If the soils are terraced, an example of a suitable cropping system is 1 year of a drilled crop, such as small grain, 1 year of grain sorghum, and 1 year of a row crop. A cover crop could be substituted for either the small grain or the grain sorghum. Vetch or winter peas should be planted occasionally. If these soils are not terraced, they should be in drilled crops continuously or in a rotation consisting of 3 years of grass and legumes and 1 year of a row crop.

Terracing and contour tillage help to control erosion. The terraces should have protected outlets for removal of surplus water. The outlets should empty into a pasture or a prepared waterway. The cropping system should provide enough residue to supply organic matter, reduce the hazard of erosion, and maintain tilth and fertility. The residues should be kept on the surface. The amount of fertilizer to be applied is best determined through soil tests.

These soils are best suited to a sprinkler system of irrigation. The cropping system in irrigated areas should include high-residue crops, and the residues should be kept on the surface. The amount of fertilizer to be applied to irrigated soils is best determined through soil tests.

A considerable acreage that has been used for crops is being converted to tame pasture. Suitable for pasture are King Ranch bluestem, Rhodesgrass, Medio bluestem, Gordo bluestem, weeping lovegrass, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Sweetclover, such as yellow blossom, Madrid, or Hubam, are suitable legumes for tame pasture. Small grain, sudangrass, sorghum almum, and johnsongrass provide good supplemental pasture. Pastures need liberal applications of nitrogen and phosphate fertilizers.

Capability unit IIIe-5, dryland; IIIe-5, irrigated

These units consist of deep, gently sloping, strongly calcareous loams, clay loams, and silty clays that have a moderately permeable subsoil. These soils are—

Austin silty clay, 3 to 5 percent slopes.
Karnes loam, 3 to 5 percent slopes.
Lewisville silty clay, 3 to 5 percent slopes.
Venus clay loam, 3 to 5 percent slopes.

These soils occur in all but the northwestern and extreme southern parts of the county. Their total acreage is about 1.5 percent of the county. About 60 percent of their acreage is cultivated.

These soils are high in lime and are somewhat droughty. Some crops, such as corn and grain sorghum, may develop chlorosis, or yellowing of the leaves. Runoff is excessive.

Small grain, winter peas, and other cool-season crops are best suited. Corn, cotton, grain sorghum, and summer peas can be grown, but yields are low. Native grass and hay and pasture mixtures do well on these soils. An example of a suitable cropping system is 1 year of small grain or sudangrass and 1 year of a row crop. Another example is 2 years of grain sorghum and 1 year of a row crop.

Controlling erosion, conserving moisture, and improving tilth are the most important management requirements. Terracing and contour tillage help to reduce runoff. Utilizing residues from small grain, grain sorghum, sorghum almum, and other crops improves structure and tilth and provides protection against erosion during heavy rains. Eroded areas should be kept in high-residue crops continuously, and organic matter, such as barnyard manure or cotton burs, should be kept on the surface. After 4 or 5 years of this kind of management, the eroded areas can be managed in the same way as the uneroded areas.

These soils are suitable for irrigation. If irrigated, they can be planted to tame pasture of bermudagrass. The amount of fertilizer to be applied to irrigated soils is best determined through soil tests.

Suitable for pasture are King Ranch bluestem, Rhodesgrass, Kleberg bluestem, Medio bluestem, Gordo bluestem, blue panicgrass, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Small grain, sudangrass, sorghum almum, and johnsongrass provide good supplemental pasture.

Capability unit IIIe-6, dryland; IIIe-5, irrigated

The one soil in these units, Karnes clay loam, 3 to 5 percent slopes, eroded, is moderately deep, moderately permeable, and strongly calcareous. It is inextensive and occurs mainly in the south-central part of the county. Nearly all of it is cultivated.

This soil is suited to cultivation, but it has been damaged by water erosion. It could be restored to productivity if erosion were controlled.

Terracing and contour tillage would help to check erosion. Terraces should have protected outlets that remove excess water to pastures or grassed waterways. Large amounts of organic matter are needed to improve structure and tilth. Small grain, winter peas, sorghum almum, sudangrass, or other high-residue crops should be grown continuously for 4 or 5 years. Residues should be kept on the surface, and additional organic matter, such as barnyard manure or cotton burs, should be applied to the most seriously eroded areas. Nitrogen and phosphate fertilizers are needed.

Irrigated areas could be planted to tame pasture consisting of bermudagrass or some other perennial grass, such as King Ranch bluestem, Rhodesgrass, Medio bluestem, and blue panicgrass. Large amounts of fertilizer are needed. The amount to be applied to irrigated soils is best determined through soil tests.

Capability unit IIIe-7, dryland; IIIe-6, irrigated

These units consist of shallow to moderately deep, nearly level, moderately permeable clay loams and silty clays. These soils are—

Patrick soils, 1 to 3 percent slopes.
Stephen silty clay, 1 to 3 percent slopes.

These soils occur in all parts of the county. Their total acreage is about 2 percent of the county. About half of their acreage is cultivated.

These soils are droughty and are low in natural fertility. Water erosion is a slight hazard. The Stephen soil is limy and is underlain by chalk and chalky marl. The Patrick soils are underlain by gravel. In many places the chalk or gravel has been exposed by tillage or by water erosion.

These soils are well suited to native grass and adapted varieties of introduced grass but are poorly suited to cultivated crops. Cool-season crops grow best. The main crops are small grain, sudangrass, and grain sorghum. An example of a suitable cropping system is 3 years of high-residue crops, such as grain sorghum and small grain, and then 1 year of a row crop. Another suitable system is one that consists of 1 year of a cover crop, 1 year of a drilled crop, and 1 year of a row crop. Winter peas or Hubam sweetclover should be grown occasionally.

Conserving moisture, controlling erosion, supplying organic matter, and maintaining fertility are the important management requirements. All residues should be left on the surface. Areas where the underlying material is exposed need additional organic matter, which can be supplied by applying barnyard manure or cotton burs. Terracing and contour tillage help to reduce runoff and control erosion. The amount of fertilizer to be applied is best determined through soil tests.

Suitable for pasture are blue panicgrass, King Ranch bluestem, Kleberg bluestem, sideoats grama, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Small grain, sudangrass, and sorghum almum provide good supplemental pasture. Pastures need applications of nitrogen and phosphate fertilizers.

Capability unit IIIe-8, dryland; IIIs-1, irrigated

These units consist of level and nearly level, thick loamy fine sands that have a dense, slowly permeable or very slowly permeable subsoil. These soils are—

Hockley loamy fine sand, 0 to 3 percent slopes.
Leming loamy fine sand, 0 to 3 percent slopes.

These soils occur in the southern third of the county. Their total acreage is about 3.5 percent of the county. About 80 percent of their acreage is cultivated.

The surface layer takes in water well, but the subsoil impedes the movement of both water and roots. Natural fertility is low. Wind erosion is a slight to moderate hazard, and the surface is billowy in places.

If properly managed, these soils are productive. Watermelons, peanuts, corn, and grain sorghum are the main crops. Tame pasture consisting of native grass or of adapted varieties of introduced grass do well also. An example of a suitable cropping system is 3 years of drilled crops and then 1 year of a row crop. The row crop should be followed by a winter cover crop.

Controlling erosion, conserving moisture, supplying organic matter, and maintaining fertility are the chief management requirements. If the soils are dryfarmed, drilled crops should be included in the cropping system. Deep plowing helps to maintain a cloddy surface and serves as an emergency and temporary control of wind erosion. Grass and weeds should be allowed to grow late in summer and early in fall, as this increases the amount of organic matter and helps to conserve soil moisture. The amount of fertilizer to be applied is best determined through soil tests.

Much of the acreage is being converted to tame pasture by seeding, sprigging, or sodding with proven varieties of grass. Weeds are controlled by cultivation, mowing, or shredding, or by using chemicals. Pastures are fertilized, and grazing or mowing is controlled until the grass is established. Suitable for tame pasture are Coastal bermudagrass, Rhodesgrass, blue panicgrass, Medio bluestem, and weeping lovegrass.

These soils are suited to sprinkler irrigation. If they are irrigated, the cropping system should include crops that provide enough residue to control wind erosion, maintain tilth, and supply organic matter. The residues should be worked into the surface layer. Liberal applications of nitrogen and phosphate fertilizers are needed.

Capability unit IIIe–9, dryland; IIIs–2, irrigated

The one soil in these units, Duval loamy fine sand, 1 to 5 percent slopes, is deep and has a thick surface layer and a crumbly, moderately permeable subsoil. This soil occurs mainly in the extreme southern part of the county and makes up less than 1 percent of the acreage. About 85 percent of it is cultivated.

This soil takes in water well but has a moderate to low capacity to store water for plants. It is slightly to moderately susceptible to wind and water erosion.

This soil is fairly productive if properly managed. Small grain, grain sorghum, corn, peanuts, and watermelons are the main crops. Native grass and adapted varieties of introduced grass are well suited also.

A good cropping system is that of keeping the soil in drilled small grain or sudangrass half the time, or in a cover crop of grass and legumes for 1 year and then in a row crop for 1 year.

Damage from wind erosion can be limited by keeping a cover of vegetation on this soil, either by growing a cover crop or by utilizing all plant residues. Small grain, winter peas, and other cover crops that are planted late in summer or early in fall generally make enough growth to protect the soil during the blowing season. Stripcropping and leaving grain sorghum stubble as high as feasible help to reduce the danger of wind erosion. Residues from all crops should be left on the surface. They not only protect the soil from blowing but also help to control water erosion and increase tilth and productivity. The amount of fertilizer to be applied is best determined through soil tests.

This soil is suited to sprinkler irrigation. If it is irrigated, the cropping system should include crops that leave large amounts of residue, which supply organic matter, maintain tilth, and protect the soil from wind and water erosion. All plant residues should be left on the surface. The amount of fertilizer to be applied to irrigated soils is best determined through soil tests.

Large acreages of both dryfarmed and irrigated cropland are being converted to tame pasture by seeding, sprigging, or sodding with proven varieties of grass. Weeds are controlled and grazing and mowing are regulated so that the grass can become established. The amount of fertilizer to be applied is best determined through soil tests. Suitable for tame pasture are Coastal bermudagrass, blue panicgrass, Rhodesgrass, Medio bluestem, and weeping lovegrass.

Capability unit IIIe–10, dryland

In this unit is Krum complex, which consists of deep to shallow, gently sloping and sloping, slowly permeable to moderately permeable clays on old alluvial fans and in narrow valleys. This complex occupies less than 1 percent of the county. Less than 15 percent of it is cultivated.

Most of the acreage is in native vegetation because the areas are inaccessible or because they are long, narrow, and irregularly shaped. Only a small part has been cleared and cultivated. The shallow soils are droughty; the deeper soils have good capacity to hold water. Water erosion, the chief limitation, is a moderate to serious hazard.

Small grain is the main crop. Most of it is grazed late in fall and in winter. If the soils in this complex are terraced, a suitable cropping system is 1 year of a drilled crop, 1 year of grain sorghum, and 1 year of a row crop, such as corn. If these soils are not terraced, a high-residue crop, such as drilled small grain or sudangrass, should be grown 2 years out of 3. If properly managed, the residues supply organic matter, improve tilth, and help to control water erosion.

Suitable for pasture are King Ranch bluestem, Rhodesgrass, Kleberg bluestem, Gordo bluestem, blue panicgrass, sideoats grama, little bluestem, indiangrass, green sprangletop, and Wilman lovegrass. Small grain, sudangrass, sorghum almum, and johnsongrass provide good supplemental pasture. Pastures need applications of nitrogen and phosphate fertilizers.

Capability unit IIIs–1, dryland; IIIs–3, irrigated

These units consist of deep, nearly level fine sandy loams and clay loams that have a very slowly permeable subsoil. These soils are—

Crockett fine sandy loam, 0 to 1 percent slopes.
Orelia clay loam, 0 to 1 percent slopes.

These soils are inextensive and occur mainly in the southern and southwestern parts of the county. Nearly all of their acreage is cultivated.

Internal drainage is very slow. The surface layer is slightly or moderately crusty. The subsoil is dense, compact, heavy sandy clay or stiff clay that impedes the movement of water, air, and roots. Most of the rainfall runs off.

Small grain, corn, and grain sorghum are the main crops. Native grass and adapted varieties of introduced grass grow well. An example of a suitable cropping system is 1 year of a high-residue crop, such as small grain or grain sorghum, and then 1 year of a row crop. The row crop should be followed by a winter cover crop.

Increasing the water intake and improving tilth are the chief management requirements. The cropping system should include crops that provide large amounts of residue. For best results, the residues should be left on the surface. The amount of fertilizer to be applied is best determined through soil tests.

These soils are suitable for either sprinkler or row irrigation. If they are irrigated, the cropping system should include 1 year of drilled crops and then 2 years of row crops. Vetch or winter peas should be grown occasionally; such crops supply organic matter and help to maintain tilth and fertility. All plant residues should be left on the surface. Fertilizer is needed. The amount to be applied is best determined through soil tests.

Suitable for pasture are Wilman lovegrass, Rhodesgrass, Kleberg bluestem, Gordo bluestem, blue panicgrass, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Small grain, sudangrass, sorghum almum, and johnsongrass provide good supplemental pasture. Pastures need regular applications of nitrogen and phosphate fertilizers.

Capability unit IIIs-2, dryland; IIs-2, irrigated

The soils in these units, Patrick soils, 0 to 1 percent slopes, are shallow, moderately permeable clay loams, clays, or loams. These soils occur throughout the county on terraces along the major streams and rivers. They are inextensive. Most of their acreage is cultivated.

These soils are droughty and are susceptible to compaction when moist. They are less productive than associated deeper soils.

Grain sorghum, corn, small grain, and cotton are the main crops. Native grass and hay and pasture mixtures can be grown also. An example of a suitable cropping system is 1 year of a drilled crop, such as small grain or sudangrass, and then 2 years of row crops. Another example is 1 year of grain sorghum and 1 year of a row crop.

Maintaining productivity and tilth and adapting a cropping system to the inherent soil limitations are the chief management problems. The cropping system should provide enough residue to supply organic matter, reduce loss of moisture by evaporation, and increase water intake. The residues should be left on the surface. The amount of fertilizer to be applied is best determined through soil tests.

These soils are suited to either sprinkler or row irrigation. If irrigated, they should be mulched or kept in a cover crop or in grass and legumes for 1 year and then in row crops for 2 years. All residues should be kept on the surface. Fertilizer is needed. The amount to be applied to irrigated soils is best determined through soil tests.

Suitable for pasture are Kleberg bluestem, Gordo bluestem, blue panicgrass, weeping lovegrass, and Coastal bermudagrass or other adapted varieties of giant bermudagrass.

Capability unit IVe-1, dryland; IVs-1, irrigated

The one soil in these units, Orelia clay loam, 1 to 3 percent slopes, is deep and dark colored and has a very slowly permeable subsoil. This soil occurs in the southern third of the county. It occupies less than 1 percent of the acreage. About 70 percent of it is cultivated.

This soil has a moderate supply of plant nutrients. Ordinarily, it has poor tilth. The surface layer is slightly crusty and soaks up only a small amount of rainfall.

Small grain, grain sorghum, and corn are the main crops. Coastal bermudagrass, sudangrass, flax, and cotton are grown also, but less extensively. Native grass and adapted varieties of introduced grass are well suited. An example of a suitable cropping system is 1 year of a drilled crop, such as small grain or sudangrass, and 1 year of a row crop. The row crop should be followed by a winter cover crop.

Conserving moisture and improving tilth and productivity are the chief management requirements. The cropping system should include high-residue crops. For best results, all plant residues should be left on the surface. The amount of fertilizer to be applied is best determined through soil tests.

This soil is suited to row irrigation. If it is irrigated, the cropping system should include 1 year of a cover crop, or of grass and legumes, or of a drilled crop and then 1 year of a row crop. All residues should be left on the surface. The amount of fertilizer to be applied to irrigated soils is best determined through soil tests.

Suitable for pasture are Kleberg bluestem, blue panicgrass, weeping lovegrass, Medio bluestem, Gordo bluestem, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Pastures need applications of nitrogen and phosphate fertilizers.

Capability unit IVe-2, dryland

The one soil in this unit, San Antonio clay loam, 3 to 5 percent slopes, is deep, dark colored, and noncalcareous. It has a dense, blocky, very slowly permeable subsoil. This soil occurs mainly in the eastern and southeastern parts of the county. It makes up less than 1 percent of the acreage. About 60 percent of it is cultivated.

This soil takes in water very slowly when wet. It is moderately susceptible to water erosion.

Small grain, grain sorghum, and corn are the main crops. Native grass and adapted varieties of introduced grass do well also. An example of a suitable cropping system is 1 year of grain sorghum planted in rows and then 1 year of a drilled crop, such as small grain or sudangrass. Sweetclover can be substituted occasionally for grain sorghum.

Controlling erosion, conserving moisture, and improving tilth and productivity are the chief management requirements. If this soil is cultivated, a complete terrace system should be installed and all tillage should be on the contour. The cropping system should include crops that leave large amounts of residue. All residues should be left on the surface. The amount of fertilizer to be applied is best determined through soil tests.

Much of the acreage is being converted to tame pasture. Suitable for tame pasture are blue panicgrass, Medio bluestem, Kleberg bluestem, weeping lovegrass, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Small grain, sudangrass, sorghum almum, and johnsongrass provide good supplemental pasture. Pastures need applications of nitrogen and phosphate fertilizers.

Capability unit IVe-3, dryland

This unit consists of deep, gently sloping and sloping, dark-colored, calcareous clays and gravelly clays that have a slowly permeable subsoil. These soils are—

Houston clay, 3 to 5 percent slopes, severely eroded.
Houston Black gravelly clay, 5 to 8 percent slopes.

These soils occur mainly in the northeastern, central, and southwestern parts of the county. They make up about 1 percent of the acreage. About 75 percent of their acreage is cultivated.

Water intake is good when these soils are dry but very slow when they are wet. Water erosion is a hazard, particularly during heavy rains. Natural fertility is moderately high.

Corn, grain sorghum, cotton, and small grain are the main crops. Native grass and adapted varieties of introduced grass do well. If these soils are cultivated, they should be in grass and legumes 4 years out of 5 or continuously in drilled crops, such as small grain and sudangrass.

Controlling erosion, conserving moisture, and improving tilth and productivity are the chief management requirements. All plant residues should be left on the surface. The amount of fertilizer to be applied is best determined through soil tests.

Suitable for tame pasture are deep-rooted grasses, such as King Ranch bluestem, Rhodesgrass, Kleberg bluestem, and Coastal bermudagrass. Small grain, sudangrass, sorghum almum, and johnsongrass provide good supplemental grazing. Pastures need liberal applications of nitrogen and phosphate fertilizers.

Capability unit IVe-4, dryland

This unit consists of Webb soils, 3 to 5 percent slopes, eroded. These soils are deep, fine sandy loams that have a slowly permeable subsoil. They occur mainly in the southern third of the county. Their total acreage is about 2 percent of the county. About half of their acreage is cultivated.

These soils have been damaged by erosion and are somewhat droughty. Erosion has exposed the dense, blocky subsoil (fig. 23); consequently, tilth is poor. Many gullies have formed. Runoff collects in these gullied areas, thereby increasing the hazard of erosion.

Small grain, corn, and grain sorghum are the main cultivated crops. Bermudagrass, sudangrass, flax, and other hay and pasture mixtures are grown also, but less extensively. If these soils are terraced, an example of a suitable cropping system is 1 year of grain sorghum, 1 year of a cover crop, and 1 year of a row crop. The row crop should be followed by a winter cover crop. A drilled crop, such as small grain, can be substituted for the cover crop. If these soils are not terraced, they should be in grass and legumes for 3 or 4 years and then in grain sorghum for 1 year.

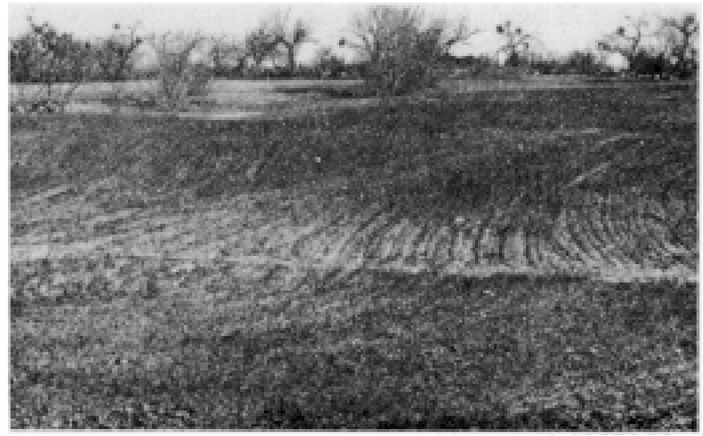

***Figure 23.*—An eroded Webb soil. Note the light-colored areas where erosion has exposed the subsoil. The deeper gullies are not cultivated.**

Controlling erosion, conserving moisture, and improving tilth and productivity are the chief management requirements. Terracing and contour tillage are important. Terraces should empty into pastures or grassed waterways. The cropping system should include crops that leave large amounts of residue, and all residues should be left on the surface. Nitrogen and phosphate fertilizers are needed. The amount to be applied is best determined through soil tests.

Suitable for tame pasture are Kleberg bluestem, blue panicgrass, Medio bluestem, Gordo bluestem, weeping lovegrass, and Coastal bermudagrass or other adapted varieties of giant bermudagrass. Small grain, sudangrass, and sorghum almum provide good supplemental pasture. Pastures need applications of nitrogen and phosphate fertilizers.

Capability unit IVe-5, dryland; IIIe-7, irrigated

These units consist of gently sloping loamy fine sands that have a moderately slowly permeable to very slowly permeable subsoil. These soils are—

Duval soils, 3 to 5 percent slopes, eroded.
Hockley loamy fine sand, 3 to 5 percent slopes.

These soils occur in the southeastern and southern parts of the county. They make up almost 2 percent of the acreage. About 80 percent of their acreage is cultivated.

The sandy surface layer has low capacity to hold water and plant nutrients. Some areas have been damaged by wind and water erosion.

These soils are best suited to native grass or to adapted varieties of introduced grass. Grain sorghum, small grain, corn, peanuts, and watermelons are the main cultivated crops. An example of a suitable cropping system is 2 years of small grain, 1 year of grain sorghum, and then 1 year of a row crop. A cover crop can be substituted for the small grain in the rotation.

Although these soils are best suited to perennial vegetation, they can be farmed if a continuous cover of plants and plant residues is maintained. A drilled crop should be included in the cropping system. Deep plowing increases the amount of clay in the surface layer. The eroded areas can be terraced if enough of the clayey subsoil material is used to stabilize the terrace ridges. Productivity can be increased by the addition of nitrogen and phosphate fertilizers. The amount to be applied is best determined through soil tests.

These soils are best suited to the sprinkler type of irrigation. They require the same management under irrigation as they do if dryfarmed.

Suitable pasture grasses are Coastal bermudagrass, weeping lovegrass, blue panicgrass, Medio bluestem, and Kleberg bluestem. Small grain and sudangrass provide good supplemental pasture. Pastures need applications of nitrogen and phosphate fertilizers.

Capability unit IVe-6, dryland; IIIs-4, irrigated

The one soil in these units, Eufaula fine sand, 0 to 5 percent slopes, is a deep, loose sand that is underlain by sandy clay loam at a depth of 42 to 100 inches or more. In places the slope is as much as 8 percent. This soil occurs in the extreme southern part of the county. It makes up about 5 percent of the acreage. About 10 or 12 percent of it is cultivated, and the rest is used as range.

This soil has low capacity to hold water and plant nutrients. It is highly susceptible to wind erosion and is best suited to perennial vegetation.

Peanuts and watermelons are the main cultivated crops. Small grain, grain sorghum, and corn are also grown, but less extensively. An example of a suitable cropping system is 1 year of grain sorghum and then 1 year of a row crop. The row crop should be followed by a winter cover crop.

Controlling erosion, conserving moisture, and improving fertility are the chief management requirements. If cultivated, this soil must be protected by maintaining a continuous cover of plants and plant residues. The residues should be left on the surface. They not only supply organic matter and help to control wind erosion but also reduce the loss of moisture by evaporation. Wind stripcropping helps to control soil blowing. The amount of fertilizer to be applied is best determined through soil tests.

The sprinkler type of irrigation is most suitable. If irrigated, this soil should be planted to small grain for 1 year and then to a row crop for 1 year. A cover crop or a grass or legume crop can be substituted for the small grain. A winter cover crop should be grown also. Fertilizer is needed. The amount to be applied to irrigated soils is best determined through soil tests.

Large acreages of cropland are being converted to pasture, mostly irrigated tame pasture. Suitable for pasture are Coastal bermudagrass or other adapted varieties of giant bermudagrass. Liberal applications of nitrogen and phosphate fertilizers are needed.

Capability unit IVe-7, dryland

This unit consists of shallow and deep, nearly level and gently sloping, moderately permeable clay loams and silty clays. These soils are—

Brackett-Austin complex, 1 to 5 percent slopes.
Brackett clay loam, 1 to 5 percent slopes.
Patrick soils, 3 to 5 percent slopes.
Stephen silty clay, 3 to 5 percent slopes.

These soils occur mainly in the north-central half of the county. They occupy less than 1 percent of the acreage. About half of their acreage is cultivated.

For the most part, these soils are so shallow that they cannot store large amounts of water. They are too droughty to be productive of row crops. They are moderately susceptible to water erosion. Natural fertility is low.

These soils are best suited to native grass or to adapted varieties of introduced grass. Small grain is the main cultivated crop. An example of a suitable cropping system is 3 or 4 years of small grain and then 1 year of grain sorghum.

Conserving moisture, controlling erosion, and improving tilth are the chief management requirements. If these soils are cultivated, a complete terrace system should be installed and all tillage should be on the contour. Terrace outlets should be protected, and excess water should empty into pastures or into grassed waterways. The cropping system should provide large amounts of plant residues, and residues should be left on the surface.

Suitable for pasture are bermudagrass, King Ranch bluestem, blue panicgrass, sideoats grama, little bluestem, and johnsongrass. Small grain, sudangrass, sorghum almum, and johnsongrass provide good supplemental pasture. Pastures need applications of nitrogen and phosphate fertilizers.

Capability unit Vw-1, dryland

The soils in this unit, Trinity and Frio soils, frequently flooded, are deep, dark-colored, calcareous clays or clay loams on flood plains. These soils are nearly level and poorly drained. They occur mainly in the northern half of the county. Their total acreage is about 3 percent of the county. Less than 5 percent of their acreage is cultivated.

These soils receive runoff from higher lying soils and are subject to the hazards of flooding, scouring, and deposition of fresh material. For the most part, they are slowly permeable to water, air, and roots. Natural fertility is high.

Because of flooding, these soils are not suited to cultivated crops. They are best suited to native grass or to adapted varieties of introduced grass. They are highly productive but require careful management.

Maintaining an adequate cover of vegetation is most important. Ordinarily, such cover can be established by proper seeding and by regulation of grazing and mowing. Only half the current growth of native grass should be grazed off. Mowing or spraying helps to keep down undesirable weeds and brush. Brush control may be needed in some areas. Some scoured or gullied areas may need to be shaped.

These soils are used mostly for permanent hay or as pasture and range. There are suitable sites for farm ponds and for wildlife and recreational areas.

Capability unit Vw–2, dryland

The soils in this unit, Zavala and Gowen soils, frequently flooded, are deep, poorly drained, somewhat granular, noncalcareous fine sandy loams and clay loams on flood plains. These soils occur mainly in the southern half of the county. Their total acreage is less than 1 percent of the county. Less than 5 percent of their acreage is cultivated.

These soils receive runoff from higher lying soils and are subject to the hazards of flooding, scouring, and deposition after every heavy rain. They are moderately permeable to water, air, and roots. Natural fertility is moderate.

Because of flooding, these soils are not suited to cultivated crops. They are best suited to native grass or to adapted varieties of introduced grass. They are moderately productive but require careful management.

Maintaining an adequate cover of vegetation is most important. Ordinarily, such cover can be established by proper seeding and by regulation of grazing and mowing. Only half the current growth of native grass should be grazed off. Mowing, spraying, or shredding helps to keep down undesirable weeds and brush. Brush control may be needed in some areas. Some scoured or gullied areas may need to be shaped.

These soils are used mostly for permanent hay or as pasture and range. There are suitable sites for farm ponds and for wildlife and recreational areas.

Capability unit VIe–1, dryland

This unit consists of deep, gently sloping, eroded fine sandy loams and clay loams that have a slowly permeable or very slowly permeable subsoil. These soils are—

Crockett soils, 2 to 5 percent slopes, eroded.
San Antonio clay loam, 3 to 5 percent slopes, eroded.
Webb soils, 3 to 5 percent slopes, severely eroded.

These soils occur mainly in the southeastern and southern parts of the county. They make up less than 1 percent of the acreage. About 35 percent of their acreage is cultivated.

The organic-matter content of these soils is low, and the natural fertility is moderate to low. Runoff is rapid, and gullies have formed.

These soils have been damaged by erosion to the degree that they are not suited to cultivated crops. They are best suited to native grass or to adapted varieties of perennial grass. They are only moderately productive.

The chief management need is to establish and maintain an adequate cover of vegetation. Such management includes regulation of grazing or mowing, increasing fertility, improving water intake, and controlling erosion. Only half the current growth of native grass should be grazed off. Mowing, spraying, or shredding helps to keep down weeds, brush, and undesirable plants. Brush control may be needed in some areas. Diversion terraces may be needed. Some gullies need to be shaped or to be stabilized by means of erosion-control structures.

These soils are used mostly for permanent hay or as pasture and range. There are suitable sites for farm ponds and for wildlife and recreational areas.

Capability unit VIe–2, dryland

The soils in this unit, Houston–Sumter clays, 5 to 10 percent slopes, severely eroded, are deep to very shallow and have a slowly permeable subsoil. These soils occur in the northeastern, central, and southwestern parts of the county. Their total acreage is less than 2 percent of the county. About 30 percent of their acreage is cultivated.

These soils are droughty, moderate to low in natural fertility, and low in organic-matter content. They have been damaged by water erosion. Runoff is rapid, and gullies form readily. The capacity to store water is fair to poor.

Because of the strong slopes and the damage from erosion, these soils are not suited to cultivated crops. They are best suited to native grass or to adapted varieties of perennial grass. They are moderately productive during seasons of normal rainfall but require careful management.

Establishing an adequate cover of vegetation by seeding and by regulation of grazing is the chief management need. Grazing should be regulated so that half the current growth of desirable grass is left as a protective cover. Brush control is needed in some areas. Diversion terraces may be needed in gullied areas. Some gullies need to be shaped, and some need to be stabilized by means of erosion-control structures.

These soils are used for hay crops or as pasture and range. There are suitable sites for farm ponds and for wildlife and recreational areas.

Capability unit VIe–4, dryland

The one soil in this unit, Hockley loamy fine sand, 3 to 5 percent slopes, eroded, is deep and has a slowly permeable subsoil. This soil occurs in the southern third of the county. It makes up about 1 percent of the acreage. About 45 percent of it is cultivated.

This soil is droughty, moderately low in natural fertility, and low in organic-matter content. It has been damaged by erosion. Runoff is rapid. Gullies form readily, and existing gullies increase in size.

Because this soil is highly susceptible to water erosion, it is not suited to cultivated crops. It is best suited to native grass or to adapted varieties of introduced grass. It is only fairly productive.

Establishing a good cover of vegetation is the chief management requirement. Grazing must be regulated. Brush control may be needed in some areas. Most drainageways can be converted to grassed waterways. Diversion terraces may be needed in some gullied areas. In places erosion-control structures are needed to stabilize gullied natural waterways.

This soil is used mostly for hay crops or as tame pasture and range. There are suitable sites for farm ponds and for wildlife and recreational areas.

Capability unit VIs–1, dryland

The soils in this unit, Crawford and Bexar stony soils, are moderately deep and shallow, noncalcareous stony clays and cherty clay loams that have a slowly permeable subsoil. These soils occur in the northern third of the county. They make up about 5 percent of the acreage.

Because these soils are so rocky, they are not suited to cultivated crops. They are best suited to native grass.

Natural fertility is high, and nutritious grass grows abundantly. Careful management is required.

Establishing a cover of perennial native grass that increases in quality and quantity and protects the soil from erosion is the chief management need. Grazing should be regulated so that half the current growth of desirable grass is left each year. Range seeding, brush control, fencing, and water development may be needed.

For the most part, these soils are used as range or for suburban homesites. There are suitable sites for farm ponds and for wildlife and recreational areas.

Capability unit VIs–2, dryland

This unit consists of very shallow, dark-colored stony clays and stony clay loams over chalk and hard limestone bedrock. These soils are—

Tarrant association, gently undulating.
Tarrant soils, chalk substratum, undulating.

For the most part, these soils are very shallow and rocky. They have limited capacity to store water and consequently are droughty. They are moderately high in natural fertility but only fairly productive. There are, however, small areas of deep and moderately deep clayey soils that are moderately productive.

These soils are not suited to cultivated crops. They are best suited to native grass.

Establishing an adequate cover of native grass that increases in quality and quantity and protects the soils from erosion is the chief management need. Grazing should be regulated so that half the current growth of desirable grass is left each year. Deferment of grazing, water development, brush control, range seeding, and fencing may be needed.

These soils are used mostly as range or for suburban homesites. There are also suitable sites for wildlife and recreational areas.

Capability unit VIs–3, dryland

This unit consists of very shallow, rolling and hilly, dark-colored stony clays and stony clay loams over hard limestone bedrock. These soils are—

Brackett-Tarrant association, hilly (Tarrant soils only).
Tarrant association, rolling.
Tarrant association, hilly.

These soils are fertile but droughty. They are also susceptible to water erosion. They are not suitable for cultivation and are best used as range. They are moderately productive but require careful management.

Providing an adequate cover of grass that will protect these soils from erosion is the chief management need. Grazing should be regulated so that only half the current growth is grazed each year. Deferment of grazing, range seeding, water development, fencing, and brush control are a few of the necessary management practices.

These soils are used mostly as range. There are suitable sites for wildlife and recreational areas and also for suburban uses.

Capability unit VIIs–1, dryland

The soils in this unit, Brackett soils, 5 to 12 percent slopes, are very shallow, light-colored, calcareous gravelly to stony clay loams over soft limestone bedrock interbedded with hard limestone. These soils occur mainly in the northwestern part of the county. Their total acreage is less than 2 percent of the county. Less than 15 percent of their acreage is cultivated.

These soils are droughty and limy. A crust is likely to form on the surface. Natural fertility is low. Water erosion is a hazard.

These are unproductive soils that are not suited to cultivated crops. They are best suited to native grass. They need careful management.

The chief management need is to maintain an adequate cover of vegetation. Grazing should be regulated so that only half the current growth of desirable grass is grazed off. Deferment of grazing, range seeding, water development, fencing, and brush control are a few of the necessary management practices.

These soils are used mostly as range. There are suitable sites for farm ponds and for wildlife and recreational areas.

Capability unit VIIs–2, dryland

This unit consists of very shallow, hilly or moderately steep, light-colored, calcareous gravelly to stony clay loams over soft limestone bedrock interbedded with hard limestone. These soils are—

Brackett soils, 12 to 30 percent slopes.
Brackett-Tarrant association, hilly (Brackett soils only).

These soils occur in the northern and northwestern parts of the county. They make up almost 6 percent of the acreage.

Natural fertility is low, and the water-storage capacity is limited. The surface tends to crust. Water erosion is the chief hazard. These soils are best suited to native grass. They require careful management.

Maintaining an adequate cover of vegetation is the chief management need.

Grazing should be regulated so that only half the current growth of desirable grass is grazed off. Deferment of grazing, range seeding, water development, fencing, and brush control are a few of the necessary management practices.

These soils are used mostly as range. There are suitable sites for farm ponds and for wildlife and recreational areas.

Capability unit VIIs–3, dryland

This unit consists of deep gullies, hilly gravelly land, and outcrops of caliche. There is little or no soil. The land types in this unit are—

Gullied land.
Hilly gravelly land.

These land types occur throughout the county but are inextensive. Less than 5 percent of their acreage is cultivated. They are best suited to native grass, but they are not productive and the vegetation is scanty and of poor quality.

Maintaining an adequate cover of vegetation is the chief management need.

Grazing should be regulated so that only half the current growth of native grass is grazed off. Deferment of grazing, fencing, range seeding, and brush control are a few of the necessary management practices. These land types are used mostly as range. There are suitable sites also for wildlife and recreational areas.

Predictions of Crop Yields

Table 2 lists the soils of Bexar County and gives predictions of average acre yields of the principal crops under two levels of dryland management. The figures in the A columns are predictions of yields under ordinary management; those in the B columns are predictions of yields under improved management but are not assumed to represent the maximum obtainable.

The improved management used to obtain the yields given in the B columns of table 2 includes the following measures:

1. Consistent use of soil-improving crops, cover crops, and high-residue crops in the rotations.
2. Proper management of crop residues.
3. Conservation of moisture by means of such practices as terracing and contour farming.
4. Timely application of fertilizer in amounts determined by soil and crop needs.
5. Timely tillage, seeding, and harvesting.
6. Timely measures for control of weeds, insects, and plant diseases.
7. Selection of proven better varieties of crops, timely planting, and proper spacing.

TABLE 2.—*Predicted average acre yields of the principal crops under two levels of management (dryland)*

[Yields in A columns are those obtained under ordinary management; those in B columns are yields to be expected under improved management. Dashes indicate that the soil is not commonly used for crops]

Soil	Cotton		Corn		Grain sorghum		Wheat	
	A	B	A	B	A	B	A	B
	Lb. of lint	*Lb. of lint*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*
Austin silty clay, 1 to 3 percent slopes	200	300	22	36	1, 800	3, 000	14	26
Austin silty clay, 3 to 5 percent slopes	180	275	20	34	1, 600	2, 800	13	24
Brackett soils, 12 to 30 percent slopes	-	-	-	-	-	-	-	-
Brackett soils, 5 to 12 percent slopes	-	-	-	-	-	-	-	-
Brackett clay loam, 1 to 5 percent slopes	135	175	11	21	750	1, 550	7	15
Brackett-Austin complex, 1 to 5 percent slopes:								
Brackett	135	175	11	21	750	1, 550	7	15
Austin	180	275	20	34	1, 600	2, 800	13	24
Brackett-Tarrant association, hilly	-	-	-	-	-	-	-	-
Crawford and Bexar stony soils	-	-	-	-	-	-	-	-
Crawford clay	250	325	25	40	2, 200	3, 500	23	35
Crockett fine sandy loam, 0 to 1 percent slopes	150	275	17	28	1, 400	2, 400	12	20
Crockett fine sandy loam, 1 to 3 percent slopes	125	250	15	26	1, 200	2, 200	10	18
Crockett soils, 2 to 5 percent slopes, eroded	-	-	-	-	-	-	-	-
Duval fine sandy loam, 1 to 3 percent slopes	190	240	17	26	1, 400	2, 400	14	22
Duval fine sandy loam, 3 to 5 percent slopes	175	230	16	25	1, 300	2, 300	13	21
Duval loamy fine sand, 1 to 5 percent slopes	95	200	11	20	950	1, 650	7	14
Duval soils, 3 to 5 percent slopes, eroded	90	195	10	19	900	1, 600	7	14
Eufaula fine sand, 0 to 5 percent slopes	90	200	10	21	800	1, 500	6	14
Frio clay loam	245	315	25	37	2, 100	3, 300	18	27
Gowen clay loam	220	320	24	40	2, 000	3, 200	16	30
Gullied land	-	-	-	-	-	-	-	-
Hilly gravelly land	-	-	-	-	-	-	-	-
Hockley loamy fine sand, 0 to 3 percent slopes	100	225	12	22	1, 000	1, 800	8	15
Hockley loamy fine sand, 3 to 5 percent slopes	90	210	11	21	900	1, 700	7	14
Hockley loamy fine sand, 3 to 5 percent slopes, eroded	80	200	10	20	800	1, 600	6	13
Houston clay, 1 to 3 percent slopes	225	325	23	37	2, 000	3, 300	20	32
Houston clay, 3 to 5 percent slopes, eroded	225	325	23	37	2, 000	3, 300	20	32
Houston clay, 3 to 5 percent slopes, severely eroded	215	300	20	34	1, 800	3, 100	17	29
Houston-Sumter clays, 5 to 10 percent slopes, severely eroded	-	-	-	-	-	-	-	-
Houston Black clay, 0 to 1 percent slopes	300	425	28	42	2, 400	3, 900	25	38
Houston Black clay, 1 to 3 percent slopes	275	350	26	38	2, 200	3, 700	23	36
Houston Black clay, 3 to 5 percent slopes	245	325	24	35	2, 000	3, 400	21	33
Houston Black clay, terrace, 0 to 1 percent slopes	300	425	28	42	2, 400	3, 900	25	38
Houston Black clay, terrace, 1 to 3 percent slopes	275	350	26	38	2, 200	3, 700	23	36
Houston Black gravelly clay, 1 to 3 percent slopes	280	360	27	40	2, 300	3, 800	24	37
Houston Black gravelly clay, 3 to 5 percent slopes	255	330	25	36	2, 100	3, 500	22	34
Houston Black gravelly clay, 5 to 8 percent slopes	235	300	21	32	1, 800	3, 200	17	29
Karnes loam, 1 to 3 percent slopes	190	275	21	33	1, 800	2, 600	13	25
Karnes loam, 3 to 5 percent slopes	175	260	18	30	1, 600	2, 400	12	24
Karnes clay loam, 3 to 5 percent slopes, eroded	190	240	18	30	1, 500	2, 500	12	21
Krum complex	200	250	20	32	1, 600	2, 700	13	22
Leming loamy fine sand, 0 to 3 percent slopes	120	235	14	23	1, 100	1, 900	10	16
Lewisville silty clay, 0 to 1 percent slopes	245	345	25	40	2, 100	3, 400	16	28
Lewisville silty clay, 1 to 3 percent slopes	225	320	23	38	1, 900	3, 000	16	28
Lewisville silty clay, 3 to 5 percent slopes	200	275	20	34	1, 600	2, 800	13	24
Orelia clay loam, 0 to 1 percent slopes	220	300	24	35	2, 000	3, 200	16	30
Orelia clay loam, 1 to 3 percent slopes	200	275	22	30	1, 800	3, 000	12	26
Patrick soils, 0 to 1 percent slopes	180	250	18	28	1, 400	2, 200	14	22

TABLE 2.—*Predicted average acre yields of the principal crops under two levels of management (dryland)*—Continued

Soil	Cotton		Corn		Grain sorghum		Wheat	
	A	B	A	B	A	B	A	B
	Lb. of lint	*Lb. of lint*	*Bu.*	*Bu.*	*Lb.*	*Lb.*	*Bu.*	*Bu.*
Patrick soils, 1 to 3 percent slopes	160	225	16	26	1, 200	2, 000	12	20
Patrick soils, 3 to 5 percent slopes	150	200	14	24	1, 000	1, 800	10	18
Pits and Quarries								
San Antonio clay loam, 1 to 3 percent slopes	220	300	24	35	2, 000	3, 200	16	30
San Antonio clay loam, 3 to 5 percent slopes	200	275	22	32	1, 800	2, 800	14	28
San Antonio clay loam, 3 to 5 percent slopes, eroded	185	230	20	30	1, 600	2, 600	12	26
Stephen silty clay, 1 to 3 percent slopes	160	225	16	26	1, 200	2, 000	12	20
Stephen silty clay, 3 to 5 percent slopes	150	200	14	24	1, 000	1, 800	10	18
Tarrant association, gently undulating								
Tarrant association, rolling								
Tarrant association, hilly								
Tarrant soils, chalk substratum, undulating								
Trinity clay	300	425	30	45	2, 500	4, 000	26	40
Trinity and Frio soils, frequently flooded								
Venus loam, 0 to 1 percent slopes	220	300	22	36	1, 800	3, 000	15	26
Venus loam, 1 to 3 percent slopes	190	275	21	33	1, 800	2, 600	13	25
Venus clay loam, 0 to 1 percent slopes	240	310	24	36	2, 000	3, 200	17	26
Venus clay loam, 1 to 3 percent slopes	220	275	22	34	1, 800	2, 800	15	24
Venus clay loam, 3 to 5 percent slopes	200	265	20	30	1, 600	2, 600	13	22
Webb fine sandy loam, 1 to 3 percent slopes	130	260	18	28	1, 300	2, 400	14	22
Webb fine sandy loam, 3 to 5 percent slopes	100	225	13	24	1, 000	2, 000	8	16
Webb soils, 3 to 5 percent slopes, eroded	80	200	11	22	800	1, 800	6	14
Webb soils, 3 to 5 percent slopes, severely eroded								
Willacy loam, 0 to 1 percent slopes	240	325	24	38	2, 000	3, 300	16	28
Willacy loam, 1 to 3 percent slopes	220	300	22	36	1, 800	3, 000	15	26
Zavala fine sandy loam	205	195	20	34	1, 700	2, 800	14	25
Zavala and Gowen soils, frequently flooded								

Ordinary management is management that is deficient in one or more of the measures that make up a program of improved management.

The predictions in table 2 are based on information obtained from farmers and on the results of long-term experiments. No predictions of yields are given for miscellaneous land types and for the soils that are not commonly used for the specified crops. Such soils include those mapped in associations; some steep, stony, or severely eroded soils; and soils that are frequently flooded.

Range[2]

Native grassland amounts to about 40 percent of the total land area of Bexar County, or nearly 320,000 acres. Two areas in the county are used primarily for range. The larger of these is the Edwards Plateau, which is a limestone area in the northern third of the county (fig. 24). This area has about 214,000 acres of rangeland. The other is much smaller. It consists of about 35,000 acres of sandhills located in the southern end of the county. The remaining 71,000 acres of rangeland consists of bottom lands that are flooded occasionally and of small pastures on approximately 1,000 livestock farms scattered throughout the county. On almost all the ranches, some cropland is used for supplemental grazing. The chief crops used for temporary grazing are small grain, sudangrass, and johnsongrass.

The original grass cover of Bexar County consisted principally of medium height grasses. The rangelands have been grazed by domestic livestock since early in the 1700's, when the Spanish missions were established. Grazing has been both heavy and continuous and has resulted in deterioration of the plant cover and in excessive crusting of the soil. The better forage plants have decreased, and brush and other inferior plants have increased.

Production of range vegetation is affected by the climate. In Bexar County, there are two well-defined growing seasons. The season of greatest production extends through April, May, and June. In most years, this is the period when rainfall is heaviest and temperatures are most favorable for the growth of warm-season grasses. The other growing season is during September and October. Rainfall is generally lighter during this period than in spring, and cool temperatures at night during the last part of the fall season slow the growth of warm-season grasses. High temperatures and low rainfall retard the growth of forage plants during July and August. In December, January, February, and March, warm-season plants grow very slowly because of the short days, cool temperatures, and low rainfall. High humidity and misty weather during this period often cause standing dry grass to deteriorate in food value. Overgrazed ranges are likely to be short of suitable forage during this part of the winter season.

Range sites and condition classes

Rangeland is classified into range sites according to its ability to produce native vegetation. Different kinds of range produce different kinds and amounts of grass. The inherent productive capacity of different areas of

[2] This section prepared by DEAN ISAACS, range conservationist, Soil Conservation Service.

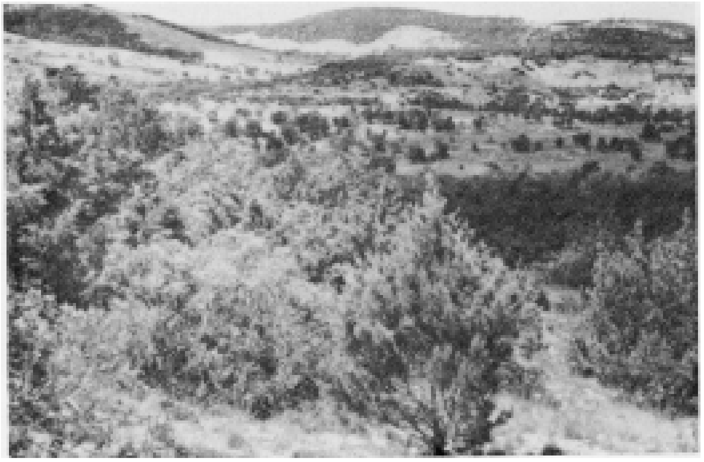

Figure 24.—**Typical landscape on Edwards Plateau.**

rangeland depends principally on the combined effects of the soils and the climate. Each range site has its own soils and environmental conditions, and these produce a characteristic plant community.

Climax vegetation is the stabilized plant community on a particular range site. It reproduces itself and makes only small adjustments over a period of years, so long as the environment remains unchanged. In the descriptions of range sites, native plants are referred to as increasers, decreasers, and invaders. Increasers and decreasers are a part of the climax vegetation.

Livestock graze selectively and seek the plants that are the most palatable. Decreasers are steadily reduced or killed out under heavy continuous grazing because the livestock generally prefer them. Increasers are plants that begin to spread when the decreasers begin to decline. These plants are commonly shorter and less palatable than the decreasers. If the increasers are grazed heavily, they may decline and be replaced by invader plants. Invaders are plants normally not present in the climax vegetation. Many are plants not suitable for grazing, such as brush, and others are less palatable, low-growing grasses and weeds.

Four range condition classes are recognized. The classes are based on degree of departure from the original or climax vegetation brought about by grazing or other use. They show the difference between what is now growing on the site and the native vegetation that originally grew on that particular site. Range condition is expressed as follows: A range is in *excellent condition* if 75 to 100 percent of the vegetation is of the same kind as in the original stand. It is in *good condition* if the percentage is between 50 and 75, in *fair condition* if the percentage is between 25 and 50, and in *poor condition* if the percentage is less than 25.

Good range management requires recognition of the range site and determination of range condition. Range that is kept in good or excellent condition provides optimum forage yields and is protected against excessive erosion and loss of water. Local representatives of the Soil Conservation Service can help make range-site and range-condition determinations and can help in the planning of a management program that will improve or maintain the condition of the range.

Descriptions of range sites

The soils of Bexar County have been grouped into ten major range sites and eight minor ones. The major sites are called Rocky Upland, Low Stony Hill, Steep Rocky, Adobe, Steep Adobe, Redland, Sandy Savannah, Valley, Loamy Bottomland, and Rolling Blacklands. The minor sites occur as small scattered tracts.

Each site differs enough from all the others to produce a significantly different kind and amount of climax vegetation and to require different management. Descriptions of the individual sites follow. Each description includes information about the nature of the soils, the topography, and the native vegetation. Each also gives predictions of herbage yields. The predictions are based partly on records of yields from clipped plots and partly on estimates. They represent air-dry weight of herbage. Woody plants are not included.

ROCKY UPLAND RANGE SITE

This site is made up mainly of very shallow, dark-gray, calcareous clay loams and clays that have varying amounts of stones, flagstones, cobblestones, gravel, and channery fragments scattered on the surface and distributed through the profile. These soils are predominantly 6 to 10 inches deep, but there are pockets of deeper soil and also spots where bedrock is exposed. The soils in this site are—

Tarrant association, gently undulating.
Tarrant soils, chalk substratum, undulating.

Small tracts of the Redland site and of the Adobe site are commonly associated with the Rocky Upland site, and some are included within areas of the Rocky Upland site.

Areas typical of the Rocky Upland site are reached by going approximately 8 miles northwest from San Antonio on Culebra Road, then about 2.5 miles north on Tezel Road. The areas are in pastures on either side of the road.

The dominant decreasers on this site are little bluestem (which makes up 50 percent of the climax vegetation), sideoats grama, plains lovegrass, Canada wildrye, and green sprangletop.

The increasers are hairy grama, buffalograss, curly mesquite, slim tridens, Texas wintergrass, and fall witchgrass. Woody increasers are live oak and shin oak.

As the range condition declines, the site is invaded by hairy tridens, red grama, tumblegrass, Evax, pricklypear, buffalo-bur, mealycup sage, and three-awn. Ashe juniper is the main woody invader.

Yields of forage vary, depending on the depth of the soil. Low moisture-holding capacity limits productivity, but rain that falls as small showers is utilized effectively, because of the rocky surface.

If in excellent condition, this site yields about 4,000 pounds per acre of grasses, forbs, and annuals in years when the moisture supply is favorable. If in poor condition, it yields about 750 pounds. Figure 25 shows the contrast in appearance between an area of this site in good condition and an area in poor condition.

LOW STONY HILL RANGE SITE

This site is made up of very shallow, dark-gray, calcareous clay loams and clays that have varying amounts

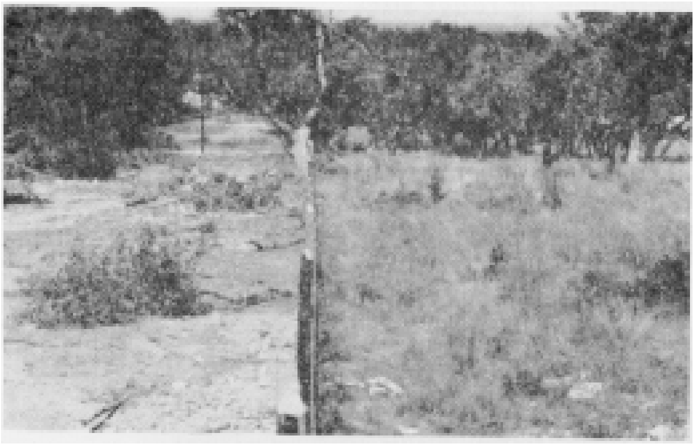

Figure 25.—**Rocky Upland range site. The pasture on the right of the fence is in good condition, and the one on the left of the fence is in poor condition.**

of stones, cobblestones, flagstones, channery fragments, and gravel scattered on the surface and distributed through the profile. The depth of these soils ranges from 5 to 12 inches but is predominantly less than 6 inches. There are scattered pockets of deep soil. The underlying limestone is cracked and fissured, and the cracks contain some soil fines. The soils in this site are—

Tarrant soils in Brackett-Tarrant association, hilly.
Tarrant association, rolling.

An area typical of the Low Stony Hill site is approximately 12 miles northeast of San Antonio on Bulverde Road, half a mile north of its intersection with Evans Road and to the west of the road.

The dominant decreasers on this site are little bluestem, indiangrass, sideoats grama, green sprangletop, plains lovegrass, and Texas cupgrass.

The increasers are hairy dropseed, buffalograss, Texas wintergrass, feather bluestem, Wright three-awn, and perennial legumes. Woody increasers are scrubby live oak and shin oak. Forbs classed as increasers or as part of the climax vegetation are bush sunflower, orange zexmenia, and sagewort.

As the range condition declines, this site is invaded by purple three-awn, hairy tridens, Texas grama, red grama, queensdelight, annual grasses and forbs, Ashe juniper, Texas persimmon, and Texas oak.

This site is productive if well managed. It is seldom bare of vegetation, partly because moisture is held among the surface rocks and in the fissures in the underlying limestone.

If in excellent condition, this site yields about 3,750 pounds of herbage per acre in favorable years. If in poor condition, it yields about 1,000 pounds.

STEEP ROCKY RANGE SITE

This site is made up of very shallow, very dark grayish-brown, calcareous clay loams and clays that have stones, cobblestones, flagstones, channery fragments, and gravel scattered on the surface and distributed through the profile. Stones, limestone fragments, and exposures of bedrock cover from 40 to 70 percent of the surface. Stones and fragments make up 20 to 50 percent of the soil mass, by volume. The terrain is rough enough to obstruct the movement of livestock (fig. 26). The slope range is 12 to 45 percent, and the escarpments along some of the major streams are very steep. The only mapping unit in this site is—

Tarrant association, hilly.

An area typical of the Steep Rocky site is reached by going approximately 13 miles northwest from San Antonio on U.S. Highway No. 87, then 1 mile west and southwest on Heuermann Road. The area is half a mile southeast of the road, in a large pasture.

The dominant decreasers on this site are little bluestem, sideoats grama, tall dropseed, and green sprangletop. Indiangrass and big bluestem grow in pockets of deeper soil, and Canada wildrye in clumps of shin oak on the ridges.

The increasers are slim tridens, Wright three-awn, fall witchgrass, and Texas wintergrass. Palatable browse plants include skunkbush sumac, evergreen sumac, Lindheimer silktassel, and kidneywood. Texas oak, Lacey oak, and live oak are woody increasers.

As the range condition declines, the site is invaded by three-awn, Texas grama, red grama, mat sandbur, and annual weeds and grasses. Ashe juniper and Texas persimmon are the primary woody invaders.

If in good or excellent condition, this site yields about 3,600 pounds of herbage per acre in favorable years. If in poor condition, it yields as little as 750 pounds.

ADOBE RANGE SITE

This site is made up of shallow, strongly calcareous, light-gray clay loams, silty clay loams, and loams. Gravel and channery fragments, from half an inch to 8 inches in diameter, cover from 3 to 35 percent of the surface. The topography is undulating and rolling; the slope range is 3 to 14 percent. The depth of the soils ranges up to 14 inches, but in some places there is almost no soil, and the underlying marl, chalky marl, and limestone are very near the surface. Water is stored in the marl and chalky marl. The soils in this site are—

Brackett clay loam, 1 to 5 percent slopes.
Brackett soils, 5 to 12 percent slopes.
Brackett soils in Brackett-Austin complex.

Figure 26.—**Steep Rocky range site. This area is in good condition but needs treatment for control of brush.**

An area typical of the Adobe site is approximately 13 miles west of San Antonio on Potranco Road, 1 mile beyond the intersection of Potranco Road and Talley Road, in a pasture south of the road.

Small areas of Krum complex and Tarrant association, rolling, are mapped with the soils that make up this range site.

The climax vegetation consists of mid and tall grasses (fig. 27). It includes little bluestem, which makes up 50 to 80 percent of the vegetation, plains lovegrass, tall dropseed, hairy dropseed, and sideoats grama. Minor amounts of indiangrass and Lindheimer muhly grow in pockets of deeper soil.

Increasers include seep muhly, Texas wintergrass, tall grama, feather bluestem, Wright three-awn, and fall witchgrass. Desirable forbs are orange zexmenia, pitchers sage, and bush sunflower. Texas oak is a woody increaser in some areas.

Invaders include three-awn, queensdelight, Ashe juniper, agrito, and Texas persimmon.

Productivity is limited because the soils are shallow and low in fertility. Keeping a protective litter on the surface is difficult. If unprotected, the surface crusts readily, and the crust slows water intake. The free lime in the soil tends to tie up plant nutrients, especially phosphorus. Consequently, the forage is less palatable to livestock than forage on other sites, and distribution of grazing becomes a problem. It may be necessary to supply supplemental feed that contains phosphorus.

If in excellent condition, this site yields about 4,000 pounds of herbage per acre. If in poor condition, it yields about 500 pounds.

STEEP ADOBE RANGE SITE

This site is made up mainly of very shallow, light-gray to yellowish, strongly calcareous clay loams, silty clays, and clays that have gravel, channery fragments, cobblestones, and stones scattered over the surface and distributed through the profile. These soils are hilly or steep. The slopes are long, and the hills are cone shaped or nearly so and are separated by low saddles. Numerous ledges of hard limestone give the slopes a "stairstep" appearance. The soils in this site are—

Brackett soils, 12 to 30 percent slopes.
Brackett soils in Brackett-Tarrant association, hilly.

***Figure 27.*—Adobe range site in good condition.**

An area typical of the Steep Adobe site is reached by going approximately 12 miles northwest from San Antonio on Bandera Road, then north on the Scenic Loop, 1 mile beyond its intersection with Babcock Road. The area is 600 feet west of the highway, in a large pasture.

The decreasers on this site are mid grasses. They include little bluestem, which makes up 50 to 75 percent of the vegetation, plains lovegrass, sideoats grama, and hairy dropseed. Minor decreasers that grow where the moisture supply is favorable are indiangrass, Lindheimer muhly, big bluestem, and switchgrass.

Increasers are tall grama, seep muhly, slim tridens, fall witchgrass, and orange zexmenia. Live oak, Texas oak, and evergreen sumac are woody increasers.

As the range condition declines, the site is invaded by hairy tridens, red grama, Texas grama, three-awn, queensdelight, Ashe juniper, and annual grasses and forbs.

Productivity is fair, even though the soils are shallow, because the parent material stores moisture and can be penetrated by plant roots. Erosion and crusting become severe if the plant cover is depleted. The free lime in the soils makes some nutrients, especially phosphorus, unavailable to plants. As a result the forage is less palatable to livestock than forage on other sites. Distribution of grazing becomes a problem, and supplemental feed containing phosphorus should be supplied for the livestock.

If in excellent condition, this site yields 3,500 pounds of herbage per acre in favorable years. If in poor condition, it yields about 1,000 pounds.

REDLAND RANGE SITE

This site is made up of very dark brown to reddish-brown, clayey, noncalcareous soils of the limestone uplands. Stones, coarse chert, and gravel are scattered on the surface and distributed through the profile. These soils are 14 to 30 inches thick over limestone. The topography is nearly level to gently sloping. The soils in this site are—

Crawford clay.
Crawford and Bexar stony soils.

Areas typical of this site are reached by going approximately 8 miles north from San Antonio on U.S. Highway No. 281, then east approximately 1 mile on Redland Road. The areas are in pastures on either side of the road.

Small areas of Tarrant association, rolling, are mapped with the soils that make up this site.

The dominant decreasers on this site are little bluestem, indiangrass, plains lovegrass, Canada wildrye, and big bluestem. Ten percent of the site has a canopy of post oak and blackjack oak.

The increasers are sideoats grama, Texas wintergrass, hairy dropseed, silver bluestem, and cane bluestem. Post oak and blackjack oak also tend to spread.

As the range condition declines, the site is invaded by curly mesquite, three-awn, Evax, and other annual forbs and grasses, and also by mesquite, huisache, and pricklypear (fig. 28).

This is one of the most productive range sites in the county, and the forage it produces is of high quality because phosphorus and other essential nutrients are available in adequate amounts. The vegetation recovers

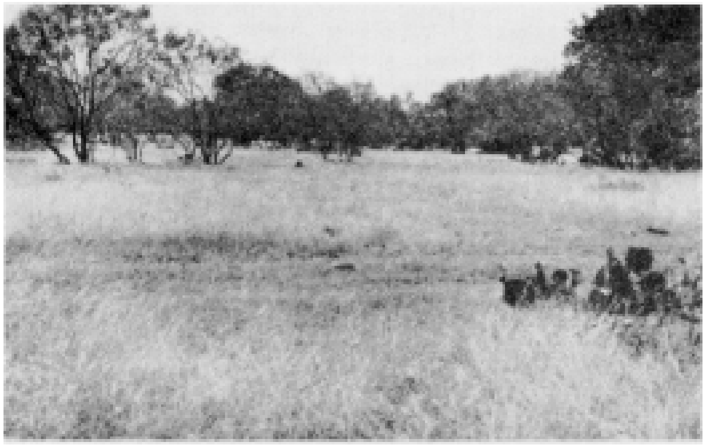

***Figure 28.*—Redland range site. This area has been invaded by mesquite and pricklypear.**

rapidly after grazing. Control of grazing may be the only management requirement. If post oak is so thick that the grass cannot grow, girdling the oak generally provides adequate control.

If in excellent condition, this site yields about 6,000 pounds of herbage per acre in favorable years. If in poor condition, it yields about 2,000 pounds.

SANDY SAVANNAH RANGE SITE

This site is made up of deep, pale-brown fine sands underlain at variable depths by rapidly permeable sandy loam or sandy clay loam. The topography is gently sloping or billowy and undulating. The slope ranges up to 10 percent but is predominantly between 2 and 4 percent. The site is in the southern part of the county and is locally called the sand hills. The only soil in this site is—

Eufaula fine sand, 0 to 5 percent slopes.

Areas typical of the Sandy Savannah site are reached by going approximately 10 miles south from the San Antonio city limits on State Highway 346, then three-quarters of a mile east on Jett Road. The areas are on both sides of the road.

The climax vegetation is of the savannah type. The dominant decreasers, which make up about 75 percent of the herbaceous vegetation, are little bluestem, crinkle-awn, indiangrass, switchgrass, and purpletop. The site is characterized by an overstory of post oak, blackjack oak, and hickory.

The increasers are Pan American balsamscale, tall dropseed, brownseed paspalum, spike bristlegrass, and sideoats grama. Legumes, such as bundleflower, snoutbean, tephrosia, lespedeza, dalea, mimosa, and partridgepea, are native to this site, and also grapevines, smilax, poison-oak, and poison-ivy.

As the range condition declines, the site is invaded by fringeleaf paspalum, sand dropseed, red lovegrass, hooded windmillgrass, gummy lovegrass, tumble lovegrass, and fringed signalgrass, along with such woody plants as mesquite, hickory, and lime pricklyash. Post oak, blackjack oak, and hickory increase in density (fig. 29).

The fertility of the soils in this site is low. The water-holding capacity per foot of depth is low, but the soils are so deep that they store enough moisture for tall grasses and trees.

If in excellent condition, this site produces 5,000 to 5,500 pounds of herbage per acre in favorable years. If in poor condition, it produces about 1,000 pounds.

VALLEY RANGE SITE

The soils that make up this site are deep, moderately permeable, calcareous, grayish-brown to dark-gray clays and clay loams. These soils are in long, narrow valleys in the limestone prairies. They are predominantly nearly level or gently sloping but include small areas that are steeper. The only mapping unit in this site is—

Krum complex.

Included in this complex are small areas of Lewisville silty clay, 1 to 3 percent slopes, and of Trinity and Frio soils, frequently flooded.

An area typical of the Valley site is reached by going approximately 13 miles north from San Antonio on U.S. Highway No. 281 and then approximately 1 mile west on Borgfeld Road. The area is in a pasture south of the road.

The dominant decreasers on this site are little bluestem, indiangrass, big bluestem, switchgrass, and Canada wildrye. Southwestern bristlegrass, threeflower melic, eastern gamagrass, white tridens, and vine-mesquite are minor decreasers. Maximilian sunflower is a common decreaser forb. Oak motts and open stands of other large trees are part of the climax vegetation.

The principal increasers are Texas wintergrass, silver bluestem, Scribner panicum, meadow dropseed, sideoats grama, paspalum, pitchers sage, and Engelmanndaisy.

Invader grasses are red grama, three-awn, tumblegrass, and all annuals. Invading forbs are croton, queensdelight, mealycup sage, upright prairie coneflower, ragweed, wedgeleaf fogfruit, and sneezeweed. Woody invaders include hackberry and mesquite.

This is a productive site. The soils are fertile and have high water-holding capacity. The forage is of high quality, the water supply is adequate, and the topography is such that livestock can move about easily. Consequently, this site is likely to be heavily grazed.

If in excellent condition, this site yields about 6,500 pounds of herbage per acre in favorable years. If in poor condition, it yields about 2,000 pounds.

***Figure 29.*—Sandy Savannah range site. The vegetation is mostly post oak, blackjack oak, hickory, and annual weeds and grasses.**

LOAMY BOTTOMLAND RANGE SITE

The soils that make up this site are deep, brownish-gray clay loams, silty clay loams, and fine sandy loams that are flooded occasionally but are well drained. They are predominantly level but have a slightly uneven surface in places. The site includes the flood plains of the Medina River, the San Antonio River, Cibolo Creek, Leon Creek, Salado Creek, and other major streams. The soils in this site are—

Frio clay loam.
Frio soils in Trinity and Frio soils, frequently flooded.
Zavala fine sandy loam.
Zavala soils in Zavala and Gowen soils, frequently flooded.

Typical of the Loamy Bottomland site are areas on either side of the Medina River, approximately 5 miles south of the San Antonio city limits, where State Highway 346 crosses the river.

Decreasers in the climax vegetation include switchgrass, big bluestem, indiangrass, little bluestem, fourflower trichloris, plains lovegrass, southwestern bristlegrass, vine-mesquite, and big cenchrus.

Increasers make up 25 percent of the vegetation and include silver bluestem, sideoats grama, Texas wintergrass, plains bristlegrass, and Arizona cottontop.

Invaders include buffalograss, curly mesquite, white tridens, filly panicum, fall witchgrass, hooded windmillgrass, Halls panicum, perennial three-awn, whorled dropseed, red grama, and bermudagrass. Mesquite, huisache, retama, spiny hackberry, and condalia are woody invaders.

The soils in this site are fertile and have good moisture-supplying capacity. Conditions are favorable for the growth of tall grasses and trees. Large trees are common, and the underbrush is dense enough to create a problem. Areas that are flooded frequently are likely to become weedy.

If in excellent condition, this site yields about 8,500 pounds of herbage per acre in favorable years. If in poor condition, it yields about 2,000 pounds.

ROLLING BLACKLANDS RANGE SITE

The soils that make up this site are deep, slowly permeable, calcareous, gray to dark-gray clays. The slopes are smooth and rather long. The gradient ranges from 0 to 8 percent but is predominantly between 1.5 and 4 percent. The soils in this site are—

Austin silty clay, 1 to 3 percent slopes.
Austin silty clay, 3 to 5 percent slopes.
Austin soils in Brackett-Austin complex, 1 to 5 percent slopes.
Houston clay, 1 to 3 percent slopes.
Houston clay, 3 to 5 percent slopes, eroded.
Houston clay, 3 to 5 percent slopes, severely eroded.
Houston soils in Houston-Sumter clays, 5 to 10 percent slopes, severely eroded.
Houston Black clay, 0 to 1 percent slopes.
Houston Black clay, 1 to 3 percent slopes.
Houston Black clay, 3 to 5 percent slopes.
Houston Black clay, terrace, 0 to 1 percent slopes.
Houston Black clay, terrace, 1 to 3 percent slopes.
Houston Black gravelly clay, 1 to 3 percent slopes.
Houston Black gravelly clay, 3 to 5 percent slopes.
Houston Black gravelly clay, 5 to 8 percent slopes.

Small areas of Trinity and Frio soils, frequently flooded, are mapped with the soils of this site.

An area typical of the Rolling Blacklands site is in a pasture north of Benz-Englemann Road, approximately 6 miles northeast of San Antonio and 1.25 miles west of the intersection of Benz-Englemann Road and Farm-to-Market Road 1516.

The climax vegetation on this site consisted of grass and some scattered stands of live oak. The decreasers include twoflower trichloris, sideoats grama, silver bluestem, little bluestem, Arizona cottontop, plains lovegrass, plains bristlegrass, alkali sacaton, and lovegrass tridens.

The increasers are curly mesquite, spike bristlegrass, pink pappusgrass, fall witchgrass, slim tridens, and Wright three-awn.

As the range condition declines, the site is invaded by whorled dropseed, red grama, hairy tridens, Texas grama, purple three-awn, Halls panicum, and annuals. Woody invaders include spiny hackberry, blackbrush acacia, mesquite, guayacan, whitebrush, pricklypear, Texas colubrina, kidneywood, agrito, condalia, and tasajillo.

The soils in this site are highly fertile, but intake of water is slow because the surface layer is clayey. Hoofpans and surface crusting are common. If the vegetation is removed, erosion is a hazard.

If in excellent condition, this site yields 3,500 to 4,500 pounds of herbage per acre in favorable years. If in poor condition, it yields about 1,000 pounds.

CLAY LOAM RANGE SITE

The soils that make up this site are moderately deep, dark-brown to grayish-brown, calcareous clay loams, silty clay loams, loams, and light clays. They are nearly level or gently undulating. The slope range is 0 to 8 percent, but slopes of less than 3 percent predominate. The soils in this site are—

Gullied land.
Karnes loam, 1 to 3 percent slopes.
Karnes loam, 3 to 5 percent slopes.
Karnes clay loam, 3 to 5 percent slopes, eroded.
Lewisville silty clay, 0 to 1 percent slopes.
Lewisville silty clay, 1 to 3 percent slopes.
Lewisville silty clay, 3 to 5 percent slopes.
Venus loam, 0 to 1 percent slopes.
Venus loam, 1 to 3 percent slopes.
Venus clay loam, 0 to 1 percent slopes.
Venus clay loam, 1 to 3 percent slopes.
Venus clay loam, 3 to 5 percent slopes.
Willacy loam, 0 to 1 percent slopes.
Willacy loam, 1 to 3 percent slopes.

Some areas of Gullied land include steep stream embankments.

Typical of the Clay Loam site is an area reached by going 5 miles south from the San Antonio city limits on Applewhite Road. This area is on the Walsh Brothers' ranch, 1 mile east of ranch headquarters.

The dominant decreasers on this site are cane bluestem, silver bluestem, fourflower trichloris, sideoats grama, plains lovegrass, Texas cupgrass, and Arizona cottontop. There is some little bluestem.

The increasers are spike bristlegrass, Texas wintergrass, pink pappusgrass, buffalograss, curly mesquite, and fall witchgrass.

As the range condition declines, the site is invaded by Halls panicum, Texas grama, hooded windmillgrass, sand dropseed, red grama, purple three-awn, and hairy tridens. Woody invaders include mesquite, condalia, whitebrush, spiny hackberry, blackbrush, acacia, agrito, persimmon, pricklypear, and tasajillo.

In the steeper parts of this site, the soils are susceptible to erosion, especially if they lack a cover of vegetation. Natural recovery of the forage plants is slowed by the growth of brush. Fertility is high, and the water-holding capacity is high. The rate of water intake is moderate, except where the surface is crusted.

If in excellent condition, this site yields 4,000 to 4,500 pounds of herbage per acre in favorable years. If in poor condition, it yields about 850 pounds.

SANDY LOAM RANGE SITE

The soils that make up this site are deep, moderately permeable, reddish-brown fine sandy loams. The slopes are undulating and fairly long. The gradient ranges from 1 to 6 percent. The soils in this site are —

Duval fine sandy loam, 1 to 3 percent slopes.
Duval fine sandy loam, 3 to 5 percent slopes.

An area typical of this site is in a pasture reached by going approximately 10 miles southeast from San Antonio on U.S. Highway No. 181 and then three-quarters of a mile east on Elmendorf-Lavernia Road. The pasture is south of the road.

The dominant decreasers on this site are little bluestem, silver bluestem, cane bluestem, Arizona cottontop, sideoats grama, plains lovegrass, and lovegrass tridens.

The increasers are spike bristlegrass, fall witchgrass, pink pappusgrass, hairy grama, Reverchon panicum, Texas wintergrass, hooded windmillgrass, buffalograss, Wright three-awn, curly mesquite, and sand dropseed.

Invading grasses are purple three-awn, fringeleaf paspalum, red grama, Texas grama, red lovegrass, Halls panicum, gummy lovegrass, and tumble windmillgrass. Woody invaders include mesquite, whitebrush, spiny hackberry, condalia, Texas colubrina, tasajillo, and pricklypear.

This site has no particular problems or limitations. The natural fertility is high, and small amounts of rainfall are used effectively.

If in excellent condition, this site yields 4,000 to 5,000 pounds of herbage per acre in favorable years. If in poor condition, it yields about 1,000 pounds.

TIGHT SANDY LOAM RANGE SITE

The soils that make up this site, which is in the southern third of the county, are deep, reddish-brown to grayish-brown, noncalcareous fine sandy loams that have a slowly permeable clay subsoil. They are nearly level or gently sloping. These soils are—

Crockett fine sandy loam, 0 to 1 percent slopes.
Crockett fine sandy loam, 1 to 3 percent slopes.
Crockett soils, 2 to 5 percent slopes, eroded.
Webb fine sandy loam, 1 to 3 percent slopes.
Webb fine sandy loam, 3 to 5 percent slopes.
Webb soils, 3 to 5 percent slopes, eroded.
Webb soils, 3 to 5 percent slopes, severely eroded.

An area typical of the Tight Sandy Loam site is in a pasture that is east of Old Pleasanton Road, approximately 6 miles south of San Antonio, and half a mile south of the intersection of Old Pleasanton Road and Trumbo Road.

The decreasers on this site are Arizona cottontop, feathery bluestem, fourflower trichloris, little bluestem, sideoats grama, lovegrass tridens, and plains lovegrass.

Increasers make up about 40 percent of the vegetation and include spike bristlegrass, pink pappusgrass, hairy grama, hooded windmillgrass, Reverchon panicum, and fall witchgrass.

Invaders include red grama, Halls panicum, purple three-awn, annual weeds, and such woody plants as whitebrush, mesquite, lotebush, spiny hackberry, guayacan, catclaw, tasajillo, and pricklypear.

This site produces forage of high quality, but if it is allowed to deteriorate it recovers slowly because it becomes infested with brush (fig. 30). Erosion is a hazard unless an adequate cover of vegetation is maintained. Water intake is moderate, except when the surface layer is saturated.

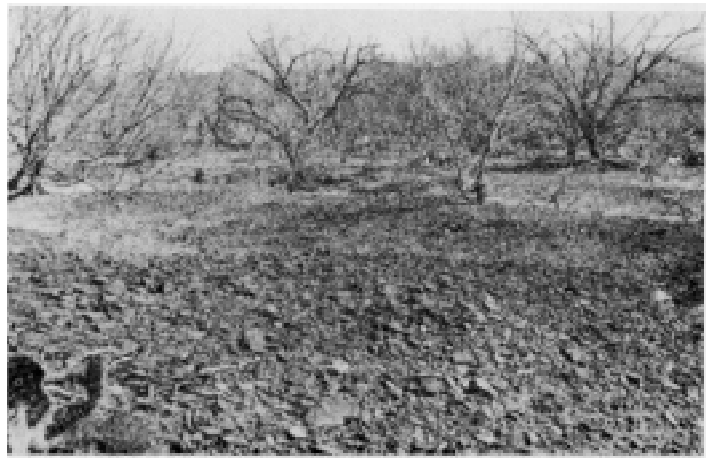

***Figure 30.*—Tight Sandy Loam site. This area is in poor condition. Mesquite, cacti, and annual grasses and forbs are all that is growing. The soils are not protected against erosion or loss of moisture.**

If in excellent condition, this site yields about 4,000 pounds of herbage per acre in years of average rainfall. If in poor condition, it yields about 800 pounds.

DEEP SAND RANGE SITE

The soils that make up this site are gently sloping, deep, pale-brown to brown loamy fine sands that have a subsoil of sandy clay or sandy clay loam. The surface layer is 18 to 30 inches thick. This site is in the southern part of the county. It was originally an open prairie and had no woody overstory, but it has been invaded by mesquite trees. The soils in this site are—

Duval loamy fine sand, 1 to 5 percent slopes.
Duval soils, 3 to 5 percent slopes, eroded.
Hockley loamy fine sand, 0 to 3 percent slopes.
Hockley loamy fine sand, 3 to 5 percent slopes.
Hockley loamy fine sand, 3 to 5 percent slopes, eroded.
Leming loamy fine sand, 0 to 3 percent slopes.

Typical of the Deep Sand site is the area south and east of the intersection of Applewhite Road and Neal Road, approximately 8 miles south of San Antonio.

The climax vegetation on this site is characterized by tall and mid grasses. The dominant decreasers are seacoast bluestem, crinkle-awn, switchgrass, indiangrass, purpletop, big bluestem, Scribners panicum, and sand lovegrass.

The increasers are spike bristlegrass, feathery bluestem, Pan American balsamscale, sideoats grama, tall dropseed, brownseed paspalum, fringeleaf paspalum, and sand dropseed. Invaders include red lovegrass, hooded windmillgrass, gummy lovegrass, Silveusgrass, tumble lovegrass, fringed signalgrass, and many forbs and annuals. Mesquite and pricklypear are the principal woody invaders.

The forage is of low quality. Water intake is rapid, so small amounts of rainfall are utilized, but nevertheless it is difficult to keep production high if the range is used continuously.

If this site is in excellent condition, it yields about 6,000 pounds of herbage per acre in favorable years. If it is in poor condition, it yields about 1,500 pounds.

HARDLAND RANGE SITE

The soils that make up this site are deep, dark grayish-brown to dark-brown clay loams and sandy clay loams that have a subsoil of very slowly permeable clay. They are on uplands in the southern part of the county. The topography is nearly level or gently sloping. The soils in this site are—

- Orelia clay loam, 0 to 1 percent slopes.
- Orelia clay loam, 1 to 3 percent slopes.
- San Antonio clay loam, 1 to 3 percent slopes.
- San Antonio clay loam, 3 to 5 percent slopes.
- San Antonio clay loam, 3 to 5 percent slopes, eroded.

An area typical of this site is in a pasture that is reached by going approximately 10 miles southwest from San Antonio on Old Pearsall Road, then three-quarters of a mile north on Shepherd Road. The pasture is west of the road.

Decreasers make up about 65 percent of the vegetation on this site and include Arizona cottontop, plains bristlegrass, fourflower trichloris, little bluestem, cane bluestem, and vine-mesquite.

The increasers are pink pappusgrass, spike bristlegrass, buffalograss, curly mesquite, and Texas wintergrass.

Common invaders are red grama, red three-awn, Texas grama, tumble windmillgrass, coneflower, mesquite, huisache, and lotebush.

The soils in this site are droughty and poorly aerated. Erosion is a slight hazard. Water may stand for a while on level areas.

If in excellent condition, this site yields 4,500 pounds of herbage per acre in years of average rainfall. If in poor condition, it yields about 1,000 pounds.

BOTTOMLAND RANGE SITE

The soils that make up this site are deep, dark-gray, calcareous clays. They are on the flood plains of the large drainageways and streams that drain the blacklands, and they are flooded frequently. The grasses are those that can withstand flooding. The soils in this site are—

- Gowen clay loam.
- Trinity clay.
- Trinity soils in Trinity and Frio soils, frequently flooded.
- Gowen soils in Zavala and Gowen soils, frequently flooded.

Typical of this site is an area reached by going approximately 16 miles east from San Antonio on U.S. Highway No. 90, then 4 miles south on Farm-to-Market Road 1518. The area is east of the point where Farm-to-Market Road 1518 crosses Martinez Creek.

Decreasers, principally switchgrass and sacaton, make up a large percent of the potential vegetation on this site. Other decreasers are fourflower trichloris, southwestern bristlegrass, little bluestem, indiangrass, sideoats grama, vine-mesquite, and plains lovegrass.

The increasers are white tridens, spike bristlegrass, Texas wintergrass, silver bluestem, pink pappusgrass, and Arizona cottontop.

Invaders include buffalograss, curly mesquite, fall witchgrass, spiny hackberry, and devilweed aster. Smallhead sneezeweed and upright prairie coneflower are also common invaders. If the range is in poor condition, these plants may dominate. Live oak, elm, hackberry, and pecan trees are common on this site.

The soils in this site are fertile. Water intake is slow, but the available moisture capacity is very good. Frequent floods add to the moisture supply.

If in excellent condition, this site yields 7,000 to 7,500 pounds of herbage per acre in years of average rainfall. If in poor condition, it yields about 2,500 pounds.

SHALLOW RANGE SITE

The soils that make up this site are shallow, gray to grayish-brown clays, clay loams, and sandy clay loams, ordinarily underlain by gravel or highly calcareous alluvium. The site is on the uplands, most commonly parallel to large drainageways. The soils in this site are—

- Patrick soils, 0 to 1 percent slopes.
- Patrick soils, 1 to 3 percent slopes.
- Patrick soils, 3 to 5 percent slopes.

Typical of this site is an area in a large pasture reached by going approximately 14 miles northwest of San Antonio on Culebra Road and then about 2 miles north on Galm Road, to the point where the road turns east. The area is about 200 yards northwest of Galm Road.

The decreasers on this site are little bluestem, indiangrass, plains lovegrass, trichloris, and Arizona cottontop. These grasses make up about 60 percent of the vegetation.

The increasers include sideoats grama, Texas bristlegrass, vine-mesquite, curly mesquite, buffalograss, and Texas wintergrass.

As the range condition declines, the site is invaded by red grama, red three-awn, Halls panicum, slim tridens, and annual grasses and forbs. Woody invaders are mesquite, spiny hackberry, lotebush, huisache, catclaw, and blackbrush acacia.

Although the soils in this site are moderately high in natural fertility, production of forage is limited by lack of water. Water intake is moderate, and the water-holding capacity is limited. The steeper slopes erode if left without a cover of vegetation.

If in excellent condition, this site yields 4,500 pounds of herbage per acre in years of average rainfall. If in poor condition, it yields about 850 pounds.

SHALLOW RIDGE RANGE SITE

The soils that make up this site are very shallow or shallow, highly calcareous, light brownish-gray clay loams, silty clays, and gravelly clay loams. The substratum is chalk, marl, or caliche. Limestone gravel is scattered on the surface and distributed through the profile. The slope is predominantly between 1 and 6 percent but is steeper in a few spots. The topography is characterized by low hills. The soils in this site are—

Hilly gravelly land.
Sumter soils in Houston-Sumter clays, 5 to 10 percent slopes, severely eroded.
Stephen silty clay, 1 to 3 percent slopes.
Stephen silty clay, 3 to 5 percent slopes.

An area typical of the Shallow Ridge site is in a pasture reached by going approximately 7 miles northeast of San Antonio on Nacogdoches Road, then a quarter of a mile north on Stahl Road. The pasture is west of the road.

The climax vegetation on this site is characterized by mid grass and scattered live oak trees. The dominant decreasers are little bluestem, sideoats grama, wildrye, and plains lovegrass.

Increasers are bristlegrass, Texas wintergrass, buffalograss, curly mesquite, slim tridens, and fall witchgrass. Live oak, which forms a 5-percent crown canopy in the climax vegetation, is an increaser, also.

As range condition declines, this site is invaded by three-awn, red grama, agrito, condalia, tasajillo, pricklypear, and annual grasses and forbs. Huisache, mesquite, Texas persimmon, and mescalbean are the principal woody invaders.

Low water-holding capacity keeps the productivity of this site fairly low. Small amounts of rainfall are utilized effectively, however, because of the gravel on and in the soils.

If in excellent condition, this site yields about 3,200 pounds of herbage per acre in favorable years. If in poor condition, it yields 750 pounds or less.

Management of rangeland

The principal requirements for good range management are selecting the kind of livestock to which the range is best suited, limiting grazing to protect the plant cover, and making seasonal adjustments in the number of livestock to make the best use of the available forage.

On the Edwards Plateau, the climax vegetation is a combination of grass, browse, and forbs. It provides suitable grazing for cattle, sheep, and goats. Grazing by sheep and goats may help to prevent the spread of brush and weeds. In the southern part of the county, the vegetation is such that the range is best suited to cattle.

Grazing should be controlled so that no more than half of the annual growth of the major forage plants is removed. By so limiting the use of the range, the plant cover can be maintained and the gain per animal can be increased. It is advisable to keep some pasture in reserve or to have a source of supplemental feed for times when the growth of range vegetation is poor. Keeping some readily salable livestock, rather than all breeding stock, is another practice that makes it possible to balance the size of the herd with the supply of forage.

Removing all livestock from a part of the range during the growing season permits the recovery of vegetation that has been closely grazed. This practice is important not only for maintaining the quality of the forage but also for insuring adequate cover for control of erosion and conservation of moisture. It is particularly important for pastures that consist of a mixture of range sites. Such pastures are likely to be grazed unevenly because the stock prefer the vegetation of one site over that of the others. Deferment gives all parts of the range an equal chance for recovery.

Preventing overuse of one site or one part of a pasture is a problem in the Edwards Plateau. Distribution of grazing by cattle can be encouraged by placing salt, supplemental feed, and water in the areas least used. Fencing between sites may be necessary. Goats and sheep will graze on the higher, rougher parts of the range, which cattle avoid.

On some range sites, brush control may be necessary to keep mesquite, pricklypear, and other invading woody plants from crowding out the grass. Some brush should be left to provide food and cover for wildlife.

Seeding is necessary for converting cropland and idle land to range, and seeding may be advisable for speeding the recovery of range that has been overgrazed. Native grasses are to be preferred for seeding, because they will reproduce and provide a lasting cover if not overgrazed. On the Edwards Plateau, seeding is generally needed only in fields that have been cultivated and in areas that have been burned. The vegetation in areas that have been used only for grazing will recover naturally, because the rocks and brush that cover much of the surface protect the grass and keep it from being damaged by brush-control measures. In other parts of the county, brush control is likely to destroy the grass and make range seeding necessary.

Local representatives of the Soil Conservation Service and the Extension Service are available to help plan management programs for individual ranches.

Engineering [3]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, facilities for water storage, erosion-control structures, drainage systems, and sewage-disposal systems. The properties most important to an engineer are permeability to water, shear strength, compaction characteristics, drainage, shrink-swell characteristics, grain size, plasticity, and pH. Topography, the depth to bedrock, and the depth to the water table are important also.

Information in this report can be used to—

1. Make soil and land use studies that will aid in the selection and development of industrial, business, residential, and recreational sites.
2. Make estimates of runoff and erosion characteristics for use in designing structures and planning dams for soil and water conservation.
3. Make preliminary estimates of the engineering properties of soils for use in planning the construction of farm ponds, irrigation systems, and other structures for soil and water conservation.
4. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, residential construction, and

[3] This section prepared by J. C. WARD, agricultural engineer, Soil Conservation Service.

storage areas, and in planning detailed soil surveys at the selected locations.
5. Locate probable sources of sand, gravel, topsoil, and other construction material.
6. Correlate performance of engineering structures with soil mapping units, and thus develop information useful in designing and maintaining structures.
7. Determine the suitability of soil units for cross-country movement of vehicles and construction equipment.
8. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
9. Develop other preliminary estimates for construction in a particular area.

With the use of the soil map for identification, the engineering interpretations reported here can be useful for many purposes. It should be emphasized that they may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of layers here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Some of the terms used by soil scientists may be unfamiliar to engineers and other personnel, and some words, such as *soil*, *clay*, *silt*, *sand*, *aggregate*, and *granular*, have special meanings in soil science. These terms are defined in the Glossary.

Engineering classification systems

Most highway engineers classify soil materials according to the system approved by the American Association of State Highway Officials (*1*). In this system, soil materials are classified in seven principal groups. The groups range from A–1, in which are gravelly soils of high bearing capacity, to A–7, which consists of clay soils that have low strength when wet. In each group the relative engineering value of the soil material is indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest.

Some engineers prefer the Unified soil classification system (*8*). In this system, 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. Particle-size distribution is the basis for the GW, GP, SW, and SP classes. Particle-size distribution, liquid limit, and plasticity index form the basis for the GM, GC, SM, and SC classes and for all the classes of fine-grained soils.

The estimated classifications of the soils in Bexar County according to both systems are given in table 3.

Soil properties and engineering interpretations

Table 3, which begins on page 64, gives descriptions of the soils mapped in Bexar County and estimates of specified properties of each soil that are significant in engineering. Following are brief explanations of those headings in table 3 that are not self-explanatory.

Permeability refers to the rate at which water moves through the uncompacted soil. It is measured in inches per hour, and the rate differs from one horizon to another in the same soil.

Available water refers to the approximate amount of capillary water in a given soil when that soil is wet to field capacity. When the soil is air dry, this amount of water will wet it to a depth of 1 inch without deeper percolation.

Unit dry weight was determined by standard AASHO procedures (Proctor density test, 3 layers, 25 blows each layer, using a 5.5-pound rammer and a 12-inch drop). The figures represent a range for the soil type. The values shown are for guidance only. For design and construction control, the soils at the construction site should be tested.

Measurements of the electrical resistivity of some soils were available (see table 8 in the section "Underground utility lines"). Estimates of the resistivity of the other soils were based on tests of similar soils.

Each of the categories of potential volumetric change indicates a range in swell index. Swell index, expressed as pounds per square foot, refers to the pressure exerted by a given soil against a restraining force when the soil expands as a result of an increase in moisture content. "Very critical" indicates a swell index of more than 4,725 pounds per square foot; "critical," a range of 3,200 to 4,725 pounds; "marginal," a range of 1,675 to 3,200 pounds; and "noncritical," an index of less than 1,675 pounds per square foot.

Estimates of the hardness of the underlying material are according to the Mohs scale, a system in which hardness is graded by using common minerals as standards. The scale is as follows: 1, talc; 2, gypsum; 3, calcite; 4, fluorite; 5, apatite; 6, orthoclase; 7, quartz; 8, topaz; 9, corundum; 10, diamond.

In table 4, which begins on page 74, are interpretations based on the estimated properties described in table 3, the test data recorded in table 5, and field experience. The interpretations were formulated after consultation with engineers of the city of San Antonio.

Road subbase.—Any of the coarse-grained soils can be used as subbase material. Those of class GW are best (*2*). Only slightly less desirable are poorly graded gravels and such silty gravels as are in class GP. Soils of class GC are reasonably good as subbase material, those of class SM are good to adequate, and those of class SC are fair for use under pavement of suitable design. Fine-grained soils are no better than fair as subbase material. If they are used, their poorer qualities need to be compensated for in the design of flexible pavement by increasing the thickness of the base material above the subbase, and in the design of rigid pavement by increasing the thickness of the pavement or adding a base-course layer.

Road fill.—The soils most suitable for use as subbase are also those most suitable for use as fill. Soils of the GP and SM classes can be used where conditions are favorable and are better than those of the GC class (*2*). Soils of the other groups can be used if their limitations are considered in designing the pavement.

TABLE 3.—*Brief descriptions of soils and estimates*

[Dashes in columns indicate there were

Map symbol	Soil name	Description of horizons to depth indicated	Depth from surface (typical)	Classification			Percentage passing sieve—			
				USDA texture	Unified	AASHO	1 inch (25.4 mm.)	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)
			In.							
AuB	Austin silty clay, 1 to 3 percent slopes.	About 26 to 56 inches of calcareous, very crumbly silty clay, over altered chalk.	0 to 28	Silty clay	CH	A-7	95 to 100	95 to 100	90 to 100	75 to 90
AuC	Austin silty clay, 3 to 5 percent slopes		28 to 45	Silty clay	CL or CH	A-6 or A-7	95 to 100	95 to 100	85 to 100	70 to 85
BpC	Brackett clay loam, 1 to 5 percent slopes.	8 to 18 inches of strongly calcareous clay loam, over layers of soft, chalky limestone.	0 to 15	Clay loam	CL or ML-CL.	A-6 or A-4	90 ot 100	85 to 100	75 to 90	65 to 85
BrD	Brackett soils, 5 to 12 percent slopes.	4 to 12 inches of calcareous clay loam, loam, or silty clay loam, over chalk, marl, and soft limestone; angular pebbles and fragments on the surface and in the solum.	0 to 12	Clay loam	CL	A-6 or A-7	90 to 100	85 to 100	75 to 90	65 to 85
BrE	Brackett soils, 12 to 30 percent slopes.									
BsC	Brackett-Austin complex, 1 to 5 percent slopes.									
	Brackett	See description of Brackett clay loam, 1 to 5 percent slopes (BpC).								
	Austin	See description of Austin silty clays (AuB, AuC).								
BtE	Brackett-Tarrant association, hilly									
	Brackett	See description of Brackett soils (Brd, BrE).								
	Tarrant	See description of Tarrant associations (TaB, TaC, TaD).								
Ca	Crawford clay.	17 to 45 inches of slowly permeable, calcareous clay over hard limestone; limestone fragments on surface and in profile, but make up less than 10 percent of volume.	0 to 34	Clay	MH-CH	A-7	90 to 100	85 to 100	85 to 100	70 to 90
Cb	Crawford and Bexar stony soils.									
	Crawford	See description of Crawford clay (Ca).								
	Bexar	14 to 22 inches of cherty clay loam or loam, over 6 to 14 inches of clay that is 50 percent chert; chert limits shrink-swell potential. Hard limestone below a depth of 16 to 36 inches.	0 to 17	Cherty clay loam to loam.	GC or CL	A-4, A-6, or A-2.	80 to 100	50 to 80	25 to 75	20 to 50
			17 to 28	Cherty clay	GC	A-2	30 to 50	30 to 45	30 to 40	20 to 30
CfA	Crockett fine sandy loam, 0 to 1 percent slopes.	About 8 to 14 inches of noncalcareous fine sandy loam, over 25 to 40 inches of slowly permeable, noncalcareous sandy clay or heavy sandy clay loam, which grades to unconsolidated, calcareous sandy clay to sandy clay loam. Shale and sandstone at a depth of 4 to 10 feet.	0 to 10	Fine sandy loam	SM or SC	A-2 or A-4	95 to 100	95 to 100	95 to 100	20 to 50
			10 to 44	Sandy clay to sandy clay loam.	SC, CL, or CH.	A-6 or A-7	95 to 100	95 to 100	95 to 100	45 to 60
CfB	Crockett fine sandy loam, 1 to 3 percent slopes.		44 to 72	Sandy clay	CL	A-6	95 to 100	95 to 100	95 to 100	45 to 60
CkC2	Crockett soils, 2 to 5 percent slopes, eroded.									

See footnote at end of table.

of soil properties significant in engineering

no data on which to base an estimate]

Permeability	Reaction	Available water	Unit dry weight	Potential volumetric change category (PVC)	Electrical resistivity at depth of 4 feet [1]	Underlying material to a depth of 10 feet		
						Range in depth to underlying material	Description of underlying material	Hardness (Mohs scale)
In./hr.	*pH*	*In./in.*	*Lb./cu. ft.*		*Ohms/cc.*	*In.*		
0.8 to 1.2	7.9 to 8.4	0.16 to 0.18	75 to 105	Critical or marginal.	700 to 1,600	26 to 56	About 27 inches of thin-bedded altered chalk with vertical fractures; restricted permeability. Below a depth of about 72 inches, thin-bedded chalk and occasional hard strata; very restricted permeability.	Mostly less than 2.5.
1.0 to 1.4	7.9 to 8.4	0.16 to 0.18	80 to 110	Marginal or noncritical.				
1.0 to 1.2	7.9 to 8.4	0.14 to 0.16	90 to 120	Critical or marginal.	1,000 to 2,200	8 to 18	Jointed, fractured, thin-bedded altered chalk in upper part; occasional layers of hard limestone; limestone becomes harder with increasing depth.	Mostly less than 2.5; some strata more than 2.5.
1.0 to 1.2	7.9 to 8.4	0.14 to 0.16	90 to 120	Critical or marginal.	1,800 to 2,800	4 to 12	About 8 inches of jointed, fractured, thin-bedded altered chalk or marl. Below a depth of 20 inches, altered chalk or soft limestone and occasional layers of hard limestone; limestone becomes harder with increasing depth.	Mostly less than 2.5; some strata more than 2.5.
0.2 to 0.5	6.2 to 7.0	0.18 to 0.21	75 to 105	Very critical	850 to 1,100	17 to 45	Hard, crystalline limestone; thick bedded and fractured; cracks filled with clay; upper part weathered and smooth. Shale or marly clay instead of limestone in a few places.	More than 2.5.
1.0 to 1.5	6.6 to 7.3	0.16 to 0.18	95 to 125	Noncritical	1,800 to 2,600	16 to 36	Hard, crystalline limestone; thin bedded to thick bedded; coarsely fractured, both vertically and horizontally, but becomes more nearly massive with increasing depth.	More than 2.5.
0.1 to 0.2	6.6 to 7.3	0.18 to 0.21	115 to 130	Very critical or critical.				
1.0 to 1.5	6.0 to 7.3	0.08 to 0.13	100 to 125	Noncritical	1,100 to 1,600	48 to 120	Sandy shale, or interbedded shale and weakly to strongly cemented sandstone, underlain by soft to hard, calcareous sandstone and cemented sandy earth.	Less than 2.5.
0.6 to 0.8	6.3 to 7.3	0.18 to 0.21	80 to 120	Critical or marginal.				
0.6 to 1.0	7.9 to 8.4	0.18 to 0.21	100 to 125	Marginal or noncritical.				

TABLE 3.—*Brief descriptions of soils and estimates*

[Dashes in columns indicate there were

Map symbol	Soil name	Description of horizons to depth indicated	Depth from surface (typical)	Classification			Percentage passing sieve—			
				USDA texture	Unified	AASHO	1 inch (25.4 mm.)	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)
			In.							
DnB	Duval fine sandy loam, 1 to 3 percent slopes.	About 10 to 26 inches of brown to reddish-brown, slightly acid, friable fine sandy loam, over 20 to 44 inches of reddish, slightly acid light sandy clay loam; below this is weakly stratified sandy loam, sandy clay loam, and, in places, soft sandstone.	0 to 14	Fine sandy loam	SM or SC	A-2 or A-4	95 to 100	95 to 100	95 to 100	20 to 50
DnC	Duval fine sandy loam, 3 to 5 percent slopes.		14 to 62	Light sandy clay loam.	SC, CL, or SM.	A-4 or A-6	95 to 100	95 to 100	95 to 100	45 to 60
DmC	Duval loamy fine sand, 1 to 5 percent slopes.	12 to 26 inches of loamy fine sand, over 20 to 46 inches of sandy loam to sandy clay loam; below this is sandy shale interbedded with weakly cemented sandstone.	0 to 16	Loamy fine sand	SM	A-2 or A-4	95 to 100	95 to 100	95 to 100	15 to 40
DsC2	Duval soils, 3 to 5 percent slopes, eroded.		16 to 60	Sandy clay loam	SC, CL, SM, or SM-SC.	A-4 or A-6	95 to 100	95 to 100	95 to 100	45 to 60
EuC	Eufaula fine sand, 0 to 5 percent slopes.	30 to 72 inches of rapidly permeable, noncalcareous fine sand, over 12 to 72 inches of fine sand with thin horizontal lenses of sandy loam, overlying sandy clay loam at depths of 49 to 120 inches or more.	0 to 74	Fine sand	SW	A-1 or A-3	----------	----------	----------	----------
			74+	Sandy clay loam	SC	A-4	----------	----------	----------	----------
Fr	Frio clay loam.	About 25 to 45 inches of calcareous clay loam, over 11 to 47 inches or more of loam or stratified clay loam and sandy loam; underlain locally by beds of gravel or alternate beds of gravel and loamy material at depths of 36 to 72 inches or more.	0 to 35	Clay loam	CL or CH	A-6 or A-7	95 to 100	85 to 100	75 to 85	65 to 85
			35 to 84+	Loam with thin strata of clay loam and sandy loam.	GM, SM, or CL.	A-2 or A-6	95 to 100	40 to 90	40 to 90	25 to 90
Go	Gowen clay loam.	About 36 to 54 inches of noncalcareous light clay loam, over noncalcareous, stratified alluvium.	0 to 48	Clay loam	CL	A-6	95 to 100	95 to 100	85 to 100	55 to 80
			48 to 60+	Clay loam with thin strata of sandy loam and sandy clay.	CL, ML-CL, SC, or SM-SC.	A-6 or A-4	95 to 100	95 to 100	85 to 100	35 to 60
Gu	Gullied land.	Streambank escarpments and gullied areas along streambanks; soil material so variable that properties cannot be estimated.								
HgD	Hilly gravelly land.	Mostly gravel pits and caliche outcrops; little soil; so variable that properties cannot be estimated.								
HkB	Hockley loamy fine sand, 0 to 3 percent slopes.	About 12 to 25 inches of noncalcareous loamy fine sand, over about 17 to 47 inches of noncalcareous sandy clay to sandy clay loam, over many feet of weakly stratified sandy clay loam and sandy loam or interbedded sandy shale and sandstone.	0 to 16	Loamy fine sand	SM	A-2 or A-4	95 to 100	95 to 100	95 to 100	15 to 40
			16 to 40	Sandy clay or sandy clay loam.	SC or CL	A-7 or A-6	95 to 100	95 to 100	95 to 100	45 to 60
HkC	Hockley loamy fine sand, 3 to 5 percent slopes.		40 to 72	Sandy clay loam with weakly cemented sandstone.	SC, CL, or SM-SC.	A-7 or A-6	95 to 100	95 to 100	95 to 100	45 to 60
HkC2	Hockley loamy fine sand, 3 to 5 percent slopes, eroded.									

See footnote at end of table.

of soil properties significant in engineering—Continued

no data on which to base an estimate]

Permeability	Reaction	Available water	Unit dry weight	Potential volumetric change category (PVC)	Electrical resistivity at depth of 4 feet [1]	Underlying material to a depth of 10 feet: Range in depth to underlying material	Underlying material to a depth of 10 feet: Description of underlying material	Underlying material to a depth of 10 feet: Hardness (Mohs scale)
In./hr.	*pH*	*In./in.*	*Lb./cu. ft.*		*Ohms/cc.*	*In.*		
1.0 to 1.5	6.0 to 6.5	0.08 to 0.13	100 to 125	Noncritical	1,200 to 1,800	48 to 96	Weakly stratified sandy loam and sandy clay loam with thin strata of weakly cemented sandstone.	Less than 2.5.
1.0 to 1.5	5.5 to 6.5	0.10 to 0.15	95 to 120	Critical or marginal.				
2.0 to 3.0	6.1 to 7.3	0.07 to 0.09	100 to 125	Noncritical	1,400 to 1,800	54 to 72	Sandy and loamy earths with thin strata of weakly cemented sandstone.	Less than 2.5.
1.0 to 1.5	6.1 to 7.3	0.12 to 0.14	105 to 125	Marginal or noncritical.				
3.0 to 5.0	5.5 to 6.3	0.04 to 0.07	100 to 135	Noncritical	1,400 to 1,800	49 to 120	Very porous fine sand	Less than 1.
1.5 to 2.5	6.0 to 7.5	0.10 to 0.12	75 to 120	Noncritical.				
1.0 to 2.0	7.9 to 8.4	0.14 to 0.16	90 to 120	Marginal	600 to 1,600	36 to 72 or more.	Massive or loose loamy sediments interbedded with gravel.	Loamy sediments less than 1; pebbles more than 2.5.
1.5 to 2.5+	7.9 to 8.4	0.14 to 0.16	90 to 120	Marginal.				
1.0 to 1.5	6.0 to 7.3	0.14 to 0.16	90 to 120	Critical	650 to 1,100	36 to 60 or more.	Massive, stratified alluvium; layers of sandy clay, clay loam, loam, and sandy loam.	Less than 1.
1.0 to 2.5+	7.3 to 8.4	0.14 to 0.16	100 to 125	Critical to noncritical.				
2.0 to 3.0	5.5 to 7.0	0.10 to 0.14	100 to 125	Noncritical	1,000 to 1,600	48 to 96	Sandy clay loam or light sandy clay with weakly cemented sandstone.	Fine earth less than 1; sandstone less than 2.5.
0.6 to 0.8	5.5 to 6.5	0.18 to 0.21	95 to 120	Critical or marginal.				
0.6 to 1.0	6.1 to 7.3	0.16 to 0.18	105 to 125	Critical or marginal.				

TABLE 3.—*Brief descriptions of soils and estimates*

[Dashes in columns indicate there were

Map symbol	Soil name	Description of horizons to depth indicated	Depth from surface (typical)	Classification			Percentage passing sieve—			
				USDA texture	Unified	AASHO	1 inch (25.4 mm.)	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)
			In.							
HnB	Houston clay, 1 to 3 percent slopes.	24 to 62 inches of slowly permeable, calcareous clay; contains a little gravel (less than 7 percent); underlain by clay, chalk, or marl.	0 to 25	Clay	CH	A-7	95 to 100	95 to 100	95 to 100	80 to 85
HnC2	Houston clay, 3 to 5 percent slopes, eroded.		25 to 44	Clay	CH	A-7	95 to 100	95 to 100	95 to 100	80 to 85
HnC3	Houston clay, 3 to 5 percent slopes, severely eroded.		44 to 62+	Marly clay	CH or CL	A-7 or A-6	95 to 100	95 to 100	95 to 100	80 to 85
HoD3	Houston-Sumter clays, 5 to 10 percent slopes, severely eroded.									
	Houston	See description of Houston clays (HnB, HnC2, HnC3).								
	Sumter	About 5 to 12 inches of brownish to yellowish, calcareous clay, over marly clay that contains numerous lime concretions; the material below a depth of about 84 inches may be shaly.	0 to 8	Gravelly clay; 5 to 8 percent chert fragments.	CH or CL	A-7	95 to 100	95 to 100	90 to 100	90 to 100
HsA	Houston Black clay, 0 to 1 percent slopes.	About 38 to 64 inches of slowly permeable, calcareous clay and about 10 to 24 inches of clay or silty clay; some gravel (less than 7 percent); marl, chalk, or marly clay at a depth of about 48 to 84 inches.	0 to 50	Clay	CH	A-7	95 to 100	95 to 100	95 to 100	80 to 85
HsB	Houston Black clay, 1 to 3 percent slopes.		50 to 62	Clay to silty clay	CH or CL	A-7 to A-6	95 to 100	95 to 100	95 to 110	80 to 85
HsC	Houston Black clay, 3 to 5 percent slopes.									
HtA	Houston Black clay, terrace, 0 to 1 percent slopes.	About 42 to 60 inches of calcareous clay, over about 18 to 24 inches of clayey alluvium, which grades to gravelly alluvium of varying textures at a depth of 58 to 120 inches.	0 to 58	Clay	CH	A-7	95 to 100	95 to 100	95 to 100	80 to 90
			58 to 80	Clay	CL or CH	A-7	95 to 100	95 to 100	90 to 100	75 to 90
HtB	Houston Black clay, terrace, 1 to 3 percent slopes.		80 to 120	Gravelly clay loam.	CL or GC	A-7 or A-2	95 to 100	60 to 100	50 to 100	35 to 85
HuB	Houston Black gravelly clay, 1 to 3 percent slopes.	36 to 60 inches of gravelly calcareous clay; 10 to 20 percent gravel; overlying clay and marly clay.	0 to 48	Gravelly clay	GC	A-2	70 to 100	60 to 100	50 to 100	50 to 85
			48 to 60+	Clay	CH or GC	A-7 or A-2	80 to 100	75 to 100	60 to 100	45 to 85
HuC	Houston Black gravelly clay, 3 to 5 percent slopes.									
HuD	Houston Black gravelly clay, 5 to 8 percent slopes.									
KaB	Karnes loam, 1 to 3 percent slopes.	20 to 44 inches or more of calcareous loam to light clay loam, over stratified alluvium. Gravel in some places at a depth of 48 inches or more.	0 to 38	Loam or clay loam.	CL or ML-CL.	A-6 or A-4.	95 to 100	95 to 100	95 to 100	80 to 90
KaC	Karnes loam, 3 to 5 percent slopes.		38 to 60+	Stratified loam, clay loam, sandy loam, and gravelly loam.	CL, ML-CL, SM, or GM.	A-6, or A-4, A-2.	50 to 100	40 to 90	40 to 90	25 to 90
KcC2	Karnes clay loam, 3 to 5 percent slopes, eroded.									
Kr	Krum complex.	Predominantly clay; about 18 to 36 inches of dark-gray, calcareous clay, over about 12 to 20 inches of calcareous light clay, over clayey marl or clay; some profiles contain limestone fragments and calcium carbonate concretions.	0 to 30	Clay	CH	A-7	90 to 100	90 to 100	85 to 95	75 to 90
			30 to 50	Clay	CH	A-7	90 to 100	90 to 100	85 to 95	75 to 90
			50 to 62	Clay and limestone fragments.	CH	A-7	85 to 95	85 to 100	75 to 85	60 to 80

See footnote at end of table.

of soil properties significant in engineering—Continued

no data on which to base an estimate]

Permeability	Reaction	Available water	Unit dry weight	Potential volumetric change category (PVC)	Electrical resistivity at depth of 4 feet [1]	Underlying material to a depth of 10 feet: Range in depth to underlying material	Underlying material to a depth of 10 feet: Description of underlying material	Underlying material to a depth of 10 feet: Hardness (Mohs scale)
In./hr.	*pH*	*In./in.*	*Lb./cu. ft.*		*Ohms/cc.*	*In.*		
0.3 to 0.5 0.1 to 0.2 Less than 0.1.	7.6 to 8.4 7.6 to 8.4 7.6 to 8.4	0.18 to 0.21 0.18 to 0.21 0.21+	75 to 105 75 to 105 80 to 110	Very critical Very critical Very critical to marginal.	250 to 750	48 to 60	Calcareous clay and shaly clay; irregular jointing and cleavage. Grades to less altered material.	Less than 1.
0.2 to 0.4	7.9 to 8.4	0.18 to 0.21	80 to 110	Very critical or critical.	1,300 to 1,700	5 to 12	Calcareous clay to a depth of about 84 inches; shaly clay below; irregular jointing and cleavage.	Less than 2.5.
0.4 to 0.6 0.1 to 0.2	7.6 to 8.4 7.9 to 8.4	0.18 to 0.21 0.18 to 0.21	75 to 105 80 to 110	Very critical Very critical or critical.	170 to 900	48 to 84	Calcareous clay; shaly clay in some profiles below a depth of about 84 inches; shaly clay has irregular jointing and cleavage.	Less than 1.
0.3 to 0.5 0.4 to 0.8 0.5 to 1.5+	7.9 to 8.4 7.9 to 8.4 7.9 to 8.4	0.18 to 0.21 0.18 to 0.21 0.14 to 0.18	75 to 105 80 to 115 90 to 125	Very critical Very critical. Critical or marginal.	300 to 950	72 to 120 or more.	Loose gravel of chert and limestone, mixed with varying amounts of sand; some coarse fragments more than 3 inches in diameter. Locally, gravel may be strongly cemented with lime, or it may be capped with a thin layer of caliche.	Fine earth less than 1; pebbles more than 2.5.
0.5 to 0.8 0.2 to 0.4	7.9 to 8.4 7.9 to 8.4	0.17 to 0.18 0.18 to 0.21	115 to 130 75 to 105	Very critical Very critical or critical.	400 to 1,100	36 to 60	Marly clay, or soft, dense shale, or soft, fissile shale; irregular cleavage or massive.	Pebbles, more than 2.5; fine earth less than 1.
2.0 to 2.5 2.5+	7.9 to 8.4 7.9 to 8.4	0.12 to 0.14 0.08 to 0.10	85 to 120 95 to 125	Noncritical Noncritical	1,300 to 1,700	20 to 44 inches or more	Loamy alluvium, underlain in places by gravel below a depth of about 48 inches or more.	Less than 1; pebbles more than 2.5.
0.8 to 1.0 0.8 to 1.0 0.8 to 1.0	7.9 to 8.4 7.9 to 8.4 7.9 to 8.4	0.16 to 0.18 0.16 to 0.18 0.16 to 0.17	75 to 105 95 to 125 100 to 130	Very critical or critical. Very critical or critical. Very critical to marginal.	700 to 1,100	30 to 56	Limestone; either massive, or fractured and embedded in clay; depth to bedrock is more than 5 feet.	Limestone fragments more than 2.5; rest of material less than 1.

TABLE 3.—*Brief descriptions of soils and estimates*

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Map symbol	Soil name	Description of horizons to depth indicated	Depth from surface (typical)	Classification			Percentage passing sieve—			
				USDA texture	Unified	AASHO	1 inch (25.4 mm.)	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)
			In.							
LfB	Leming loamy fine sand, 0 to 3 percent slopes.	13 to 30 inches of noncalcareous loamy fine sand, over 12 to 32 inches of very slowly permeable, slightly calcareous clay or sandy clay, over calcareous sandy clay.	0 to 22	Loamy fine sand	SM	A-2 or A-4	95 to 100	95 to 100	95 to 100	20 to 50
			28 to 42	Sandy clay	CL or SC	A-7 or A-6	95 to 100	95 to 100	95 to 100	45 to 60
			42+	Heavy sandy clay loam.	SC or CL	A-6	95 to 100	95 to 100	95 to 100	45 to 60
LvA	Lewisville silty clay, 0 to 1 percent slopes.	About 27 to 60 inches of calcareous, moderately crumbly silty clay or heavy clay loam; grades to loamy alluvium; rounded concretions of calcium carbonate and soft masses below a depth of 36 to 60 inches; gravel in some places at a depth of 5 to 12 feet.	0 to 44	Silty clay	CL	A-6	95 to 100	95 to 100	95 to 100	85 to 90
LvB	Lewisville silty clay, 1 to 3 percent slopes.		44 to 62	Silty clay loam	CL	A-6	95 to 100	90 to 100	90 to 100	80 to 90
LvC	Lewisville silty clay, 3 to 5 percent slopes.		62 to 84+	Clay loam grading to gravelly loam in the lower part.	CL, ML, SM, or GM.	A-6 or A-4	95 to 100	90 to 100	90 to 80	65 to 80
OrA	Orelia clay loam, 0 to 1 percent slopes.	7 to 17 inches of slowly permeable, noncalcareous sandy clay loam, over 28 to 48 inches of slightly calcareous sandy clay or clay, over calcareous clay or clay loam.	0 to 12	Sandy clay loam	CL	A-7	95 to 100	95 to 100	95 to 100	80 to 90
			12 to 38	Sandy clay	CL or CH	A-7	95 to 100	95 to 100	95 to 100	80 to 90
OrB	Orelia clay loam, 1 to 3 percent slopes.		38 to 60+	Clay	CH	A-7	95 to 100	95 to 100	95 to 100	80 to 90
PaA	Patrick soils, 0 to 1 percent slopes.	10 to about 30 inches of calcareous clay loam, loam, silty clay loam, and light clay; underlain by porous gravelly material that may be several feet thick and in places is cemented in the uppermost 3 or 4 inches; gravel consists of limestone and chert and ranges in size from ¼ inch to more than 3 inches.	0 to 17	Clay loam	CL, ML-CL, or CH.	A-6, A-4, or A-7.	95 to 100	85 to 100	80 to 95	50 to 95
PaB	Patrick soils, 1 to 3 percent slopes.		17 to 60+	Gravel bed containing loamy soil material.	GM or GC	A-2	25 to 50	20 to 50	15 to 50	10 to 40
PaC	Patrick soils, 3 to 5 percent slopes.									
Pt	Pits and Quarries	No engineering uses.								
SaB	San Antonio clay loam, 1 to 3 percent slopes.	About 6 to 15 inches of noncalcareous clay loam to sandy clay loam, over about 17 to 30 inches of noncalcareous clay to heavy clay loam; at a depth of 26 to 45 inches, yellowish clay loam and large sandstones that occur erratically.	0 to 8	Clay loam	CL	A-6	95 to 100	95 to 100	95 to 100	80 to 85
			8 to 28	Clay	CH	A-7	95 to 100	95 to 100	95 to 100	80 to 85
			28 to 60	Clay loam	CL	A-6 or A-7	95 to 100	95 to 100	95 to 100	80 to 85
SaC	San Antonio clay loam, 3 to 5 percent slopes.		60 to 120	Clay loam and sandy clay loam, with some interbedded sandstone.	CL	A-6 or A-4	95 to 100	95 to 100	95 to 100	80 to 85
SaC2	San Antonio clay loam, 3 to 5 percent slopes, eroded.									
ScB	Stephen silty clay, 1 to 3 percent slopes.	10 to 22 inches of calcareous, crumbly silty clay containing few chalk fragments over 2 to 12 inches of chalk rubble with fine earth in the interstices, over chalk that is hard in the upper few inches and alternatingly soft and hard below.	0 to 18	Silty clay	CH or CL	A-7	95 to 100	95 to 100	90 to 100	85 to 90
ScC	Stephen silty clay, 3 to 5 percent slopes.		18 to 24	Silty clay and soft chalk.						
			24 to 30+	Chalk.						
TaB	Tarrant association, gently undulating.	5 to 12 inches of calcareous clay tc clay loam containing many limestone fragments, over 7 to about 12	0 to 10	Clay loam	CL or CH	A-7	60 to 95	60 to 95	60 to 90	60 to 85
TaC	Tarrant association, rolling.									

See footnote at end of table.

of soil properties significant in engineering—Continued

no data on which to base an estimate]

Permeability	Reaction	Available water	Unit dry weight	Potential volumetric change category (PVC)	Electrical resistivity at depth of 4 feet [1]	Underlying material to a depth of 10 feet: Range in depth to underlying material	Underlying material to a depth of 10 feet: Description of underlying material	Underlying material to a depth of 10 feet: Hardness (Mohs scale)
In./hr.	*pH*	*In./in.*	*Lb./cu. ft.*		*Ohms/cc.*	*In.*		
1.0 to 1.5	6.0 to 7.3	0.07 to 0.09	100 to 125	Noncritical	1,000 to 1,600	42 to 62	Stratified loamy fine sand and clay; massive	Less than 1.
0.6 to 0.8	6.0 to 7.3	0.18 to 0.21	80 to 120	Critical or marginal.				
1.0 to 1.2	7.9 to 8.4	0.14 to 0.16	100 to 125	Critical or marginal.				
1.0 to 1.2	7.9 to 8.4	0.16 to 0.18	85 to 110	Very critical or critical.	550 to 1,100	36 to 60	Friable, massive, loamy alluvium; gravel at depth of 5 feet or more and generally at depth of at least 10 feet.	Less than 1; pebbles in the underlying gravel beds more than 2.5.
1.0 to 2.0	7.9 to 8.4	0.16 to 0.18	90 to 120	Critical or marginal.				
1.0 to 5.0+	7.9 to 8.4	0.10 to 0.16	100 to 125	Marginal				
0.6 to 0.8	6.8 to 7.3	0.18 to 0.21	90 to 120	Critical or marginal.	750 to 1,300	30 to 65	Calcareous clay or clay loam containing few to common gypsum crystals and few concretions and soft lumps of lime.	Mostly less than 1; gypsum crystals 2, and lime concretions 3.
0.6 to 0.8	7.9 to 8.4	0.20 to 0.23	90 to 120	Critical				
0.2 to 0.5	7.9 to 8.4	0.20 to 0.23	90 to 120	Critical				
1.0 to 1.5	7.9 to 8.4	0.17 to 0.18	90 to 125, or 75 to 105.	Critical or marginal.	1,200 to 1,700	10 to 30	Loose gravel beds which in some places have hard caliche or cemented gravel in the upper part.	More than 2.5.
2.0 to 5.0+	7.9 to 8.4	0.14 to 0.16	115 to 130	Noncritical				
0.8 to 1.0	6.3 to 7.0	0.18 to 0.21	90 to 120	Critical	750 to 1,300	30 to 120	Rounded floatrock consisting of strongly cemented, massive sandstone; stones are several feet in diameter and are embedded in soil material; they occur every 100 to 300 feet and lie at various angles.	Soil material less than 1; sandstone more than 2.5.
0.7 to 0.8	7.4 to 7.8	0.20 to 0.23	75 to 105	Critical				
0.6 to 0.8	7.9 to 8.4	0.20 to 0.23	90 to 120	Critical				
0.8 to 1.0	7.9 to 8.4	0.18 to 0.21	90 to 120	Noncritical				
0.8 to 1.2	7.9 to 8.4	0.16 to 0.18	75 to 105	Critical	1,050 to 1,500	10 to 22	Alternating layers of hard and soft chalk; hard in upper few inches and alternatingly soft and hard below.	Mostly less than 2.5; some strata more than 2.5.
1.0 to 1.5	7.3 to 8.4	0.16 to 0.18	75 to 105	Marginal	1,500 to 3,400	12 to 24	Crystalline limestone; platy and fractured; thin bedded in uppermost 2 or 3 feet; thicker bedded at greater depths.	More than 2.5.

776-905—66——6

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				USDA texture	Unified	AASHO	1 inch (25.4 mm.)	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)
	Continued—		*In.*							
TaD	Tarrant association, hilly.	inches of fractured limestone containing fine earth in interstices, over fractured limestone.								
Tb	Tarrant soils, chalk substratum, undulating.	About 5 to 10 inches of gravelly clay loam, over chalk.	0 to 8	Gravelly clay loam.	GC or CL	A-6 or A-7	80 to 95	80 to 95	60 to 90	50 to 90
Tc	Trinity clay.	About 40 to 70 inches of slowly permeable calcareous clay; substratum is stratified clayey alluvium that, in places, contains gravel layers.	0 to 65	Clay	CH	A-7	95 to 100	95 to 100	85 to 100	80 to 90
Tf	Trinity and Frio soils, frequently flooded.									
	Trinity	See description of Trinity clay (Tc).								
	Frio	See description of Frio clay loam (Fr).								
VaA	Venus loam, 0 to 1 percent slopes.	30 to 62 inches of calcareous loam to light clay loam, over loamy alluvium or gravel.	0 to 30	Heavy loam	CL or ML-CL.	A-6 or A-4	95 to 100	95 to 100	95 to 100	80 to 90
VaB	Venus loam, 1 to 3 percent slopes.		30 to 62	Heavy loam	CL or ML-CL.	A-6 or A-4	95 to 100	95 to 100	95 to 100	75 to 85
VcA	Venus clay loam, 0 to 1 percent slopes.	About 16 to 50 inches of calcareous clay loam to loam, over loamy alluvium; gravel, cemented in places, below a depth of 6 feet.	0 to 16	Clay loam	CL	A-7 or A-6	95 to 100	95 to 100	95 to 100	80 to 90
VcB	Venus clay loam, 1 to 3 percent slopes.		16 to 36	Light clay loam	CL	A-7 or A-6	95 to 100	90 to 100	85 to 100	75 to 85
VcC	Venus clay loam, 3 to 5 percent slopes.		36 to 72	Heavy loam	CL, ML, or GM.	A-6 or A-2	95 to 100	40 to 90	40 to 90	25 to 90
WbB	Webb fine sandy loam, 1 to 3 percent slopes.	About 5 to 18 inches of noncalcareous sandy loam, over 18 to 38 inches of noncalcareous sandy clay, clay, or heavy sandy clay loam, over calcareous sandy clay to sandy clay loam; fragments of altered sandstone common below a depth of 30 inches.	0 to 12	Fine sandy loam	SM or SC	A-4 or A-2	95 to 100	95 to 100	85 to 100	25 to 50
WbC	Webb fine sandy loam, 3 to 5 percent slopes.		12 to 26	Clay loam over sandy clay.	SC, CL or CH.	A-7 or A-6	95 to 100	95 to 100	60 to 100	45 to 60
WeC2	Webb soils, 3 to 5 percent slopes, eroded.		26 to 48	Light sandy clay interbedded with sandstone in lower part.	SC, CL, or SM-SC.	A-6 or A-7	75 to 100	75 to 100	60 to 100	45 to 60
WeC3	Webb soils, 3 to 5 percent slopes, severely eroded.									
WmA	Willacy loam, 0 to 1 percent slopes.	35 to 56 inches of noncalcareous loam to sandy clay loam, over calcareous sandy clay loam to loam underlain in places by gravel.	0 to 15	Loam	CL, or ML-CL.	A-6 or A-4	95 to 100	95 to 100	95 to 100	70 to 85
WmB	Willacy loam, 1 to 3 percent slopes.		15 to 56+	Sandy clay loam	CL	A-6 or A-7	95 to 100	95 to 100	95 to 100	80 to 85
			54 to 120	Heavy loam	ML-CL, ML, SM, or GM.	A-4	95 to 100	95 to 100	85 to 100	70 to 85
Za	Zavala fine sandy loam.	About 21 to 45 inches of fine sandy loam to loam, over stratified loamy and clayey sediments.	0 to 24	Fine sandy loam	CL-ML	A-4	95 to 100	95 to 100	95 to 100	55 to 75
			24 to 62+	Stratified light and heavy sandy clay loam.	CL	A-7	95 to 100	95 to 100	90 to 100	70 to 85
Zg	Zavala and Gowen soils, frequently flooded.									
	Zavala	See description of Zavala fine sandy loam (Za).								
	Gowen	See description of Gowen clay loam (Go).								

[1] For soils in which bedrock was at a depth of less than 4 feet, readings were made in the soil fines just above the bedrock.

of soil properties significant in engineering—Continued

no data on which to base an estimate]

Permeability	Reaction	Available water	Unit dry weight	Potential volumetric change category (PVC)	Electrical resistivity at depth of 4 feet [1]	Underlying material to a depth of 10 feet		
						Range in depth to underlying material	Description of underlying material	Hardness (Mohs scale)
In./hr.	*pH*	*In./in.*	*Lb./cu. ft.*		*Ohms/cc.*	*In.*		
0.8 to 1.0	7.9 to 8.3	0.16 to 0.18	95 to 125	Marginal	1,800 to 2,700	5 to 10	Platy, fractured chalk; thin bedded and soft in upper part, harder in lower strata.	Some more and some less than 2.5.
0.2 to 0.4	7.8 to 8.4	0.18 to 0.21	75 to 105	Very critical	350 to 750	40 to 70	Clayey and gravelly alluvium; massive; strata of gravel occur erratically.	Less than 1.
2.0 to 2.5	7.9 to 8.4	0.12 to 0.14	85 to 120	Noncritical	1,300 to 2,300	36 to 62	Loamy alluvium; massive; underlain in places by gravel.	Loamy alluvium less than 1; gravel more than 2.5.
2.0 to 2.5	7.9 to 8.4	0.12 to 0.14	90 to 120	Noncritical				
1.0 to 1.2	7.9 to 8.4	0.14 to 0.16	90 to 120	Marginal	1,100 to 1,800	16 to 50	Loamy alluvium; some stratification; underlain by gravel that may be cemented locally.	Loamy alluvium less than 1; gravel more than 2.5.
1.0 to 1.5	7.9 to 8.4	0.14 to 0.16	90 to 120	Marginal				
1.0 to 5.0+	7.9 to 8.4	0.14 to 0.16	90 to 130	Noncritical				
1.0 to 1.5	6.6 to 7.3	0.14 to 0.16	90 to 125	Noncritical	900 to 1,500	30 to 56	Sandy clay to sandy clay loam with weakly consolidated sandstone.	Less than 2.5.
0.6 to 0.8	6.6 to 7.3	0.16 to 0.18	80 to 120	Critical or marginal.				
0.6 to 1.0	7.3 to 8.4	0.14 to 0.18	90 to 125	Marginal or noncritical.				
1.0 to 1.5	7.0 to 7.5	0.14 to 0.16	90 to 120	Noncritical	800 to 1,500	35 to 56	Crumbly, limy loamy sediments underlain in places by gravel.	Less than 1.
1.0 to 1.5	7.9 to 8.4	0.14 to 0.16	90 to 120	Noncritical				
1.5 to 3.0+	7.9 to 8.4	0.10 to 0.16	85 to 115	Noncritical				
1.0 to 1.5	6.3 to 7.0	0.08 to 0.13	90 to 120	Noncritical	1,100 to 1,800	21 to 45	Loamy alluvial sediments stratified with clayey sediments.	Less than 1.
1.0 to 1.5	6.3 to 7.5	0.08 to 0.13	90 to 120	Noncritical				

TABLE 4.—*Engineering*

Soil and map symbols	Suitability for— Road subbase	Road fill	Wearing surface (untreated)	Foundations for low buildings (undisturbed conditions)	Low embankments for sewage lagoons (less than 6 ft. high)	Compacted earth lining for water reservoirs and sewage lagoons	Degree of limitation for use as sewage-disposal field	Suitability as source of— Topsoil	Sand or gravel
Austin silty clay (AuB, AuC).	Poor	Not suitable	Not suitable	Fair	Fair	Good	Moderate	Fair or poor; high lime content.	Not suitable
Brackett clay loam (BpC).	Poor	Poor	Poor	Good	Fair	Good	Severe	Poor	Not suitable
Brackett soils (BrD, BrE).	Good below depth of 6 inches.	Good below depth of 6 inches.	Poor	Good	Fair	Good	Moderate or severe; extra storage area needed.	Poor	Not suitable
Brackett-Austin complex (BsC):									
Austin	Poor	Not suitable	Not suitable	Fair	Fair	Good	Moderate	Fair or poor; high lime content.	Not suitable
Brackett	Good below depth of 6 inches.	Good below depth of 6 inches.	Poor	Good	Fair	Good	Moderate or severe; extra storage area needed.	Poor	Not suitable
Brackett-Tarrant association, hilly (BtE):									
Brackett	Good below depth of 6 inches.	Good below depth of 6 inches.	Poor	Good	Fair	Good	Moderate or severe; extra storage area needed.	Poor	Not suitable
Tarrant	Poor	Poor	Poor	Good	Poor; very shallow.	Good	Severe; limestone at depth of 1 foot.	Not suitable	Fair; bedrock can be crushed for gravel.
Crawford clay (Ca)	Poor	Poor	Poor	Poor; cracks to dangerous extent when dry.	Fair	Good	Severe; limestone bedrock at depth of 2 to 3 feet.	Fair	Not suitable
Crawford and Bexar stony soils (Cb).	Poor	Poor	Poor	Fair; hard limestone bedrock at a depth of 2 to 3 feet.	Fair	Fair; stones	Severe; limestone bedrock at depth of 2 to 3 feet.	Poor	Not suitable
Crockett fine sandy loam (CfA, CfB). Crockett soils (CkC2).	Good or fair	Good or fair	Fair or poor	Fair	Good	Good below depth of 1 foot.	Severe; extra storage area needed.	Good (surface layer).	Not suitable
Duval loamy fine sand (DmC). Duval soils (DsC2).	Good	Good	Good or fair	Fair	Fair if surface soil and subsoil are mixed.	Poor	Slight	Fair	Not suitable

interpretations

Properties affecting use in—					Properties affecting suitability for irrigation	Drainage characteristics	Corrosion potential	Susceptibility to erosion
Ponds		Terraces	Diversion terraces	Waterways				
Reservoir	Embankment							
Moderate permeability; surface layer needs core; chalky marl at depth of 4 to 9 feet.	Fair stability with flat slopes; high lime content.	Soil properties favorable.	Soil properties favorable.	Erosion hazard; high lime content.	High lime content; chlorosis hazard.	Good or fair	High	Slight to severe.
Slow permeability; chalky marl at depth of 2 feet.	Poor stability	Shallowness; chalky marl at depth of 2 feet.	Shallowness; chalky marl at depth of 2 feet.	Erosion hazard; shallowness; high lime content.	Shallowness; high lime content; chlorosis hazard.	Fair	Moderately high.	Slight to severe.
Moderate permeability; limestone interbedded with chalk at depth of 1 foot.	Fair stability	Shallowness; chalk or fractured limestone at depth of 1 foot.	Shallowness; chalk or fractured limestone at depth of 1 foot.	Shallowness; not suitable.	Shallowness; not suitable for irrigation.	Good or fair	Moderately high.	Moderate.
Moderate permeability; surface layer needs core; chalky marl at depth of 4 to 9 feet.	Fair stability with flat slopes; high lime content.	Soil properties favorable.	Soil properties favorable.	Erosion hazard; high lime content.	High lime content; chlorosis hazard.	Good or fair	High	Slight to severe.
Moderate permeability; limestone interbedded with chalk at depth of 1 foot.	Fair stability	Shallowness; chalk or fractured limestone at depth of 1 foot.	Shallowness; chalk or fractured limestone at depth of 1 foot.	Shallowness; not suitable.	Shallowness; not suitable for irrigation.	Good or fair	Moderately high.	Moderate.
Moderate permeability; limestone interbedded with chalk at depth of 1 foot.	Fair stability	Shallowness; chalk or fractured limestone at depth of 1 foot.	Shallowness; chalk or fractured limestone at depth of 1 foot.	Shallowness; not suitable.	Shallowness; not suitable for irrigation.	Good or fair	Moderately high.	Moderate.
Slow permeability; hard limestone at depth of 1 foot.	Fair stability with flat slopes.	Shallowness; limestone at depth of 1 foot; nonarable soil.	Shallowness; limestone at depth of 1 foot; diversions not feasible on hilly soils.	Shallowness; limestone at depth of 1 foot; erosion hazard.	Shallowness; limestone at depth of 1 foot; nonarable soils.	Poor; practically impervious.	Moderately high.	None to moderate.
Slow permeability; limestone bedrock at a depth or 2 to 3 feet.	Fair stability with flat slopes; high shrink-swell potential.	Soil properties favorable.	Soil properties favorable.	Soil properties favorable.	Slow permeability; high water-holding capacity; limestone bedrock at depth of 2 to 3 feet.	Fair internal drainage; bedrock at a depth of 2 to 3 feet.	High	Moderate.
Slow permeability; limestone bedrock at depth of 2 to 3 feet.	Fair stability with flat slopes; high shrink-swell potential.	Not needed; level, nonarable soils.	Soil properties favorable; very stony.	Not needed; stony, nonarable soils.	Slow permeability; limestone bedrock at depth of 2 to 3 feet; too stony to be cultivated.	Slow internal drainage; bedrock at depth of 2 to to 3 feet.	Moderately high.	None or slight.
Slow permeability; surface material needs core; sandy shale and sandstone at depth of 4 to 10 feet.	Fair stability with flat slopes.	Soil properties favorable; terraces not needed if slope is 1 percent or less.	Soil properties favorable.	Erosion hazard; soil crusts when dry; establishing vegetation is difficult.	Very slow permeability in subsoil; high water-holding capacity; tendency toward salinity.	Poor; practically impervious.	High	Slight or moderate.
Rapid permeability; excessive seepage.	Fair stability	Sandy texture; poor stability; not suitable.	Poor stability; not suitable.	Erosion hazard; siltation hazard.	Rapid intake of water; frequent applications needed; suitable for sprinkler irrigation only.	Good	Moderately high.	Moderate.

TABLE 4.—*Engineering*

Soil and map symbols	Suitability for— Road subbase	Road fill	Wearing surface (untreated)	Foundations for low buildings (undisturbed conditions)	Low embankments for sewage lagoons (less than 6 ft. high)	Compacted earth lining for water reservoirs and sewage lagoons	Degree of limitation for use as sewage-disposal field	Suitability as source of— Topsoil	Sand or gravel
Duval fine sandy loam (DnB, DnC).	Poor	Good	Poor	Good	Good	Good	Moderate	Good	Not suitable
Eufaula fine sand (EuC).	Poor	Fair	Fair	Fair	Poor; seepage hazard.	Poor	Slight	Poor	Good; well-graded sand.
Frio clay loam (Fr).	Fair below depth of 2 feet.	Fair below depth of 2 feet.	Poor	Poor; occasional flooding.	Poor; occasional flooding.	Good	Severe; occasional flooding.	Good	Fair; scattered beds of gravel.
Gowen clay loam (Go).	Poor	Poor	Poor	Fair	Poor; occasional flooding.	Good	Severe; occasional flooding.	Good	Not suitable
Gullied land (Gu).	Poor	Poor	Poor	Poor	Not suitable; steep.	Good	Not suitable	Not suitable	Fair; gravel at various depths.
Hilly gravelly land (HgD).	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable
Hockley loamy fine sand (HkB, HkC, HkC2).	Good	Fair	Good or fair	Fair	Good if surface layer is removed.	Poor in surface layer; good below depth of 2 feet.	Moderate	Fair	Not suitable
Houston clay (HnB, HnC2, HnC3).	Poor	Poor	Poor	Poor; cracks to dangerous extent when dry.	Fair	Good	Not suitable; cracks when dry; extra storage area needed.	Fair	Not suitable
Houston-Sumter clays (HoD3):									
Sumter	Poor	Poor	Poor	Poor; cracks to dangerous extent when dry.	Fair	Good	Not suitable; cracks when dry; extra storage area needed.	Poor	Not suitable
Houston	Poor	Poor	Poor	Poor; cracks to dangerous extent when dry.	Fair	Good	Not suitable; cracks when dry; extra storage area needed.	Fair	Not suitable
Houston Black clay (HsA, HsB, HsC).	Poor	Poor	Poor	Poor; cracks to dangerous extent when dry.	Fair	Good	Not suitable; cracks when dry; extra storage area needed.	Fair	Not suitable

interpretations—Continued

Properties affecting use in—: Ponds: Reservoir	Ponds: Embankment	Terraces	Diversion terraces	Waterways	Properties affecting suitability for irrigation	Drainage characteristics	Corrosion potential	Susceptibility to erosion
Moderate permeability; sandstone in substratum.	Fair or poor stability.	Soil properties favorable.	Soil properties favorable.	Soil properties favorable; erosion hazard on strongest slopes.	Moderate permeability	Good	High	None to moderate.
Rapid permeability; excessive seepage.	Poor stability	Poor stability; not suitable.	Poor stability; not suitable.	Erosion hazard; siltation hazard.	Rapid permeability; suitable for sprinkler irrigation only.	Excellent	High	None to moderate.
Moderate permeability; scattered beds of gravel.	Good stability	Not needed, because of topography.	Occasional flooding; limited application because of topography.	Occasional flooding; siltation hazard.	Moderate permeability; occasional flooding.	Good	High	Moderate.
Moderate to rapid permeability; excessive seepage.	Fair stability	Not needed, because of topography.	Soil properties favorable; limited application because of topography; occasional flooding.	Occasional flooding; siltation hazard.	Moderate permeability; moderate water-holding capacity; occasional flooding.	Good	High	None.
Erosion hazard; steep slopes.	Fair stability	Steep slopes; nonarable; not suitable for terracing.	Steep slopes; lack of outlets; limited application.	Steep slopes; erosion hazard.	Steep slopes; nonarable; not suitable for irrigation.	Good	High	Severe.
Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
Permeable surface layer; slow permeability at depth of 5 or 6 feet; needs good core.	Fair stability; surface material may be placed in back toe section.	Poor stability; limited application if soil is eroded.	Poor stability; limited application if soil is eroded.	Erosion hazard; siltation hazard; difficult to establish vegetation.	Droughty surface layer; good water-holding capacity in subsoil.	Fair; slow internal drainage.	High	Moderate.
Slow permeability; strongly calcareous marly clay at depth of 5 to 8 feet.	Fair stability with flat slopes; high shrink-swell potential.	Soil properties favorable.	Soil properties favorable; soil cracks when dry.	Poor soil-moisture relationship; soil cracks when dry.	High water-holding capacity; slow permeability; steep slopes not suitable for irrigation.	Poor; practically impervious.	Very high	Slight to severe.
Slow permeability; strongly calcareous marly clay at depth of 5 to 14 inches.	Fair stability with flat slopes; high shrink-swell potential.	Shallowness; strongly calcareous marly clay at depth of 5 to 14 inches.	Shallowness; strongly calcareous marly clay at depth of 5 to 14 inches.	Shallowness; steep slopes; poor soil-moisture relationship; soil cracks when dry.	Shallowness; steep slopes; not suitable for irrigation.	Poor; practically impervious	High	Moderate to severe.
Slow permeability; strongly calcareous marly clay at depth of 5 to 8 feet.	Fair stability with flat slopes; high shrink-swell potential.	Soil properties favorable.	Soil properties favorable; soil cracks when dry.	Poor soil-moisture relationship; soil cracks when dry.	High water-holding capacity; slow permeability; steep slopes not suitable for irrigation.	Poor; practically impervious	Very high	Slight to severe.
Slow permeability; strongly calcareous shaly clay at depth of 7 to 10 feet.	Fair stability with flat slopes; high shrink-swell potential.	Soil properties favorable; terraces not needed if slope is 1 percent or less.	Soil properties favorable.	Poor soil-moisture relationship; soil cracks when dry.	High water-holding capacity; slow permeability; strongest slopes not suitable for irrigation.	Poor; practically impervious.	Very high	Moderate or severe.

TABLE 4.—*Engineering*

Soil and map symbols	Suitability for—						Degree of limitation for use as sewage-disposal field	Suitability as source of—	
	Road subbase	Road fill	Wearing surface (untreated)	Foundations for low buildings (undisturbed conditions)	Low embankments for sewage lagoons (less than 6 ft. high)	Compacted earth lining for water reservoirs and sewage lagoons		Topsoil	Sand or gravel
Houston Black clay, terrace (HtA, HtB).	Poor	Poor	Poor	Poor; cracks to dangerous extent when dry.	Fair	Good	Not suitable; cracks when dry; extra storage area needed.	Fair	Fair; gravel at depth of to 12 feet.
Houston Black gravelly clay (HuB, HuC, HuD).	Good	Fair	Good	Poor; cracks to dangerous extent when dry.	Good or fair	Good	Not suitable; extra storage area needed; cracks.	Fair	Not suitable
Karnes loam (KaB, KaC). Karnes clay loam (KcC2).	Poor in surface layer; good below depth of 3 feet.	Poor in surface layer; good below depth of 3 feet.	Poor	Good	Fair	Fair	Moderate	Fair; high lime content.	Fair; scattered gravel beds at depth of 3 to 10 feet.
Krum complex (Kr).	Poor	Poor	Poor	Poor; cracks	Fair	Good	Moderate	Fair (surface layer).	Not suitable
Leming loamy fine sand (LfB).	Good	Good	Fair	Fair	Good or fair	Poor in surface layer; good below a depth of 2 feet.	Moderate or severe.	Fair	Not suitable
Lewisville silty clay (LvA, LvB, LvC).	Poor	Poor	Poor	Poor; cracks to dangerous extent when dry.	Fair	Good	Moderate	Fair	Fair; gravel may be found at depth of 5 to 12 feet.
Orelia clay loam (OrA, OrB).	Poor	Poor	Poor	Fair or poor	Fair	Good	Very severe; extra storage area needed.	Good	Not suitable
Patrick soils (PaA, PaB, PaC).	Good or fair below depth of 18 inches.	Fair below depth of 18 inches.	Poor	Good or fair	Fair	Good	Slight	Good (surface layer).	Good; gravel at depth of 2 or 3 feet.
Pits and Quarries (Pt).	Not applicable.	Not applicable.	Not applicable.	Not applicable	Not applicable.	Not applicable.	Not applicable	Not applicable.	Not applicable
San Antonio clay loam (SaB, SaC, SaC2).	Poor	Poor	Poor	Poor	Fair	Good	Very severe; extra storage area needed.	Fair; limited thickness.	Not suitable

interpretations—Continued

Properties affecting use in— Ponds: Reservoir	Ponds: Embankment	Terraces	Diversion terraces	Waterways	Properties affecting suitability for irrigation	Drainage characteristics	Corrosion potential	Susceptibility to erosion
Slow permeability; gravel at depth of about 9 feet.	Fair stability with flat slopes; high shrink-swell potential.	Soil properties favorable.	Soil properties favorable; soil cracks when dry.	Poor soil-moisture relationship; soil cracks when dry.	Slow permeability	Poor; practically impervious; seasonal water table at depth of more than 6 feet.	Very high	None.
Slow permeability; strongly calcareous marly clay at depth of 5 to 9 feet.	Fair stability; high shrink-swell potential.	Soil properties favorable. terraces not feasible if slope is more than 6 percent.	Soil properties favorable; soil cracks when dry.	Poor soil-moisture relationship; soil cracks when dry.	High water-holding capacity; slow permeability; steep slopes.	Poor; practically impervious.	Very high	Moderate or severe.
Moderate to rapid permeability; gravel beds at depth of 3 to 10 feet.	Good stability; moderate to rapid permeability.	Soil properties favorable.	Soil properties favorable.	Low water-holding capacity; high lime content; maintenance of vegetation difficult.	Moderate to rapid permeability; high lime content; strongest slopes not suitable for irrigation.	Excellent	High	Slight or moderate.
Moderate permeability; fractured limestone at depth of 3 to 7 feet.	Fair stability with flat slopes; high shrink-swell potential.	Soil properties favorable.	Soil properties favorable.	Soil properties favorable.	Moderate permeability; high water-holding capacity.	Good or fair	High	Slight or moderate.
Moderate permeability; excessive seepage.	Fair stability	Poor stability	Poor stability	Sandy texture; erosion hazard; siltation hazard.	Slow permeability in subsoil; rapid permeability in surface layer; moderate water-holding capacity.	Good or fair	High	None to moderate.
Moderate permeability; excessive seepage.	Fair stability with flat slopes.	Soil properties favorable; terraces not needed if slope is 1 percent or less.	Soil properties favorable.	Soil properties favorable.	Moderate permeability; moderate water-holding capacity.	Good	High	None to moderate.
Slow permeability	Fair stability with flat slopes; high shrink-swell potential.	Fair stability; terraces not needed if slope is 1 percent or less.	Soil properties favorable.	Poor soil-moisture relationship; tendency to crust when dry; establishing vegetation is difficult.	Very slow permeability; high water-holding capacity; suitability questionable.	Poor; impervious.	High	None or slight.
Moderate permeability; limestone gravel at depth of 2 or 3 feet; excessive seepage.	Fair stability	Shallowness; gravel at depth of 2 or 3 feet.	Shallowness; gravel at depth of 2 or 3 feet.	Shallowness; gravel at depth of 2 or 3 feet.	Shallowness; gravel at depth of 2 or 3 feet; moderate permeability.	Good	High	Slight or moderate.
Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable.	Not applicable.
Slow permeability; sandstone at depth of 6 to 10 feet.	Fair stability with flat slopes.	Soil properties favorable; need fairly strong gradient for drainage.	Soil cracks when dry; need fairly strong gradient for drainage.	Tendency to crust and clod; establishing vegetation is difficult.	Slow permeability; high water-holding capacity; suitability questionable.	Poor; impervious.	High	Moderate or severe.

TABLE 4.—*Engineering*

Soil and map symbols	Suitability for— Road subbase	Road fill	Wearing surface (untreated)	Foundations for low buildings (undisturbed conditions)	Low embankments for sewage lagoons (less than 6 ft. high)	Compacted earth lining for water reservoirs and sewage lagoons	Degree of limitation for use as sewage-disposal field	Suitability as source of— Topsoil	Sand or gravel
Stephen silty clay (ScB, ScC).	Poor	Poor	Poor	Fair; cracks but is shallow over chalk or limestone.	Fair	Good	Severe	Fair (surface layer).	Not suitable
Tarrant association (TaB, TaC, TaD).	Poor	Poor	Poor	Good	Poor; very shallow.	Good	Severe; limestone at depth of 1 foot.	Not suitable	Fair; bedrock can be crushed for gravel.
Tarrant soils, chalk substratum, undulating (Tb).	Good or fair below depth of 8 to 12 inches.	Poor	Poor	Good	Poor	Fair; many chalk fragments in surface layer.	Severe; chalk at depth of 8 to 12 inches.	Fair (surface layer).	Not suitable
Trinity clay (Tc)	Poor	Poor	Poor	Poor; cracks to dangerous extent when dry.	Fair	Good	Severe; extra storage area needed.	Fair	Fair; scattered gravel beds at depth of 4 to 12 feet.
Trinity and Frio soils, frequently flooded (Tf).									
Trinity	Poor	Poor	Poor	Poor; cracks to dangerous extent when dry.	Fair	Good	Severe; extra storage area needed.	Fair	Fair; scattered gravel beds at depth of 4 to 12 feet.
Frio	Fair below depth of 2 feet.	Fair below depth of 2 feet.	Poor	Poor; occasional flooding.	Poor; occasional flooding.	Good	Severe; occasional flooding.	Good	Fair; scattered gravel beds.
Venus loam (VaA, VaB). Venus clay loam (VcA, VcB, VcC).	Poor	Poor	Poor	Fair	Fair	Good	Moderate	Good	Fair; scattered gravel beds at depth of about 6 feet.
Webb fine sandy loam (WbB, WbC). Webb soils (WeC2, WeC3).	Good or fair	Good or fair	Good or fair	Poor	Good	Poor in surface layer; good below a depth of 1 foot.	Severe; extra storage area needed.	Good	Not suitable
Willacy loam (WmA, WmB).	Poor	Poor	Poor	Fair	Good	Good	Slight	Good	Fair; scattered gravel beds at depth of 4 to 12 feet.
Zavala fine sandy loam (Za).	Poor	Poor	Poor	Fair	Good	Fair	Slight	Good	Not suitable
Zavala and Gowen soils, frequently flooded (Zg).	Fair or poor	Fair	Fair	Not suitable; occasional flooding.	Fair or poor	Good to poor; variable texture.	Slight	Good	Not suitable

interpretations—Continued

Properties affecting use in—								
Ponds		Terraces	Diversion terraces	Waterways	Properties affecting suitability for irrigation	Drainage characteristics	Corrosion potential	Susceptibility to erosion
Reservoir	Embankment							
Slow permeability; shallowness; chalk at depth of 18 to 24 inches.	Poor stability	Shallowness	Shallowness	Shallowness; high lime content; establishing vegetation is difficult.	Shallowness; chalk at depth of 18 to 24 inches.	Poor	High	Moderate.
Slow permeability; hard limestone at depth of 1 foot.	Fair stability with flat slopes.	Shallowness; limestone at depth of 1 foot; nonarable soil.	Shallowness; limestone at depth of 1 foot; diversions not feasible on hilly soils.	Shallowness; limestone at depth of 1 foot; erosion hazard.	Shallowness; limestone at depth of 1 foot; nonarable soil.	Poor; practically impervious.	Moderately high.	None to moderate.
Moderate permeability; shallowness; chalk at depth of 8 to 12 inches.	Fair stability	Shallowness; chalk at depth of 8 to 12 inches; nonarable soil.	Shallowness; chalk at depth of 8 to 12 inches.	Shallowness; chalk at depth of 8 to 12 inches.	Shallowness; chalk at depth of 8 to 12 inches; nonarable.	Poor; practically impervious.	Moderately high.	None to moderate.
Slow permeability; gravel at depth of 4 to 12 feet in some areas.	Fair stability with flat slopes; high shrink-swell potential.	Not needed, because of topography.	Overflow hazard.	Overflow hazard; siltation hazard.	Slow permeability; high water-holding capacity; overflow hazard.	Poor; practically impervious.	Very high	None.
Slow permeability; gravel at depth of 4 to 12 feet in some areas.	Fair stability with flat slopes; high shrink-swell potential.	Not needed, because of topography.	Overflow hazard.	Overflow hazard; siltation hazard.	Slow permeability; high water-holding capacity; overflow hazard.	Poor; practically impervious.	Very high	None.
Moderate permeability; scattered gravel beds.	Good stability	Not needed, because of topography.	Occasional flooding; limited application because of topography.	Occasional flooding; siltation hazard.	Moderate permeability; occasional flooding.	Good	High	Moderate
Moderate to rapid permeability; high lime content; gravel at depth of 6 feet.	Fair stability with flat slopes.	Soil properties favorable; terraces not needed if slope is 1 percent or less.	Soil properties favorable.	Soil properties favorable; siltation hazard if slope is less than 1 percent.	Moderate permeability; strongest slopes not suitable for irrigation.	Good	High	None to severe.
Slow permeability; surface layer needs core; sandstone at depth of 6 to 10 feet.	Fair stability	Fair stability	Soil properties favorable.	Erosion hazard; siltation hazard.	Slow permeability in subsoil; moderate water-holding capacity.	Slow permeability.	High	Slight to severe.
Moderate permeability; gravel at depth of 4 to 12 feet in some areas.	Fair stability with flat slopes.	Not used, because of topography.	Overflow hazard.	Overflow hazard.	Moderate permeability; overflow hazard.	Good	High	None to moderate.
Moderate permeability; excessive seepage.	Fair stability	Not used, because of topography.	Use of diversions limited because of topography.	Siltation hazard.	Moderate permeability; low water-holding capacity.	Good	High	None or slight.
Moderate permeability; excessive seepage.	Fair stability	Not used, because of topography.	Use of diversions limited because of topography.	Siltation hazard.	Moderate permeability	Good	High	None or slight.

Wearing surface.—For untreated wearing surfaces, the sand-clay-gravel mixtures (class GC) are generally the most satisfactory (*2*). Results are best if the plasticity index is between 5 and 10 and the percentage of fines is not too large. Soils of the SC class are fair to good. Most fine-grained soils are not satisfactory.

Foundations.—Suitability for foundations of low buildings (no more than three stories high) depends mainly on the strength and consolidation characteristics of the soil, on the suitability of the soil for compaction, and on the shrink-swell potential of the undisturbed soil (*2*). Soils of the GW class are best for this purpose. (There are no GW soils in Bexar County.) Soils in classes GP, GM, GC, SW, SP, SM, and SC are rated fair to good. Soils of the CL and CH classes have a high shrink-swell potential and may expand when wet. Thorough soaking of such soils before construction is begun helps to reduce the shrink-swell hazard. Loose, uniformly graded sands of the SM class are likely to liquefy during construction operations if they are below the water table.

Properly compacted fill ordinarily is strong enough to support low buildings. The nature of the subsoil on which the fill is placed controls the load-carrying capacity.

Low embankments of sewage lagoons.—Stability, permeability, and percolation characteristics of soils affect suitability for use in low embankments around sewage lagoons. Such embankments generally are less than 6 feet high. Ordinarily, they are built from more or less homogeneous material found at the site. The soil on which an embankment is to be built should be investigated, as well as the soil material that is to be used in the embankment, because seepage under the embankment is possible, even if the embankment itself is built from relatively impervious material.

Soils of the GC, GM, SC, and SM classes best meet the requirements for low embankments (*2*). Soils of the MH, ML, CL, and CH classes are satisfactory if used in combination with those of the GC, SC, GM, and SM classes, but if used alone they are likely to be unstable and erodible and, consequently, to have excessive maintenance requirements. At many sites, the available soil material is so permeable that a core of impermeable material is needed in an embankment. Soils of the GC, SC, CL, and CH classes are suitable core material.

Storage-area lining.—If a compacted earth lining is needed to seal a sewage lagoon or a water-storage reservoir, soils of the GC, SC, CL, and CH classes are the best to use (*2*). These same soils and also those of the GM and SM groups can be used if a lining is needed mainly for protection against erosion and only secondarily for reduction of seepage.

TABLE 5.—*Engineering*

[Tests performed by the Texas Highway Department in accordance with standard

Soil name and location of samples	Parent material	Texas report No.	Depth from surface	Horizon	Shrinkage limit	Shrinkage ratio	Lineal shrinkage
			Inches		*Percent*		*Percent*
Austin silty clay:							
8 miles NE. of San Antonio on Nacogdoches Road and 0.5 mile NW. on Stahl Road. (Modal)	Chalky marl	61–291–R	0 to 28	A1	10	1. 98	19. 6
		61–292–R	28 to 45	AC	11	1. 99	18. 0
		61–293–R	45 to 72	C	14	1. 92	14. 8
1.25 mile E. of Randolph Boulevard in Robards, along Toepperwein Road. (Heavy)	Chalky marl	61–246–R	0 to 16	A1	12	1. 91	20. 2
		61–247–R	16 to 36	AC	10	1. 98	20. 3
		61–248–R	36 to 51	C	25	1. 58	4. 1
0.3 mile N. and 0.4 mile E. of Lockhill-Selma Road and on West Avenue. (Light)	Chalky marl	61–267–R	0 to 16	A1	12	1. 90	16. 8
		61–268–R	16 to 30	AC	13	1. 91	16. 5
		61–269–R	30 to 66	C	19	1. 73	8. 7
Houston Black clay, terrace:							
0.25 mile E. of Sam Houston High School in San Antonio on F–M Road 1346. (Modal)	Old alluvium	61–288–R	0 to 30	A1	11	1. 98	23. 0
		61–289–R	30 to 52	AC	11	1. 99	23. 2
		61–290–R	52 to 72	C	12	2. 00	21. 0
0. 25 mile S. of U.S. Highway No. 90 East, at intersection of Graytown Road and Pfeil Road. (Light)	Old alluvium	61–276–R	0 to 34	A1	9	2. 02	19. 9
		61–277–R	34 to 54	AC	9	2. 04	22. 1
		61–278–R	54 to 84	C	10	2. 09	20. 5

See footnotes at end of table.

Filter fields for sewage disposal.—For filtering septic-tank effluent, soils of classes GP, GM, GC, SP, and SM are the best materials. Sandy and gravelly soils of classes GW and SW are too coarse to be good filter material and may permit unfiltered effluent to spread through a large area. Cementation is not unusual in the silty and clayey sands and gravels of classes GM, GC, and SM, and it impairs their use for sewage-disposal purposes. Percolation tests are needed to determine the value of these soils. Soils of the SC class are fair as filtering materials. Soils of the CL and CH classes are not likely to be satisfactory (*2*). The rate of absorption is slower in such soils than in coarser textured soils, and consequently a larger disposal field and more tile lines are needed.

Table 4 rates the soils of Bexar County at five levels according to their limitations for use in filter fields. The ratings are for undisturbed soil. The degree of limitation depends upon absorptive capacity; permeability; depth to the water table; depth to rock, sand, or gravel; slope; and proximity to a stream or other body of water.

Pond reservoirs.—Soils of classes GC, SC, CL, and CH provide the best sites for pond reservoirs. These soils are so nearly impervious that little water is lost through seepage. Soils that have some layers that are predominantly silty or sandy (classes MH and SM) are less suitable for this purpose, but they may be satisfactory if they also include layers of less permeable material. Soils of the GP class generally are readily permeable and consequently are unsuitable for reservoir areas. Some can be used if compacted or if the reservoir is lined or sealed with impervious material.

Pond embankments.—Soils suitable for sewage-lagoon embankments are also suitable for pond embankments. Those of the GC, SC, and SM classes best meet the requirements. Clayey soils (CL and CH classes) and silty soils (ML class) are likely to be unstable and erodible if used alone in embankments, but they can be used if the slopes of the embankments are nearly flat. Some permeable soils can be used if compacted impervious material is used for a core. The soils on which an embankment is to be built should be investigated, as well as the soil material to be used in the embankment, because seepage under the embankment is possible even if the embankment itself is built of impervious material.

Test data

Seventeen soil samples taken from soils of six different series have been analyzed to determine particle-size distribution, plastic limit, liquid limit, and shrinkage characteristics and to establish engineering classifications. The tests were performed by the Texas Highway Department and the results were reviewed by the Bureau of Public Roads, U.S. Department of Commerce. The data obtained in these tests are recorded in table 5.

test data

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

Mechanical analysis [1]													Liquid limit	Plasticity index	Classification	
Percentage passing sieve [2]—										Percentage smaller than [2]—					AASHO	Unified [3]
2-in.	1½-in.	1-in.	¾-in.	⅜-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.				
------	------	------	------	------	100	99	87	87	84	83	63	52	56	33	A-7-6(18)---	CH.
------	------	------	------	100	99	95	85	84	82	81	60	48	52	32	A-7-6(18)---	CH.
------	------	------	------	100	99	97	95	94	91	90	67	51	46	27	A-7-6(16)---	CL.
------	------	100	98	98	98	98	94	93	91	90	61	50	63	35	A-7-6(20)---	CH.
------	------	100	99	99	98	97	86	86	84	83	63	53	60	34	A-7-6(20)---	CH.
------	------	100	98	97	88	72	50	46	38	36	20	13	33	8	A-4(1)------	SM-SC.
------	------	------	------	------	100	99	81	80	77	75	54	40	52	27	A-7-6(17)---	CH.
------	------	------	------	------	100	97	71	71	68	67	51	40	50	28	A-7-6(15)---	CL.
------	------	100	99	99	99	98	94	94	91	90	60	42	38	17	A-6(11)-----	CL.
------	------	------	------	------	100	99	98	98	86	83	63	56	71	44	A-7-6(20)---	CH.
------	------	------	------	100	99	99	95	95	85	83	63	56	72	45	A-7-6(20)---	CH.
100	97	94	90	76	61	47	39	38	34	33	25	21	64	39	A-2-7(4)----	GC.
------	------	------	------	------	100	99	98	97	82	77	48	43	56	35	A-7-6(19)---	CH.
------	------	------	------	------	------	100	98	98	86	83	56	49	64	45	A-7-6(20)---	CH.
------	------	------	------	------	------	100	98	97	86	83	54	47	57	39	A-7-6(19)---	CH.

TABLE 5.—*Engineering*

Soil name and location of samples	Parent material	Texas report No.	Depth from surface	Horizon	Shrinkage limit	Shrinkage ratio	Lineal shrinkage
			Inches		*Percent*		*Percent*
Crawford stony clay:							
6 miles N. of Loop 410 in San Antonio on U.S. Highway No. 281. (Modal)	Limestone	61-294-R	0 to 10	A1	15	1.83	11.5
		61-295-R	10 to 18	AC	12	1.89	16.1
		61-296-R	18 to 34	C	15	1.82	18.9
2 miles W. of U.S. Highway No. 281 North, on outer loop from San Antonio. (Heavy)	Limestone	61-273-R	0 to 10	A1	10	1.96	22.5
		61-274-R	10 to 28	AC	8	2.01	25.0
		61-275-R	28 to 90	C	15	1.89	12.7
0.1 mile S. on Jones-Maltsberger Road from Lockhill-Selma Road. (Light)	Limestone	61-270-R	0 to 10	A1	13	1.89	14.6
		61-271-R	10 to 20	B2-1	12	1.91	22.0
		61-272-R	26 to 36	C	13	1.89	20.9
Crockett fine sandy loam:							
6.25 miles E. of San Antonio on Sulphur Springs Road. (Modal)	Sandy clay with a few lenses of sandstone.	61-282-R	0 to 10	A1	16	1.77	2.6
		61-283-R	10 to 44	B2 and B3	11	1.96	16.3
		61-284-R	44 to 72	Cca and C	12	1.92	13.2
0.3 mile N. of Briggs Road on Kinney Road. (Heavy)	Sandy clay with a few lenses of sandstone.	61-249-R	0 to 11	A1	14	1.83	2.9
		61-250-R	11 to 40	B2	11	1.99	14.9
		61-251-R	40 to 48	Cca	11	1.97	13.0
0.9 mile N. of U.S. Highway No. 87 on Pittman Road. (Light)	Sandy clay with a few lenses of sandstone.	61-261-R	0 to 13	A1	16	1.77	2.3
		61-262-R	13 to 26	B2	12	1.92	15.6
		61-263-R	26 to 36	Cca	15	1.85	11.5
Lewisville silty clay:							
2.5 miles S. of San Antonio on Texas Highway No. 346. (Modal)	Old alluvium	61-279-R	0 to 26	A1	13	1.92	15.6
		61-280-R	26 to 48	AC	11	2.00	17.0
		61-281-R	48 to 72	Cca	13	1.96	13.5
1 mile E. of Applewhite Road on Mauerman Road. (Heavy)	Old alluvium	61-252-R	0 to 38	A1	10	1.96	18.1
		61-253-R	38 to 56	AC	10	2.01	19.7
		61-254-R	56 to 84	C	11	2.04	17.1
1 mile W. on Noyes Road from State Highway 346. (Light).	Old alluvium	61-255-R	0 to 18	A1	14	1.88	14.6
		61-256-R	18 to 38	AC	12	1.93	15.7
		61-257-R	38 to 50	Cca	13	1.95	15.6
Webb fine sandy loam:							
0.8 mile S. of Martinez on F-M Road 1516. (Modal).	Sandstone and some shale.	61-285-R	0 to 12	A1	16	1.78	4.9
		61-286-R	12 to 38	B2 and B3	11	1.98	16.5
		61-287-R	38 to 58	Cca	13	1.90	16.7
12 miles E. of San Antonio. (Heavy).	Sandstone and some shale.	61-264-R	0 to 13	A1	15	1.84	8.5
		61-265-R	13 to 38	B2 and B3	13	1.92	15.0
		61-266-R	38 to 54	Cca	17	1.78	10.2
1 mile E. of U.S. Highway No. 281 South, on F-M Road 1518. (Light).	Sandstone and some shale.	61-258-R	0 to 15	A1	19	1.68	1.7
		61-259-R	15 to 21	B1	13	1.90	12.6
		61-260-R	46 to 62	C	17	1.78	8.7

[1] Mechanical analyses according to AASHO Designation: T 88-57 (*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes for soils.

[2] Based on sample as received in laboratory. Laboratory test data not corrected for amount discarded in field sampling.

[3] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points of the A-line are to be given a

test data—Continued

Mechanical analysis [1]													Liquid limit	Plasticity index	Classification	
Percentage passing sieve [2]—										Percentage smaller than [2]—						
2-in.	1½-in.	1-in.	¾-in.	⅜-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.			AASHO	Unified [3]
------	------	------	100	99	97	93	74	73	70	66	39	32	40	21	A-6(11)	CL.
100	99	96	93	90	89	88	78	78	76	74	59	43	49	26	A-7-6(16)	CL.
------	[4] 100	99	95	88	84	81	78	78	77	76	69	66	63	37	A-7-6(20)	CH.
[5] 100	96	92	91	89	89	88	81	81	78	74	53	45	70	38	A-7-5(20)	MH-CH.
[5] 100	97	94	93	91	89	87	77	77	75	74	56	50	77	43	A-7-5(20)	MH-CH.
[6] 94	86	72	65	56	48	39	28	26	21	20	15	10	42	24	A-2-7(1)	GC.
------	100	98	92	87	84	82	79	78	71	68	44	37	45	24	A-7-6(14)	CL.
------	------	100	99	98	98	97	95	95	92	90	80	73	72	39	A-7-5(20)	MH-CH.
[7] 100	98	94	86	70	59	55	54	54	52	51	44	40	69	35	A-7-5(12)	MH-CH.
------	------	------	------	------	------	100	99	93	33	30	14	13	20	3	A-2-4(0)	SM.
------	------	------	------	100	99	98	94	92	62	58	39	34	48	31	A-7-6(14)	CL.
------	------	------	------	------	100	99	98	95	54	53	37	35	40	25	A-6(10)	CL.
------	------	------	------	------	------	100	99	96	46	37	16	13	19	4	A-4(2)	SM-SC.
------	------	------	------	------	------	100	98	97	70	65	49	45	42	26	A-7-6(14)	CL.
------	------	------	100	99	99	98	97	96	64	55	38	35	37	23	A-6(11)	CL.
------	------	------	------	------	100	99	99	96	44	34	14	12	20	3	A-4(2)	SM.
------	------	------	------	------	100	99	98	96	62	56	41	39	47	31	A-7-6(14)	CL.
------	------	------	100	99	99	98	97	92	57	49	33	30	39	25	A-6(10)	CL.
------	------	------	------	------	------	100	98	97	88	84	53	44	48	26	A-7-6(16)	CL.
------	------	------	------	100	99	98	94	93	85	83	55	46	49	29	A-7-6(17)	CL.
------	------	------	100	97	87	83	80	80	70	65	40	32	40	23	A-6(12)	CL.
------	------	------	------	------	100	99	97	96	86	82	58	49	52	29	A-7-6(18)	CH.
------	------	------	------	100	98	94	92	91	84	80	56	49	57	36	A-7-6(19)	CH.
------	------	------	100	99	97	91	88	87	79	76	48	40	48	30	A-7-6(18)	CL.
------	------	------	------	------	------	100	98	97	85	81	50	41	46	24	A-7-6(15)	CL.
------	------	------	------	------	100	99	96	95	85	81	59	49	48	26	A-7-6(16)	CL.
------	------	------	------	100	90	81	78	78	72	70	51	41	47	28	A-7-6(16)	CL.
------	------	------	------	100	99	98	97	96	57	45	21	19	24	7	A-4(4)	ML-CL.
------	100	99	98	98	97	95	93	93	72	65	48	45	47	28	A-7-6(16)	CL.
------		------	------	100	99	96	94	94	77	69	43	35	52	33	A-7-6(18)	CH.
------	------	------	------	100	97	95	94	93	66	54	29	26	32	16	A-6(9)	CL.
------	------	------	------	100	99	98	97	97	77	58	46	44	46	25	A-7-6(15)	CL.
------	------	------	100	99	95	92	90	89	71	58	30	26	39	21	A-6(12)	CL.
------	------	------	------	------	------	100	99	98	73	55	15	14	23	3	A-4(8)	ML.
------	------	------	------	100	99	96	93	92	80	67	41	38	39	22	A-6(13)	CL.
------	------	------	------	100	99	99	98	98	83	71	30	26	34	16	A-6(10)	CL.

borderline classification. Examples of borderline classifications obtained by this use are SM-SC and MH-CH.

[4] Twenty-six percent of this sample consisted of fragments between 1½ and 3 inches in size, and 13 percent consisted of fragments more than 3 inches in size. These coarse fragments were discarded in field sampling.

[5] Twenty-three percent of these samples consisted of fragments between 2 and 3 inches in size, and 16 percent consisted of fragments more than 3 inches in size. These coarse fragments were discarded in field sampling.

[6] One hundred percent passed the 3-inch sieve.

[7] Twenty-eight percent of this sample consisted of fragments between 2 and 3 inches in size, and 2 percent consisted of fragments more than 3 inches in size. These coarse fragments were discarded in field sampling.

Suburban Development

Suburban residential development and the accompanying extension of public utilities and establishment of business and recreational facilities create a need for soils information somewhat different from the information needed for purposes of agriculture. Land appraisers, realtors, city planners, builders, and others need to have facts that will help them to know what sites are suitable for homes or other buildings and what areas should be reserved for other uses. Homeowners want to landscape their property and to protect it against the particular erosion hazards of built-up communities.

The Soil Conservation Service and the city of San Antonio cooperated on a special soil survey designed to provide the kind of facts needed for the planning of suburban development.

Foundations

Bexar County has large areas of clay soils in which the clay mineral montmorillonite is abundant. Such soils are poor materials in which to set building foundations. They swell when wet then shrink and crack when dry, and in so doing they exert such pressure that walls and foundations will crack unless, and sometimes even if, specially reinforced (fig. 31 and fig. 32). The soils most likely to cause damage are the Houston clays, the Houston Black clays, Crawford clay, and the Lewisville silty clays.

Plasticity index and swell index indicate whether a soil is likely to shrink and swell enough to damage foundations. Several soil samples furnished by the Soil Conservation Service were tested on the FHA's "potential volume change" meter. Table 6 shows the swell index of each of the samples, as determined by the tests, and the plasticity index, determined from the swell index.

Sewage-disposal systems

Suburban expansion results in an increased number of septic-tank systems for sewage disposal. The effectiveness of these systems depends largely on the absorptive capacity, permeability, depth, and slope of the soils within the filter field. Also important are the ground-water level and proximity to streams or other bodies of water (*7*).

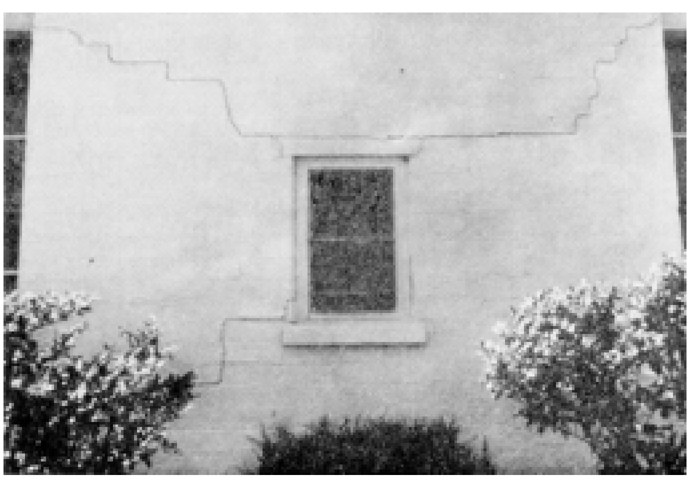

Figure 31.—**Wall of a schoolhouse built on Houston Black clay. The cracks result from the shrinking and swelling of the soil material.**

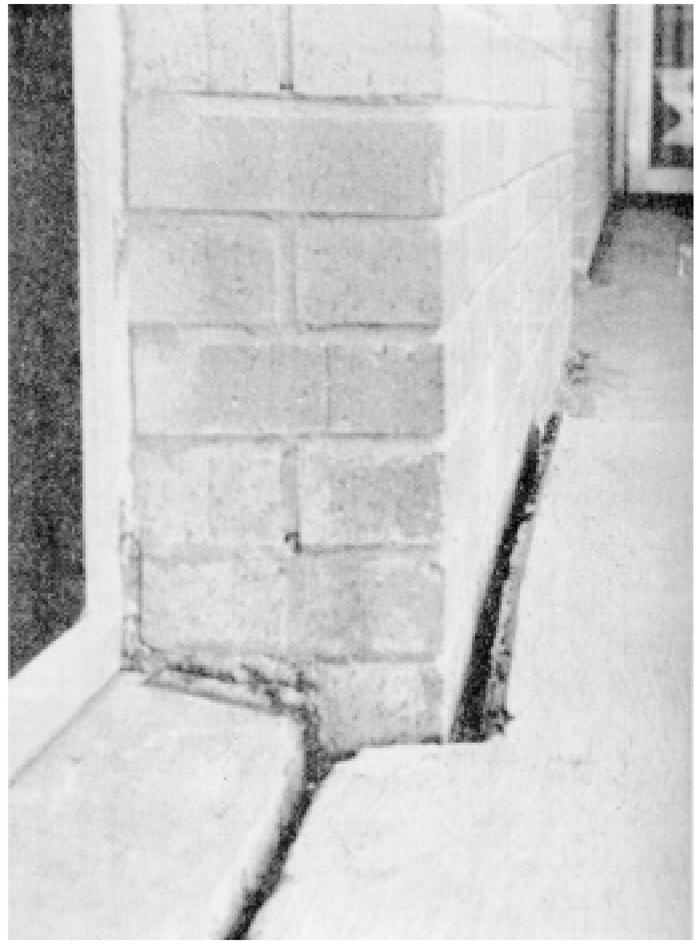

Figure 32.—**Damage to foundation of church built on Houston Black clay. This building is less than 2 years old.**

In table 4, the limitations of the soils for use in filter fields are rated at five levels, from none to very severe. By using the soil map to identify the soils and then referring to the ratings in table 4, it is possible to get a general idea of how well septic-tank systems would function in a selected area. Nevertheless, it is advisable to make a detailed inspection of the soils at the exact site that is to be used as a filter field.

Control of runoff and erosion

When the natural vegetation is removed and large expanses are covered with pavement and buildings, the amount of runoff from an area increases and the pattern of runoff changes. Runoff after a heavy rain may be two to ten times as great as when the same land was used for farming. The runoff concentrates in streets and gutters, instead of flowing into natural, meandering waterways, and the result is flooding and deposition of sediments on the lower areas.

The unusual amount and unnatural pattern of runoff in built-up areas may result in severe erosion of homesites (fig. 33) unless measures are taken to keep the

TABLE 6.—*Swell index and plasticity index of tested samples*

[Data furnished by DON WEICHLEIN, deputy chief architect, Federal Housing Administration]

Sample No.	Soil type	Location of sample	Depth sampled	Swell index	Plasticity index
			In.	*Lb./sq. ft.*	
1	Lewisville silty clay	South of San Antonio; 0.5 mile west of Somerset Road on Interstate Highway 35.	22 to 24	2, 500	20. 0
2	Venus clay loam	South of San Antonio; 0.1 mile south of Von Ormy on Interstate Highway 35.	23 to 25	1, 700	14. 8
3	Venus clay loam	Southwest of San Antonio; 0.1 mile northwest on F-M Road 2173 from Old Pearsall Road; near Southwest High School.	18 to 24	1, 075	10. 7
4	Venus clay loam	Southwest of San Antonio; near intersection of Macdona-Lacoste and Jungman Roads.	16 to 21	450	5. 8
5	Lewisville silty clay	Southwest of San Antonio; 1 mile south of Highway 90 West, on Mechler Road, across from irrigation well.	18 to 21	5, 575	44. 2
6	Austin silty clay	West of San Antonio; at intersection of Talley Road and Potranco Road (F-M Road 1957).	20 to 22	3, 925	30. 8
7	Brackett clay loam	West of San Antonio; 1.5 miles west on Potranco Road (F-M Road 1957) from intersection with Hunt Lane.	12 to 14	2, 025	17. 0
8	Houston Black clay	West of San Antonio; 1 mile south of Potranco Road (F-M Road 1957) on Hunt Lane; on Essar Ranch.	15 to 20	8, 425	70. 8
9	Lewisville silty clay	West of San Antonio; 2 miles from Loop 410 on Potranco Road (F-M Road 1957); across road from Essar Ranch headquarters.	18 to 22	4, 975	39. 0
10	Austin silty clay	West of San Antonio; at northwest corner of intersection of Loop 410 and Bandera Road.	18 to 20	2, 500	20. 0
11	Austin silty clay	Northeast of San Antonio; 0.5 mile west on O'Connor Road from U. S. Highway 81 North.	18 to 22	3, 300	26. 0
12	Brackett clay loam	Northeast of San Antonio; 0.5 mile northwest on Lockhill-Selma Road from Nacogdoches Road.	12 to 15	775	8. 5
13	Brackett clay loam	Northeast of San Antonio; 0.4 mile northeast on Stahl Road from O'Connor Road.	14 to 16	2, 175	18. 0
14	Houston Black Clay	Northeast of San Antonio; 0.2 mile southwest from Converse on F-M Road 1976 (Gibbs-Sprawl Road).	18 to 22	10, 000+	77. 0+
15	Houston Black clay	East of San Antonio; 0.6 mile north of Kirby on F-M Road 1976 (Gibbs-Sprawl Road).	15 to 20	6, 550	56. 5

***Figure 33.*—Erosion in ungraded yards.**

water spread out and moving slowly, or to divert it from areas it could damage (fig. 34), or to direct it so it will flow on an erosion-resistant surface, such as concrete or a dense sod. Erosion-control measures that are practical for protection of small residential tracts include the following:

1. Locating driveways, walks, and fences on the contour, or if that is not feasible, straight across the slope.
2. Grading to make the surface level or gently sloping. Before grading is begun, the topsoil should be removed and stockpiled, so it can be replaced on the graded surface.
3. Building diversions that will intercept runoff and keep it from flowing across erodible areas.

***Figure 34.*—Terraces and retaining walls built to prevent water erosion in landscaped yards.**

The diversion structures themselves should be protected with grass.

4. Constructing or improving waterways. Heavy runoff in built-up areas can turn natural waterways into gullies. Shaping and smoothing waterways and establishing sod in them help to prevent gullying. Artificial waterways can be created by cutting ditches, shaping them, and establishing sod in them. In some cases it may be practical to line a small ditch with concrete or to use tile or a pipeline instead of a ditch.
5. Draining seep spots and waterlogged areas with tile or other facilities.

Technical assistance may be needed in the planning of diversions, waterways, and drainage facilities, in order to be sure that the capacity is adequate for the volume of runoff that can be expected.

Table 4, which begins on page, 74, shows what soils in Bexar County are most susceptible to erosion and which are likely to need artificial drainage.

Gardening and landscaping

Suburban homeowners who want to landscape their homes need to know what kinds of soils their properties include and to what kinds of flowers, shrubs, and trees these soils are best suited.

The ideal soils for yard and garden plants are those that have a deep root zone, a loamy texture, a balanced

TABLE 7.—*Relative suitability of soils*

["Good" indicates that soils have only minor limitations; "fair," that soils have one

Plant	Soil group		
	Sands and loams; neutral or slightly acid; moderately permeable to slowly permeable subsoil (Duval, Webb, and Willacy soils)	Loams and clays; alkaline and calcareous; moderately permeable subsoil (Austin, Frio, Gowen, Lewisville, Patrick, and Venus soils)	Fine sands; deep; slightly acid (Eufaula, Hockley, and Leming soils)
Flowers:			
Agapanthus	Good. Add organic matter	Fair; too limy; chlorosis problem. Add organic matter.	Good. Fertilize, add organic matter.
Amaryllis	Good. Fertilize each year, add organic matter.	Good. Fertilize each year, add organic matter.	Fair; droughty, low in organic-matter content, low in fertility.
Anemone	Good. Fertilize each year, add organic matter.	Fair; too limy. Fertilize each year, add organic matter.	Good. Fertilize each year, add organic matter, water regularly.
Aster, annual	Good. Fertilize, add organic matter, keep moist.	Fair; too limy; chlorosis problem. Fertilize, add organic matter.	Fair; too sandy. Fertilize, condition, water often.
Aster, perennial	Good. Fertilize, add organic matter. (Plants will bloom twice a year if fertilized.)	Fair; too limy; chlorosis problem. Fertilize, add organic matter.	Good. Fertilize, keep in good tilth.
Bird-of-paradise	Fair. Fertilize, add organic matter, keep moist.	Fair; too limy; chlorosis problem. Fertilize, add organic matter.	Poor; low fertility, inadequate organic-matter content.
Bleedingheart	Good. Fertilize, keep in good tilth.	Fair; too limy. Fertilize, add organic matter.	Fair. Fertilize, add organic matter.
Caladium	Good. Water regularly, keep in good tilth.	Fair; too limy, but plant may adapt. Fertilize, keep in good tilth.	Good. Fertilize, keep in good tilth, water regularly.
Canna	Good. Fertilize, keep moist	Fair; too limy. Fertilize, keep moist.	Good. Fertilize, keep moist
Chrysanthemum	Good. Fertilize, keep in good tilth.	Fair; too limy; chlorosis problem. Fertilize, add organic matter.	Poor; low fertility, inadequate organic-matter content.
Cornflower	Good	Good	Good
Crocus	Good. Plant bulbs deep, fertilize every year.	Good. Plant bulbs deep, fertilize every year.	Good. Plant bulbs deep, fertilize every year.
Gladiolus	Good. Plant bulbs deep, fertilize at transplanting time.	Good. Plant bulbs deep, fertilize at transplanting time.	Good. Plant bulbs deep, fertilize at transplanting time, water often.
Dahlia	Good. Water twice a week, fertilize, add organic matter.	Fair; too limy. Water twice a week, fertilize, add organic matter.	Fair; droughty. Water often, fertilize, add organic matter.
Daisy, shasta	Good. Fertilize, add organic matter.	Good. Fertilize, add organic matter.	Good. Fertilize, add organic matter, water regularly.
Daylily	Good. Fertilize, keep in good tilth.	Fair; too limy. Fertilize, keep in good tilth.	Fair; somewhat droughty. Fertilize, add organic matter.
Hibiscus	Good. Fertilize, add organic matter, water often.	Good. Fertilize, add organic matter, water often.	Good. Fertilize, add organic matter, water regularly.
Hollyhock	Good. Fertilize, water often	Good. Fertilize, water often	Fair; droughty. Water often, fertilize.
Hyacinth	Good	Fair; too limy	Good. Water regularly

supply of plant nutrients, plenty of organic matter in various stages of decomposition, adequate water-supplying capacity, good drainage, and a granular or crumb structure that allows free movement of water, air, and roots. A degree of acidity or alkalinity suitable for the particular plants to be grown is also important. Roses, most annual flowers, most vegetables, and most grasses grow best in soils that are neutral or only slightly acid. Some other plants—azaleas and rhododendrons for example—need acid soils.

There are many kinds of soils in Bexar County, and many of them differ considerably from the ideal in texture, depth, permeability, and other characteristics that affect their suitability for flowers, shrubs, and trees. Success in gardening and landscaping depends on recognition of the limitations of the soils for such uses and on the practice of management that will offset the limitations.

In table 7,[4] the soils of Bexar County are grouped according to texture, reaction, and other characteristics that affect suitability for garden and yard plants. Each group is rated according to the relative suitability of the soils for specified plants, and some of the limitations and management needs are noted. The individual soils are described on pages 8 to 36 of this report, and table 3, which begins on page 64, gives information on permeability and reaction of individual soils.

[4] Mr. FRANK L. WILLIS, local nurseryman and gardening editor, assisted in the preparation of this table.

for specified yard and garden plants

or two major limitations; "poor," that soils have many major limitations]

Soil group—Continued

Sandy and clayey loams; neutral; dense subsoil (Crockett, Orelia, and San Antonio soils)	Clays; calcareous; slowly permeable (Houston and Houston Black soils)	Mostly nonarable soils; shallow or very shallow; stony; neutral or calcareous (Bexar, Brackett, Crawford, Stephen, and Tarrant)
Poor; poor internal drainage. Fertilize, add organic matter.	Poor; too clayey, too limy	Poor; droughty, stony, or too limy.
Good. Fertilize each year, add organic matter.	Good. Fertilize, add organic matter	Fair (shallow soils) or poor (very shallow and stony soils).
Fair; slow permeability. Fertilize each year, add organic matter.	Fair; too limy, slow permeability. Fertilize each year, add organic matter.	Poor; droughty, stony, or too limy.
Fair; slow permeability. Fertilize, keep moist.	Fair; too limy; chlorosis problem. Fertilize, add organic matter.	Poor; droughty, stony, or too limy.
Good. Fertilize, add organic matter	Fair, too limy; chlorosis problem. Fertilize, add organic matter.	Fair; shallow or stony.
Fair; low fertility, inadequate organic-matter content.	Good. Fertilize, keep in good tilth	Fair; shallow or stony. Water often.
Fair; poor internal drainage. Fertilize, add organic matter.	Poor; too clayey. Fertilize, add organic matter.	Poor; droughty, stony, or too limy.
Fair; poor internal drainage. Fertilize, keep in good tilth.	Poor; poor internal drainage, too limy. Fertilize.	Poor; droughty, stony, or too limy.
Good. Fertilize, keep moist	Fair; too limy. Fertilize, water occasionally	Poor; droughty, stony, or too limy.
Fair; poor internal drainage	Poor; too limy, too clayey	Poor; shallow, stony, or too limy.
Good	Good	Fair; shallow or stony.
Poor; slow permeability (bulbs may rot). Add organic matter.	Fair; slow permeability. Fertilize, add organic matter.	Poor; shallow or stony.
Fair; slow permeability. Deep-till to open subsoil, fertilize, add organic matter.	Fair; slow permeability. Fertilize, condition clayey soils by adding sand and organic matter.	Poor; shallow, droughty, or stony.
Fair; poor internal drainage. Fertilize, water.	Poor; too limy, fertilize, add organic matter	Poor; droughty, stony, or too limy.
Good. Fertilize, add organic matter	Good. Keep in good tilth	Fair; shallow or stony.
Fair; poor internal drainage. Fertilize, add organic matter.	Fair; too clayey, too limy, but plants will adapt. Fertilize, condition by adding sand and organic matter.	Poor; droughty, stony, or too limy.
Fair; poor internal drainage. Fertilize, add organic matter, water often.	Fair; slow internal drainage. Fertilize, water occasionally.	Fair; droughty. Water twice a week.
Good. Water often, fertilize	Good. Fertilize	Fair; shallow or stony.
Good	Fair; too limy	Poor; shallow, stony, or too limy.

TABLE 7.—*Relative suitability of soils*

["Good" indicates that soils have only minor limitations; "fair," that soils have one

Plant	Soil group		
	Sands and loams; neutral or slightly acid; moderately permeable to slowly permeable subsoil (Duval, Webb, and Willacy soils)	Loams and clays; alkaline and calcareous; moderately permeable subsoil (Austin, Frio, Gowen, Lewisville, Patrick, and Venus soils)	Fine sands; deep; slightly acid (Eufaula, Hockley, and Leming soils)
Flowers—Continued			
Lily	Good. Fertilize, keep in good tilth.	Fair; too limy. Fertilize, keep in good tilth.	Fair; somewhat droughty. Fertilize, add organic matter, keep moist.
Marguerite	Good. Fertilize, add organic matter.	Good. Fertilize, add organic matter.	Good. Water regularly, fertilize, add organic matter.
Marigold	Fair; not alkaline enough. Fertilize, add organic matter.	Good. Keep in good tilth	Poor; too sandy, too acid
Pansy	Good. Water often, fertilize with phosphate, add organic matter.	Good. Fertilize with phosphate, add organic matter.	Good. Water often, fertilize with phosphate, add organic matter.
Petunia	Good	Good	Good
Phlox, perennial	Good. Fertilize, add organic matter.	Poor; too limy	Good. Fertilize, add organic matter.
Poppy, oriental	Good. Fertilize, keep in good tilth.	Good. Fertilize, keep in good tilth.	Good. Water regularly, fertilize, keep in good tilth.
Ranunculus	Good. Fertilize every year, add organic matter.	Fair; too limy. Fertilize every year, add organic matter.	Good. Fertilize every year, add organic matter, water regularly.
Scilla	Good	Good	Good
Snapdragon	Good. Fertilize, add organic matter, water twice a week.	Fair; too limy. Fertilize, add organic matter, water twice a week.	Fair; droughty. Fertilize, add organic matter, water often.
Sweetpea	Good. Fertilize, keep in good tilth.	Fair; too limy; chlorosis problem. Fertilize, add organic matter.	Good. Fertilize, keep in good tilth.
Stock	Good. Fertilize, add organic matter, water twice a week.	Fair; too limy. Fertilize, add organic matter, water twice a week.	Fair; droughty. Fertilize, add organic matter, water often.
Zinnia	Good	Good	Good
Shrubs:			
Azalea	Good. Fertilize twice a year, add organic matter, water regularly.	Poor; too limy. Acidify with sulfur, fertilize twice a year, water regularly.	Good. Fertilize twice a year, add organic matter, water often.
Barbados-cherry	Good	Good. Add organic matter	Good. Fertilize, water occasionally.
Bottlebrush	Good. Fertilize	Good. Fertilize	Good. Fertilize, add organic matter, water regularly.
Bougainvillaea	Good. Fertilize, keep in good tilth.	Good. Fertilize, keep in good tilth.	Good. Fertilize, keep in good tilth.
Butterflybush	Good. Fertilize, add organic matter.	Poor; too limy. Acidify with sulfur, add organic matter, fertilize.	Good. Fertilize, add organic matter.
Bridalwreath	Good. Fertilize, add organic matter.	Good. Fertilize, keep in good tilth.	Good. Fertilize, keep in good tilth.
Camellia	Good. Fertilize twice a year, add organic matter, water regularly.	Poor; too limy. Acidify with sulfur, add organic matter, fertilize twice a year, water regularly.	Good. Fertilize twice a year, add organic matter, water often.
Duranta	Fair; somewhat droughty. Water regularly.	Good. Water twice a week	Fair; droughty, low in fertility
Gardenia	Good. Fertilize twice a year, add organic matter, water regularly.	Poor; too limy. Acidify with sulfur, add organic matter, fertilize, water regularly.	Good. Fertilize twice a year, add organic matter, water often.
Goldflower	Good	Good	Good
Guava	Good. Fertilize, water	Good. Fertilize, and water regularly.	Good. Fertilize, water regularly
Hydrangea	Fair; not acid enough. Add organic matter, fertilize, water regularly.	Poor; too limy; chlorosis problem. Acidify, fertilize, add organic matter.	Fair; not acid enough. Fertilize, add organic matter.
Jasmine, yellow	Good. Fertilize, keep in good tilth.	Good. Fertilize, maintain tilth	Good. Fertilize, keep in good tilth.
Mockorange	Good. Fertilize, add organic matter.	Poor; too limy. Acidify with sulfur, add organic matter, fertilize.	Good. Fertilize, add organic matter.

for specified yard and garden plants—Continued

or two major limitations; "poor," that soils have many major limitations]

Soil group—Continued		
Sandy and clayey loams; neutral; dense subsoil (Crockett, Orelia, and San Antonio soils)	Clays; calcareous; slowly permeable (Houston and Houston Black soils)	Mostly nonarable soils; shallow or very shallow; stony; neutral or calcareous (Bexar, Brackett, Crawford, Stephen, and Tarrant)
Fair; very slowly permeable subsoil. Fertilize, deep-till to open subsoil, keep moist.	Fair; too limy, slow permeability. Fertilize, condition by adding sand and organic matter.	Poor; droughty, stony, or too limy.
Good. Fertilize, add organic matter	Good. Keep in good tilth	Fair; droughty or stony.
Fair; not alkaline enough. Fertilize, add organic matter.	Good. Keep in good tilth	Poor; droughty or stony.
Fair; slow permeability. Water often, fertilize with phosphate, add organic matter.	Fair; too clayey, slow permeability. Fertilize, condition by adding sand and organic matter.	Poor; droughty or stony.
Good	Good	Fair; shallow or stony.
Fair; slow permeability. Fertilize, add organic matter.	Poor; too limy, slow permeability	Poor; droughty, stony, or too limy.
Good. Fertilize, keep in good tilth	Good. Keep in good tilth	Fair; shallow or stony.
Fair; slow permeability. Fertilize every year, deep-till to open subsoil, add organic matter.	Fair; too limy, slow permeability. Fertilize every year, add organic matter.	Poor; droughty, stony, or too limy.
Fair; poor internal drainage may cause root rot.	Fair; poor internal drainage may cause root rot.	Fair (shallow soils) or poor (stony, very shallow soils).
Fair; poor internal drainage. Fertilize, add organic matter, water twice a week.	Poor; too limy, slow permeability. Fertilize, add organic matter.	Poor; droughty, stony, or too limy.
Fair; slow permeability; root growth limited. Fertilize, add organic matter.	Fair; too clayey, too limy, slow permeability, chlorosis problem, root growth limited.	Poor; droughty, stony, or too limy.
Fair; poor internal drainage. Fertilize, add organic matter, water twice a week.	Poor; too limy, slow permeability. Fertilize, add organic matter.	Poor; droughty, stony, or too limy.
Good	Good	Fair; shallow or stony.
Fair; poor internal drainage. Deep-till to open subsoil, fertilize twice a year, water regularly.	Poor; too limy, poor internal drainage	Poor; shallow soils too limy or too stony; very shallow soils too droughty.
Good. Add organic matter	Good. Keep in good tilth	Fair (shallow soils) or poor (very shallow and stony soils).
Good. Fertilize, add organic matter	Good. Fertilize, add organic matter	Fair (shallow soils) or poor (very shallow and stony soils).
Good. Fertilize, keep in good tilth	Good. Fertilize, keep in good tilth	Fair; shallow or stony. Fertilize, water occasionally.
Poor; poor internal drainage may cause root rot.	Poor; too limy; poor internal drainage	Poor; shallow, stony, or too limy.
Good. Fertilize, keep in good tilth	Good. Fertilize, keep in good tilth	Fair; shallow or stony.
Fair; poor internal drainage. Deep-till to open subsoil, fertilize twice a year, water regularly.	Poor; too limy; poor internal drainage	Poor; shallow soils too limy or too stony; very shallow soils too droughty.
Fair; somewhat droughty	Good. Water regularly	Poor; too droughty or too stony.
Fair; poor internal drainage. Deep-till to open subsoil, add organic matter, fertilize, water regularly.	Poor; too limy, poor internal drainage	Poor; shallow soils too limy or stony; very shallow soils too droughty.
Good	Good	Fair; droughty, stony, or low in fertility.
Good. Fertilize, water regularly	Good. Fertilize, water regularly	Fair; droughty, stony, or low in fertility.
Poor; slow permeability, not acid enough	Poor; slow internal drainage; too limy; chlorosis problem.	Poor; droughty, stony, or too limy.
Good. Fertilize, keep in good tilth	Good. Fertilize, keep in good tilth	Poor; droughty. Fertilize, water regularly.
Poor; poor internal drainage may cause root rot.	Poor; too limy, slow permeability	Poor; shallow, stony, or too limy.

TABLE 7.—*Relative suitability of soils*

["Good" indicates that soils have only minor limitations; "fair," that soils have one

Plant	Soil group: Sands and loams; neutral or slightly acid; moderately permeable to slowly permeable subsoil (Duval, Webb, and Willacy soils)	Soil group: Loams and clays; alkaline and calcareous; moderately permeable subsoil (Austin, Frio, Gowen, Lewisville, Patrick, and Venus soils)	Soil group: Fine sands; deep; slightly acid (Eufaula, Hockley, and Leming soils)
Shrubs—Continued			
Oleander	Good. Fertilize, water occasionally.	Good. Fertilize, water occasionally.	Good. Fertilize, water often.
Pyracantha	Good. Fertilize, keep in good tilth.	Fair; too limy. Acidify with sulfur, add organic matter, fertilize.	Good. Fertilize, water regularly, keep in good tilth.
Quince, flowering	Good. Fertilize, water regularly.	Good. Fertilize, water regularly.	Good. Fertilize, water regularly.
Trees:			
Arborvitae	Good. Fertilize, water regularly.	Good. Fertilize, water regularly.	Good. Fertilize, water often.
Ash, Arizona	Good. Fertilize, water regularly.	Good. Fertilize, water regularly.	Good. Fertilize, water often.
Cape-jasmine	Good. Fertilize twice a year, keep in good tilth, water regularly.	Poor; too limy. Acidify with sulfur, add organic matter, fertilize, water regularly.	Good. Fertilize twice a year, keep in good tilth, water often.
Cedrus deodara	Good. Fertilize, water regularly.	Fair; too limy, but tree will adapt. Fertilize, water regularly.	Good. Fertilize, water often.
Cherry, flowering	Good. Fertilize, add organic matter.	Poor; too limy. Acidify with sulfur, add organic matter, fertilize.	Good. Fertilize, keep in good tilth.
Crabapple, flowering	Good. Fertilize, add organic matter.	Poor; too limy. Acidify with sulfur, add organic matter, fertilize.	Good. Fertilize, keep in good tilth.
Crapemyrtle	Good. Fertilize at time of pruning.	Good. Fertilize at time of pruning.	Good. Fertilize at time of pruning.
Dogwood	Good. Fertilize twice a year, add organic matter, water regularly.	Poor; too limy. Acidify with sulfur, add organic matter, fertilize twice a year, water regularly.	Good. Fertilize twice a year, add organic matter, water often.
Elm, American	Good. Fertilize, water regularly.	Good. Fertilize, water regularly.	Good. Fertilize, water regularly.
Halepensis	Good. Fertilize, water regularly.	Good. Fertilize, water regularly.	Good. Fertilize, water often.
Japanese black pine	Good. Fertilize, water regularly.	Good. Fertilize, water regularly.	Good. Fertilize, water often.
Live oak	Good. Fertilize, water regularly.	Good. Fertilize, water regularly.	Good. Fertilize, water often.
Magnolia	Good. Water regularly.	Good. Keep moist.	Good. Water often.
Peach	Good. Fertilize, water regularly.	Good. Fertilize, water regularly.	Good. Fertilize, water often.
Pecan	Good. Fertilize, water once a week.	Good. Fertilize, water once a week.	Good. Fertilize, water twice a week.
Plum	Good. Fertilize, water regularly.	Good. Fertilize, water regularly.	Good. Fertilize, water often.
Sycamore	Good. Fertilize, water regularly.	Good. Fertilize, water regularly.	Good. Fertilize, water often.

for specified yard and garden plants—Continued

or two major limitations; "poor," that soils have many major limitations]

Soil group—Continued		
Sandy and clayey loams; neutral; dense subsoil (Crockett, Orelia, and San Antonio soils)	Clays; calcareous; slowly permeable (Houston and Houston Black soils)	Mostly nonarable soils; shallow or very shallow; stony; neutral or calcareous (Bexar, Brackett, Crawford, Stephen, and Tarrant)
Good. Fertilize, water occasionally	Good. Fertilize, water occasionally	Fair. Fertilize, water often.
Good. Fertilize, keep in good tilth	Fair; too limy. Acidify with sulfur, add organic matter, fertilize.	Poor; droughty or too limy.
Good. Fertilize, water regularly	Good. Fertilize, water regularly	Fair; droughty. Fertilize, water often.
Good. Fertilize, water regularly	Good. Fertilize, water occasionally	Fair; droughty. Fertilize, water often.
Good. Fertilize, water regularly	Good. Fertilize, water occasionally	Fair; droughty. Fertilize, water often.
Fair; poor internal drainage. Deep-till to open subsoil, add organic matter, fertilize, water regularly.	Poor; too limy, poor internal drainage	Poor; droughty or too limy.
Good. Fertilize, water regularly	Fair; too limy. Fertilize, water occasionally.	Fair; too limy. Fertilize, water often.
Poor; poor internal drainage may cause root rot.	Poor; too limy, slow permeability	Poor; droughty or too limy.
Poor; poor internal drainage may cause root rot.	Poor; too limy, slow permeability	Poor; droughty or too limy.
Good. Fertilize at time of pruning	Good. Fertilize at time of pruning	Fair or good. Fertilize at time of pruning.
Fair; poor internal drainage. Deep-till to open subsoil, add organic matter, fertilize twice a year.	Poor; too limy; poor internal drainage	Poor; shallow soils too limy or too stony; very shallow soils too droughty.
Good. Fertilize, water regularly	Good. Fertilize, water occasionally	Fair; droughty. Fertilize, water often.
Good. Fertilize, water regularly	Good. Fertilize, water occasionally	Fair; droughty. Fertilize, water often.
Good. Fertilize, water regularly	Good. Fertilize, water occasionally	Fair; shallow. Fertilize, water often.
Good. Fertilize, water regularly	Good. Fertilize, water occasionally	Good. Fertilize, water regularly.
Good. Keep moist	Good. Water occasionally	Fair; droughty. Water often.
Fair; poor internal drainage. Fertilize, water.	Fair; slow permeability. Condition by adding sand and organic matter, fertilize, water.	Fair; droughty. Fertilize, water often.
Good. Fertilize, water once a week	Good. Fertilize, water occasionally	Fair; droughty. Fertilize, water often.
Good. Fertilize, water regularly	Good. Fertilize, water occasionally	Fair; droughty. Fertilize, water often.
Good. Fertilize, water regularly	Good. Fertilize, water occasionally	Fair; shallow. Fertilize, water often.

Underground utility lines

Water mains, gas pipelines, communication lines, and sewer pipes that are buried in the soil may corrode and break unless protected against certain electrobiochemical reactions resulting from the inherent properties of the soil.

All metals corrode to some degree when buried in the soil, and some metals corrode more rapidly in some soils than in others. The corrosion potential depends on the physical, chemical, electrical, and biological characteristics of the soil—for example, oxygen concentration, concentration of anaerobic bacteria, and moisture content—and on external factors, such as manmade electrical currents. Design and construction also have an influence. The likelihood of corrosion is intensified by connecting dissimilar metals, by burying metal structures at varying depths, and by extending pipelines through different kinds of soils.

Although electrical resistivity is only one factor in corrosion, measurements of that property permit a classification of probable corrosion potential. The soils of Bexar County were tested with an electrical-resistivity meter, which measures resistance to a flow of current. Most of the soils were tested for resistivity at a depth of 4 feet, because the gas and water lines in San Antonio are ordinarily at that depth. Soils in which bedrock is less than 4 feet below the surface were tested just above the bedrock. The results of the tests and interpretations based on the tests are shown in table 8. Minimum and maximum readings were recorded, and averages were determined arithmetically. The measurements were made when the soils were wet to field capacity. The results are stated in terms of ohms per cubic centimeter. A low value indicates low resistivity (or high conductivity) and a high corrosion potential. The ranges in resistivity were translated into categories of corrosion potential as follows:

Very high	0 to 750 ohms per cubic centimeter
High	750 to 1,500 ohms per cubic centimeter
Moderately high	1,500 to 3,000 ohms per cubic centimeter
Moderately low	3,000 to 10,000 ohms per cubic centimeter
Low	10,000 to 50,000 ohms per cubic centimeter
Very low	50,000 to 100,000 ohms per cubic centimeter

In soils that have a high shrink-swell potential, stresses created by volume changes can break cast iron pipe. To prevent breakage, it may be necessary to cushion the pipes with sand. Gravelly and stony soils that have a high shrink-swell potential present another problem. Volumetric changes can cause the gravel and stones to rub against buried pipes and damage protective coatings that were applied to prevent corrosion.

Samples of some of the major soils in and near San Antonio have been tested to obtain data on potential volumetric change. The results of the laboratory tests are presented in table 9. Estimates of potential volumetric change for all the soils in the county are given in table 3, which begins on p. 64.

TABLE 8.—*Electrical resistivity and corrosion potential*

[Except as otherwise indicated in footnotes, determinations were made on soil fines at a depth of 4 feet]

Soil type	Electrical resistivity (ohms per cubic centimeter)			Corrosion-potential category
	Low	*High*	*Average*	
Austin silty clay	700	1, 600	1, 450	Very high to moderately high.
Brackett clay loam [1]	1, 000	2, 200	1, 550	High or moderately high.
Bexar stony soils [1]	1, 800	2, 700	2, 200	Moderately high.
Crawford stony soils.[1]	1, 800	2, 600	2, 200	Moderately high.
Crawford clay [1]	850	1, 100	930	High.
Crockett fine sandy loam.	1, 100	1, 600	1, 330	High or moderately high.
Duval loamy fine sand.	1, 400	1, 800	1, 580	High or moderately high.
Duval fine sandy loam.	1, 200	1, 800	1, 440	High or moderately high.
Eufaula fine sand [2]	1, 400	1, 800	1, 580	High or moderately high.
Frio clay loam	600	1, 600	940	Very high to moderately high.
Gowen clay loam	650	1, 100	870	Very high or high.
Hockley loamy fine sand.	1, 000	1, 600	1, 360	High or moderately high.
Houston clay	250	750	600	Very high.
Houston Black clay	170	900	480	Very high or high.
Houston Black clay, terrace.	300	950	390	Very high or high.
Houston Black gravelly clay.	400	1, 100	740	Very high or high.
Karnes loam	1, 300	1, 700	1, 500	High or moderately high.
Krum complex	700	1, 100	890	Very high or high.
Leming loamy fine sand. [2]	1, 000	1, 600	1, 360	High or moderately high.
Lewisville silty clay.	550	1, 100	810	Very high or high.
Orelia clay loam [2]	750	1, 300	890	High.
Patrick soils [1]	1, 200	1, 700	1, 490	High or moderately high.
San Antonio clay loam.	750	1, 300	880	High.
Stephen silty clay [1]	1, 050	1, 500	1, 300	High.
Sumter clay [1]	1, 300	1, 700	1, 580	High or moderately high.
Tarrant soils [1]	1, 500	3, 400	1, 940	Moderately high or moderately low.
Tarrant soils, chalk substratum. [1]	1, 800	2, 700	2, 500	Moderately high.
Trinity clay	350	750	570	Very high.
Venus loam	1, 300	2, 300	1, 820	High or moderately high.
Venus clay loam	1, 100	1, 800	1, 300	High or moderately high.
Webb fine sandy loam.	900	1, 500	1, 290	High.
Willacy loam	800	1, 500	960	High.
Zavala fine sandy loam.	1, 100	1, 800	1, 400	High or moderately high.

[1] Determinations made on soil fines above bedrock.
[2] Not tested, but similar to soils that were tested.

TABLE 9.—*Test data on liquid limit and volumetric shrinkage of selected soils*

[Samples supplied by Soil Conservation Service and by William R. Hunter, special projects engineer, city of San Antonio. Tests performed by Materials Testing Laboratory, city of San Antonio]

Map symbol	Soil	Laboratory sample number	Horizon	Depth from surface	USDA texture (field determination)	Liquid limit [1]	Volumetric shrinkage [2]	Lineal shrinkage [3]
				Inches				
AuB	Austin silty clay, 1 to 3 percent slopes.	61	A1	6 to 16	Heavy silty clay	57.1	48.0	19.8
		57	AC	16 to 30	Silty clay	45.8	42.0	16.5
		56	C	30 to 64	Chalky marl	38.2	35.7	13.8
AuB	Austin silty clay, 1 to 3 percent slopes.	60	A1	8 to 16	Silty clay	49.6	44.8	18.0
		59	AC	16 to 30	Silty clay	45.1	40.4	15.6
		58	C	30 to 60	Chalk	36.7	25.9	9.5
Cb	Crawford component of Crawford and Bexar stony soils.	12	A1	0 to 12	Gravelly clay loam	25.5	43.3	17.4
		11	B2	12 to 28	Clay	71.8	51.5	21.4
Cb	Crawford component of Crawford and Bexar stony soils.	9	A1	0 to 10	Stony clay	43.7	41.3	16.0
		10	C	18 to 34	Stony clay	69.5	52.7	22.0
CfB	Crockett fine sandy loam, 1 to 3 percent slopes.	63	A12	6 to 12	Fine sandy loam	23.1	8.5	2.9
		65	B2t	12 to 34	Sandy clay	57.0	46.0	18.7
CfB	Crockett fine sandy loam, 1 to 3 percent slopes.	66	A12	8 to 12	Fine sandy loam	23.8	3.1	1.1
		62	B3t	25 to 36	Sandy clay loam	45.2	38.2	14.8
Fr	Frio clay loam.	98	A11	7 to 22	Silty clay	38.0	34.1	13.0
		100	C	22 to 52	Silty clay loam	34.6	27.4	10.0
Fr	Frio clay loam.	1	A12	7 to 16	Silty clay	42.6	36.4	13.6
		35	A13	16 to 46	Silty clay	45.5	40.5	15.8
Go	Gowen clay loam.	104	A1	12 to 38	Sandy clay loam	30.6	14.5	5.0
		107	AC	38 to 54	Sandy clay loam	29.8	25.0	9.1
Go	Gowen clay loam.	101	A1	8 to 24	Clay loam	58.4	26.1	9.7
		110	AC	24 to 48	Clay loam	26.5	28.6	10.5
HkB	Hockley loamy fine sand, 0 to 3 percent slopes.	83	A11	6 to 22	Loamy fine sand	26.0	6.7	2.3
		84	B22t	22 to 44	Sandy clay	44.5	35.5	13.6
HkB	Hockley loamy fine sand, 0 to 3 percent slopes.	87	A11	7 to 16	Loamy fine sand	25.4	8.5	2.9
		89	B22t	20 to 33	Sandy clay	45.9	37.5	14.6
HnB	Houston clay, 1 to 3 percent slopes.	7	A12	8 to 21	Clay	46.9	42.8	17.0
		5	AC	21 to 36	Clay	55.1	47.2	19.2
		6	C	36 to 50	Clay	53.0	46.3	18.8
HnB	Houston clay, 1 to 3 percent slopes.	4	A12	8 to 24	Clay	48.3	45.1	18.2
		3	AC	24 to 34	Clay	48.1	43.0	17.2
		21	C	34 to 60	Clay	40.6	41.5	16.1
HnB	Houston clay, 1 to 3 percent slopes.	22	A12	8 to 16	Clay	48.8	47.0	19.1
		2	AC	16 to 42	Clay	60.9	47.9	19.5
HnB	Houston clay, 1 to 3 percent slopes.	86	A12	8 to 24	Clay	64.5	47.9	19.5
		76	AC	24 to 36	Clay	53.4	47.9	19.5
HnB	Houston clay, 1 to 3 percent slopes.	88	A12	6 to 18	Clay	48.6	34.7	13.3
		80	AC	18 to 32	Clay	49.8	44.2	17.8
HsB	Houston Black clay, 1 to 3 percent slopes.	23	A11	8 to 18	Clay	62.7	52.4	22.0
		8	A12	18 to 42	Clay	59.4	50.9	21.0
		24	C	42 to 64	Calcareous clay	38.1	28.6	10.3
HsB	Houston Black clay, 1 to 3 percent slopes.	25	A11	8 to 21	Clay	53.5	47.2	19.2
		29	A12	21 to 40	Clay	70.0	51.8	21.6
		28	C	40 to 64	Calcareous clay	74.5	50.9	21.0
HsB	Houston Black clay, 1 to 3 percent slopes.	26	A11	6 to 20	Clay	48.6	48.5	19.6
		27	A12	20 to 50	Clay	60.9	46.4	18.8

See footnotes at end of table.

776-905—66——7

TABLE 9.—*Test data on liquid limit and volumetric shrinkage of selected soils*—Continued

Map symbol	Soil	Laboratory sample number	Horizon	Depth from surface	USDA texture (field determination)	Liquid limit [1]	Volumetric shrinkage [2]	Lineal shrinkage [3]
				Inches				
HsB	Houston Black clay, 1 to 3 percent slopes.	39	A11	6 to 18	Clay	61.7	48.5	20.0
		37	A12	18 to 40	Clay	60.1	49.1	20.1
		38	C	40 to 72	Clay	70.4	55.4	23.8
HsB	Houston Black clay, 1 to 3 percent slopes.	31	A11	6 to 16	Clay	43.0	27.4	10.0
		34	A12	16 to 40	Clay	48.6	44.3	17.8
		32	C	40 to 60	Clay	30.8	44.6	18.0
HsB	Houston Black clay, 1 to 3 percent slopes.	33	A11	8 to 18	Clay	61.9	46.3	18.8
		30	A12	18 to 38	Clay	52.9	45.7	18.6
HtA	Houston Black clay, terrace, 0 to 1 percent slopes.	54	A11	8 to 30	Clay	60.9	54.8	23.0
		52	A12	30 to 52	Clay	64.7	54.8	23.0
		55	C	52 to 72	Clay	61.3	53.9	22.7
HtA	Houston Black clay, terrace, 0 to 1 percent slopes.	49	A11	8 to 28	Clay	52.0	49.1	20.2
		50	A12	28 to 54	Clay	50.2	47.9	19.2
HtA	Houston Black clay, terrace, 0 to 1 percent slopes.	51	A11	8 to 20	Clay	49.6	48.8	20.0
		53	A12	20 to 54	Clay	52.9	49.4	20.2
HtA	Houston Black clay, terrace, 0 to 1 percent slopes.	40	A11	8 to 36	Clay	64.0	53.9	23.0
		42	A12	36 to 48	Clay	60.2	51.8	21.6
		41	C	48 to 72	Clay	73.1	54.3	23.2
HtB	Houston Black clay, terrace, 1 to 3 percent slopes.	43	A11	8 to 32	Clay	46.3	45.2	18.2
		36	A12	32 to 48	Clay	32.4	48.8	20.0
HtB	Houston Black clay, terrace, 1 to 3 percent slopes.	91	A1	7 to 28	Clay	52.0	47.2	19.2
		108	AC	28 to 56	Clay	66.3	55.0	23.0
HtB	Houston Black clay, terrace, 1 to 3 percent slopes.	105	A1	7 to 28	Clay	71.0	48.5	19.6
		95	AC	28 to 60	Clay	60.9	50.6	21.0
LvA	Lewisville silty clay, 0 to 1 percent slopes.	46	A1	7 to 24	Clay	54.8	46.1	18.6
		45	AC	24 to 38	Clay	42.7	40.5	15.7
		44	Clca	38 to 60	Clay	49.4	46.5	18.8
LvA	Lewisville silty clay, 0 to 1 percent slopes.	47	A1	6 to 28	Silty clay	41.3	39.5	15.2
		48	AC	28 to 42	Clay	45.0	42.1	16.5
LvA	Lewisville silty clay, 0 to 1 percent slopes.	20	A1	6 to 20	Clay loam	39.4	36.7	14.0
		16	AC	20 to 38	Clay loam	48.2	38.9	15.0
LvA	Lewisville silty clay, 0 to 1 percent slopes.	18	A11	0 to 15	Light clay	68.8	46.0	18.7
		19	A12	15 to 36	Light clay	64.1	45.2	18.3
LvB	Lewisville silty clay, 1 to 3 percent slopes.	92	A1	7 to 25	Clay	50.2	45.5	18.3
		96	AC	25 to 36	Clay	50.9	46.7	19.0
LvB	Lewisville silty clay, 1 to 3 percent slopes.	93	A1	6 to 24	Clay	58.3	48.2	19.8
		94	AC	24 to 35	Clay	53.4	47.0	19.2
PaA	Patrick soils, 0 to 1 percent slopes.[4]	14	A1	0 to 14	Silty clay	60.3	46.1	18.8
		13	AC	14 to 26	Clay	66.5	45.2	18.3
PaA	Patrick soils, 0 to 1 percent slopes.	17	A1	0 to 10	Clay loam	49.2	36.3	14.0
		15	AC	10 to 18	Clay loam	43.9	37.0	14.3
SaB	San Antonio clay loam, 1 to 3 percent slopes.	69	A1 and B2t.	8 to 20	Clay loam	46.5	35.0	13.4
		73	B3	20 to 30	Light clay	59.4	39.0	15.1
		72	A1 and B2t.	6 to 17	Clay loam	33.7	31.5	11.8
		71	B3	17 to 28	Light clay	40.3	34.7	13.3
Tc	Trinity clay.	77	A11	8 to 34	Clay	46.5	45.5	18.3
		90	A12	34 to 42	Clay	51.5	43.6	17.4

See footnotes at end of table.

TABLE 9.—*Test data on liquid limit and volumetric shrinkage of selected soils*—Continued

Map symbol	Soil	Laboratory sample number	Horizon	Depth from surface	USDA texture (field determination)	Liquid limit [1]	Volumetric shrinkage [2]	Lineal shrinkage [3]
				Inches				
Tf	Frio component of Trinity and Frio soils, frequently flooded.	102	A11	12 to 26	Clay loam	33. 9	32. 5	12. 3
		106	AC	26 to 36	Clay	62. 0	50. 0	20. 7
Tf	Frio component of Trinity and Frio soils, frequently flooded.	109	A11	8 to 25	Clay loam	33. 9	32. 5	12. 3
		103	C	25 to 48	Clay loam	44. 9	42. 3	16. 8
VcA	Venus clay loam, 0 to 1 percent slopes	82	A1	8 to 18	Silty clay loam	42. 1	32. 5	12. 3
		81	C1	26 to 84	Silty clay loam	40. 8	31. 5	11. 9
VcA	Venus clay loam, 0 to 1 percent slopes	79	A1	7 to 18	Silty clay loam	38. 7	33. 3	12. 8
		75	C1	25 to 80	Silty clay loam	37. 8	35. 0	14. 4
WbB	Webb fine sandy loam, 1 to 3 percent slopes.	67	AB	10 to 14	Sandy clay loam	33. 5	20. 8	7. 5
		74	B2t	14 to 26	Sandy clay loam	44. 6	40. 5	15. 8
		70	C1ca	32 to 38	Sandy clay loam	38. 3	35. 4	13. 6
WbB	Webb fine sandy loam, 1 to 3 percent slopes.	64	A1	0 to 8	Fine sandy loam	27. 8	12. 8	4. 5
		68	B2t	14 to 20	Sandy clay	47. 5	37. 5	14. 6
Zg	Zavala component of Zavala and Gowen soils, frequently flooded.	97	A11	8 to 40	Fine sandy loam	23. 9	16. 7	6. 0
		99	AC	40 to 60	Loamy fine sand	19. 6	6. 7	2. 3

[1] Percent moisture.
[2] Percent of volume at liquid limit. Measured according to Texas Highway Department Test Method Tex–107–E.
[3] Percent of one original dimension at liquid limit.
[4] This sample was Lewisville silty clay that was included in an area mapped as Patrick soils, 0 to 1 percent slopes.

Difficulty in digging trenches for the installation of water mains, gas mains, and sewers can be foreseen if the nature of the material underlying the soils is known. Table 3, which begins on page 64, includes a description of the material underlying each of the soils to a depth of 10 feet. From that table it is possible to learn which soils are shallow over rock, which are sandy and subject to sloughing, and which have other characteristics that are likely to cause problems.

Public Health

Soils data have many applications to public health problems, including the problems of sewage disposal, maintenance of a pure water supply, prevention of disease, and provision of safe and adequate shelter.

Sewage lagoons, septic-tank systems, and sewer lines need to be so located and constructed that seepage or drainage from them can not pollute water supplies. Leakage from sewage lagoons built of unsuitable soil material is one cause of pollution. Wells, streams, and lakes can become contaminated by runoff from clogged filter fields, and rapid percolation of septic-tank effluent can result in pollution of underground water. Table 4, Engineering Interpretations, which begins on page 74, shows the degree of limitation of each of the soils for use as filter fields and as a source of material for construction of sewage lagoons. The soil map shows the major drainageways of the county and can be used as a general guide in locating filter fields.

In selecting sites for sanitary land fills, it is important to consider the topography and drainage of the area and the characteristics of the soils, including texture, permeability, reaction, and the nature of the underlying material. The soil map can be useful in locating sites and identifying the soils. Table 3, which begins on page 64, gives estimates of the pertinent properties of the soils.

The stability of the soils is of major importance in the location of sewerlines. If the gradeline is interrupted, the sewerage system breaks down and a public-health hazard results. Tables 3, 6, and 8 provide information on volumetric change and corrosion potential that can be of value in locating pipelines and in planning for the protection of pipelines against corrosion and breakage.

Mosquitoes, fleas, and other disease-carrying insects breed in stagnant water. By use of the soil map and the soil descriptions, it is possible to identify areas subject to flooding and areas likely to be ponded from time to time because of nearly level topography or poor internal drainage. Once these possible trouble spots are located, the health hazard can be controlled by spraying to eliminate insects and installing drainage systems to remove the standing water that attracts insects.

Suitable shelter is a major factor in the protection of health. Particularly important is protection against flooding. Floodwater is a disease carrier, it causes sewage systems to fail, and if it stagnates it attracts disease-carrying insects. No public housing should be allowed to be built where there is danger of flooding or of ponding of surface runoff. Special problems exist around shopping centers and other suburban developments because the concentration of runoff from paved and built-up areas may overtax the drainage facilities.

Selection of sites where the soils are suitable for foundations is also essential. Some of the soils in Bexar

County shrink and swell enough to crack foundations and walls. A health hazard results because rainwater seeps in through the cracks and insects collect in the moist spots. A study of the soil map and the soil descriptions can help planners to foresee and avoid such difficulties.

Recreation

City dwellers in increasing numbers are turning to outdoor activities for recreation. Owners of farms, ranches, and woodlands within easy reach of cities thus have an opportunity for a new and potentially profitable enterprise: the development of facilities for camping, picnicking, fishing, hunting, golfing, and other forms of outdoor recreation.

The nature of the soils affects the suitability of an area for recreational uses. Table 10 lists the soils of Bexar County and shows the estimated degree of limitation of each soil for some of the principal kinds of recreational facilities. Five degrees of limitation are recognized: none, slight, moderate, severe, and very severe. The uses for which the soils are rated and the bases for the ratings are described briefly in the following paragraphs.

TABLE 10.—*Degrees of limitation of soils for*

Soil	Paths and trails for foot traffic	Riding trails and wagon roads	Picnic grounds	Campgrounds
Austin silty clay, 1 to 3 percent slopes	Moderate	Slight	Moderate	Moderate
Austin silty clay, 3 to 5 percent slopes	Moderate	Slight	Moderate	Moderate
Brackett clay loam, 1 to 5 percent slopes	Moderate	Slight	Slight	Good
Brackett soils, 5 to 12 percent slopes	Slight	Slight	Slight	Moderate
Brackett soils, 12 to 30 percent slopes	None	Moderate	Moderate	Severe
Brackett-Austin complex, 1 to 5 percent slopes	Moderate	Slight	Moderate	Severe
Brackett-Tarrant association, hilly	None	Moderate	Slight	Moderate
Crawford clay	Moderate	Moderate	Moderate	Moderate
Crawford and Bexar stony soils	None	Moderate	Moderate	Severe
Crockett fine sandy loam, 0 to 1 percent slopes	Moderate	Slight	Slight	Slight
Crockett fine sandy loam, 1 to 3 percent slopes	Moderate	Slight	Slight	Slight
Crockett soils, 2 to 5 percent slopes, eroded	Severe	Severe	Severe	Severe
Duval loamy fine sand, 1 to 5 percent slopes	Moderate	Slight	Slight	Slight
Duval fine sandy loam, 1 to 3 percent slopes	Moderate	Slight	Slight	Slight
Duval fine sandy loam, 3 to 5 percent slopes	Moderate	Slight	Slight	Slight
Duval soils, 3 to 5 percent slopes, eroded	Moderate	Moderate	Moderate	Moderate
Eufaula fine sand, 0 to 5 percent slopes	Moderate	Severe	Severe	Severe
Frio clay loam	Moderate	Slight	Slight	Slight
Gowen clay loam	Moderate	Severe	Severe	Severe
Gullied land	Severe	Very severe	Very severe	Severe
Hilly gravelly land	Moderate	Severe	Severe	Severe
Hockley loamy fine sand, 0 to 3 percent slopes	Moderate	Slight	Slight	Slight
Hockley loamy fine sand, 3 to 5 percent slopes	Moderate	Slight	Slight	Slight
Hockley loamy fine sand, 3 to 5 percent slopes, eroded	Severe	Moderate	Moderate	Moderate
Houston clay, 1 to 3 percent slopes	Moderate	Moderate	Moderate	Severe
Houston clay, 3 to 5 percent slopes, eroded	Moderate	Moderate	Moderate	Severe
Houston clay, 3 to 5 percent slopes, severely eroded	Moderate	Moderate	Moderate	Severe
Houston-Sumter clays, 5 to 10 percent slopes, severely eroded.	Moderate	Severe	Severe	Severe
Houston Black clay, 0 to 1 percent slopes	Moderate	Moderate	Moderate	Severe
Houston Black clay, 1 to 3 percent slopes	Moderate	Moderate	Moderate	Severe
Houston Black clay, 3 to 5 percent slopes	Moderate	Moderate	Moderate	Severe
Houston Black clay, terrace, 0 to 1 percent slopes	Moderate	Moderate	Moderate	Severe
Houston Black clay, terrace, 1 to 3 percent slopes	Moderate	Moderate	Moderate	Severe
Houston Black gravelly clay, 1 to 3 percent slopes	Moderate	Severe	Moderate	Severe
Houston Black gravelly clay, 3 to 5 percent slopes	Moderate	Severe	Moderate	Severe
Houston Black gravelly clay, 5 to 8 percent slopes	Moderate	Severe	Moderate	Severe
Karnes loam, 1 to 3 percent slopes	Moderate	Slight	Slight	Slight
Karnes loam, 3 to 5 percent slopes	Moderate	Slight	Slight	Slight
Karnes clay loam, 3 to 5 percent slopes, eroded	Moderate	Slight	Slight	Slight
Krum complex	Slight	Moderate	Moderate	Moderate
Leming loamy fine sand, 0 to 3 percent slopes	Moderate	Moderate	Moderate	Moderate
Lewisville silty clay, 0 to 1 percent slopes	Moderate	Slight	Moderate	Moderate
Lewisville silty clay, 1 to 3 percent slopes	Moderate	Slight	Moderate	Moderate
Lewisville silty clay, 3 to 5 percent slopes	Moderate	Slight	Moderate	Moderate
Orelia clay loam, 0 to 1 percent slopes	Moderate	Slight	Moderate	Moderate
Orelia clay loam, 1 to 3 percent slopes	Moderate	Slight	Moderate	Moderate
Pits and Quarries	(1)	(1)	(1)	(1)
Patrick soils, 0 to 1 percent slopes	Moderate	Slight	Slight	Slight
Patrick soils, 1 to 3 percent slopes	Moderate	Slight	Slight	Slight
Patrick soils, 3 to 5 percent slopes	Moderate	Slight	Slight	Slight
San Antonio clay loam, 1 to 3 percent slopes	Moderate	Moderate	Moderate	Moderate
San Antonio clay loam, 3 to 5 percent slopes	Moderate	Moderate	Moderate	Moderate

See footnote at end of table.

Paths and trails for foot traffic.—Paths and trails for hiking, nature study, and photography should preferably be in areas from which the native vegetation has not been removed. Soils of the Bexar, Brackett, Crawford, and Tarrant series are particularly well suited to these purposes. Soils on bottom lands are suitable during the seasons when they are not flooded.

Riding trails and wagon roads.—On dude ranches, vacation farms, and farms close to large cities, horseback riding and hayrides are popular. Suitable trails and roads can be maintained on most of the soils of Bexar County. Sites for barns and other buildings and fields for growing livestock feed need to be carefully selected.

Picnic grounds.—Picnicking accommodations should be uncrowded and should have suitable areas for parking cars. Generally it is advantageous to locate picnic grounds where there are opportunities for hiking, fishing, swimming, or other activities. Slope, wetness, texture, productivity, and erosion hazard are among the soil characteristics that determine the degrees of limitation given in table 10. The soils rated as having slight or no limitation are productive soils that are of loamy fine sand to clay loam texture, contain few stones, have a slope of no more than 7 percent, and are well drained

development as recreational facilities

Sites for cottages and utility buildings	Playgrounds		Hunting areas				Fishponds
	Intensive	Extensive	Upland birds	Wetland birds	Big game	Small game	
Moderate	Moderate	Moderate	Moderate	Severe	Moderate	Moderate	Slight.
Moderate	Moderate	Moderate	Moderate	Severe	Moderate	Moderate	Slight.
Moderate	Moderate	Moderate	Moderate	Moderate	Slight	Slight	Severe.
Moderate	Severe	Moderate	Moderate	Severe	Slight	Moderate	Severe.
Severe	Severe	Moderate	Moderate	Very severe	None	Moderate	Severe.
Moderate	Severe	Moderate	Moderate	Severe	Slight	Moderate	Severe.
Moderate	Severe	Slight	Moderate	Severe	Slight	Moderate	Severe.
Severe	Moderate	Slight	Slight	Moderate	None	Slight	Moderate.
Severe	Severe	Slight	Slight	Moderate	None	Slight	Severe.
Slight	Slight	Slight	Slight	Slight	Moderate	Slight	Slight.
Slight	Slight	Slight	Slight	Slight	Moderate	Slight	Slight.
Moderate	Severe	Moderate	Moderate	Slight	Severe	Moderate	Slight.
Slight	Slight	Slight	Slight	Moderate	Moderate	None	Slight.
Slight	None	Slight	Slight	Moderate	Moderate	None	Slight.
Slight	None	Slight	Slight	Moderate	Moderate	None	Slight.
Moderate	Moderate	Moderate	Moderate	Moderate	Severe	Moderate	Moderate.
None	Severe	Moderate	Moderate	Severe	Moderate	Slight	Severe.
Severe	Severe	Moderate	Slight	Slight	Slight	None	Moderate.
Severe	Severe	Moderate	Slight	Slight	Slight	None	Slight.
Severe	Moderate	Moderate	Moderate	Very severe	Severe	Moderate	Very severe.
Moderate	Severe	Moderate	Moderate	Severe	Moderate	Slight	Severe.
Slight	Slight	Slight	Slight	Slight	Moderate	Slight	Slight.
Slight	Slight	Slight	Slight	Slight	Moderate	Slight	Slight.
Moderate	Moderate	Moderate	Moderate	Slight	Severe	Moderate	Moderate.
Severe	Moderate	Slight	Slight	Slight	Moderate	Slight	None.
Severe	Moderate	Slight	Slight	Slight	Moderate	Slight	None
Severe	Moderate	Slight	Slight	Slight	Moderate	Slight	None.
Severe	Severe	Moderate	Moderate	Moderate	Severe	Moderate	Moderate.
Severe	Moderate	Moderate	Slight	Slight	Slight	Slight	None.
Severe	Moderate	Moderate	Slight	Slight	Slight	Slight	None.
Severe	Moderate	Moderate	Slight	Slight	Slight	Slight	None.
Severe	Moderate	Moderate	Slight	Slight	Moderate	Slight	None.
Severe	Moderate	Moderate	Slight	Slight	Moderate	Slight	None.
Severe	Severe	Moderate	Slight	Slight	Moderate	Slight	None.
Severe	Severe	Moderate	Slight	Slight	Moderate	Slight	None.
Severe	Severe	Moderate	Slight	Slight	Moderate	Slight	None.
Moderate	Slight	Slight	Slight	Severe	Moderate	Slight	Moderate.
Slight	Slight	Slight	Slight	Severe	Moderate	Slight	Moderate.
Moderate	Slight	Slight	Slight	Moderate	Slight	Slight	Moderate.
Severe	Moderate	Slight	Slight	Moderate	Slight	Slight	Moderate.
Slight	Moderate	Moderate	Slight	Slight	Moderate	Slight	Slight.
Moderate	Moderate	Slight	Slight	Slight	Severe	Slight	Moderate.
Moderate	Moderate	Slight	Slight	Slight	Severe	Slight	Moderate.
Moderate	Moderate	Slight	Slight	Slight	Severe	Slight	Moderate.
Moderate	Moderate	Slight	Slight	Slight	Moderate	Slight	Slight.
Moderate	Moderate	Slight	Slight	Slight	Moderate	Slight	Slight.
[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1].
Moderate	Slight	Slight	Slight	Slight	Moderate	Slight	Severe.
Moderate	Slight	Slight	Slight	Slight	Moderate	Slight	Severe.
Moderate	Slight	Slight	Slight	Slight	Moderate	Slight	Severe.
Moderate	Moderate	Slight	Slight	Slight	Moderate	Slight	Slight.
Moderate	Moderate	Slight	Slight	Slight	Moderate	Slight	Slight.

TABLE 10.—*Degrees of limitation of soils for*

Soil	Paths and trails for foot traffic	Riding trails and wagon roads	Picnic grounds	Campgrounds
San Antonio clay loam, 3 to 5 percent slopes, eroded	Moderate	Moderate	Moderate	Moderate
Stephen silty clay, 1 to 3 percent slopes	Moderate	Slight	Moderate	Moderate
Stephen silty clay, 3 to 5 percent slopes	Moderate	Slight	Moderate	Moderate
Tarrant association, gently undulating	None	Moderate	Moderate	Moderate
Tarrant soils, chalk substratum, undulating	Slight	Slight	Slight	Moderate
Tarrant association, rolling	None	Moderate	Moderate	Moderate
Tarrant association, hilly	None	Severe	Severe	Severe
Trinity clay	Severe	Severe	Severe	Severe
Trinity and Frio soils, frequently flooded	Severe	Severe	Severe	Severe
Venus loam, 0 to 1 percent slopes	Moderate	Slight	Slight	Slight
Venus loam, 1 to 3 percent slopes	Moderate	Slight	Slight	Slight
Venus clay loam, 0 to 1 percent slopes	Moderate	Slight	Slight	Slight
Venus clay loam, 1 to 3 percent slopes	Moderate	Slight	Slight	Slight
Venus clay loam, 3 to 5 percent slopes	Moderate	Slight	Slight	Slight
Webb fine sandy loam, 1 to 3 percent slopes	Moderate	Slight	Slight	Slight
Webb fine sandy loam, 3 to 5 percent slopes	Moderate	Slight	Slight	Slight
Webb soils, 3 to 5 percent slopes, eroded	Severe	Severe	Severe	Severe
Webb soils, 3 to 5 percent slopes, severely eroded	Severe	Severe	Severe	Severe
Willacy loam, 0 to 1 percent slopes	Moderate	Slight	Slight	Slight
Willacy loam, 1 to 3 percent slopes	Moderate	Slight	Slight	Slight
Zavala fine sandy loam	Severe	Moderate	Severe	Severe
Zavala and Gowen soils, frequently flooded	Severe	Severe	Severe	Severe

[1] Not rated.

or moderately well drained and safe from flooding. Poorly drained soils, steeper soils, finer textured and coarser textured soils, and stony soils are not suitable.

Campgrounds.—Campgrounds for overnight and weekend camping need to be on soils that are suitable without surfacing for parking cars and trailers and that have no hard layers to interfere with setting tent pegs. Slope, drainage, texture, stoniness, productivity, flood hazard, and erosion hazard are among the characteristics that determine degrees of limitation shown in table 10. The soils rated as having slight or no limitation are productive, moderately permeable, and moderately well drained soils, have a surface texture of loamy fine sand to clay loam, contain few stones, have a slope of between 2 and 7 percent, are safe from overflow, and are no more than moderately erodible. Poorly drained, very slowly permeable soils that are stony or have a more sandy or more clayey texture and a slope of more than 12 percent are considered to have severe limitations, as are soils that are subject to ponding or flooding.

Building sites.—On-site investigation is necessary in the selection of locations for homes and cottages, for picnic shelters, and for washrooms and other service buildings. On the basis of the ratings given in table 10, some soils can be eliminated from consideration, but even within areas of soils that are considered to have slight or no limitation, there are likely to be spots unsuitable for building sites. Slope, drainage, rockiness, productivity, shrink-swell potential, flood hazard, and erosion hazard are among the soil characteristics that determine the degrees of limitation. Favorable characteristics are good or moderately good drainage, a slope of no more than 12 percent, low shrink-swell potential, good productivity, no more than a moderate erosion hazard, safety from flooding and ponding, and freedom from stoniness. Poor drainage, stoniness, slopes of more than 35 percent, high shrink-swell potential, or a hazard of flooding or ponding constitute severe limitations.

Playgrounds, intensive and extensive.—Intensive play areas include basketball, volleyball, badminton, horseshoe, and croquet courts; diamonds for baseball and softball; and areas for swings, seesaws, and other playground equipment. Playgrounds for intensive use should not be surfaced, but they do need a cover of vegetation over most of the area. The degree of limitation of a soil for this use depends largely on wetness, flood hazard, permeability, texture, stoniness, slope, productivity, and erosion hazard. The soils rated as having slight or no limitation are stone-free sandy clay loams to loamy fine sands that have a slope of no more than 3 percent and are well drained or moderately well drained, moderately permeable to rapidly permeable, moderately to highly productive, safe from flooding and ponding, and no more than moderately erodible. The soils rated as severely limited are those that have a texture either coarser than loamy fine sand or finer than sandy clay loam, are gravelly or stony, are poorly drained, have slopes of more than 8 percent, are very slowly permeable, or are subject to flooding.

Extensive play areas are not subjected to such concentrated use and consequently can encompass soils of a wider range of characteristics. Such areas may include wildlife sanctuaries, archery ranges, bridle paths, and undisturbed areas that offer opportunity for nature study (fig. 35). The degree of limitation of a soil for these uses depends largely on wetness, flood hazard, slope, texture, productivity, and erosion hazard. Soils considered to have slight or no limitation are not subject to *development as recreational facilities*—Continued

Sites for cottages and utility buildings	Playgrounds		Hunting areas				Fishponds
	Intensive	Extensive	Upland birds	Wetland birds	Big game	Small game	
Moderate	Moderate	Slight	Slight	Slight	Moderate	Slight	Slight.
Moderate	Moderate	Slight	Moderate	Severe	Moderate	Moderate	Severe.
Moderate	Moderate	Slight	Moderate	Severe	Moderate	Moderate	Severe.
Moderate	Severe	Moderate	Moderate	Severe	None	Slight	Very severe.
Slight	Moderate	Slight	Moderate	Severe	Slight	Slight	Very severe.
Moderate	Severe	Moderate	Moderate	Severe	None	Slight	Very severe.
Severe	Severe	Moderate	Slight	Severe	None	Slight	Very severe.
Severe	Severe	Moderate	Slight	Slight	Moderate	Slight	Slight.
Very severe	Severe	Moderate	Slight	Slight	Slight	None	None.
None	Slight	Slight	Slight	Severe	Moderate	Slight	Moderate.
None	Slight	Slight	Slight	Severe	Moderate	Slight	Moderate.
Slight	Slight	Slight	Slight	Moderate	Moderate	Slight	Moderate.
Slight	Slight	Slight	Slight	Moderate	Moderate	Slight	Moderate.
Slight	Slight	Slight	Slight	Moderate	Moderate	Slight	Moderate.
Slight	Slight	Slight	Slight	Slight	Moderate	Slight	Slight.
Slight	Slight	Slight	Slight	Slight	Moderate	Slight	Slight.
Moderate to severe.	Severe	Moderate	Moderate	Moderate	Severe	Moderate	Slight.
Moderate to severe.	Severe	Moderate	Moderate	Moderate	Severe	Moderate	Slight.
Slight	Slight	Slight	Slight	Moderate	Moderate	Slight	Moderate.
Slight	Slight	Slight	Slight	Moderate	Moderate	Slight	Moderate.
None	Severe	Fair	Slight	Slight	Moderate	Slight	Moderate.
Very severe	Severe	Moderate	None	Moderate	Slight	None	None.

flooding or ponding, but they may range from clay loam to loamy fine sand in texture, from good to imperfect in drainage, and from high to low in natural fertility. The slope may be as much as 20 percent. Soils that are marshy or are frequently flooded are not suitable, nor are those that include large outcrops or escarpments of rock.

Hunting areas.—Adequate and suitable food and cover are the principal requirements for attracting game in numbers sufficient for good hunting. Table 10 shows the degree of limitation of each of the soils in Bexar County as an environment for the principal kinds of game birds and animals.

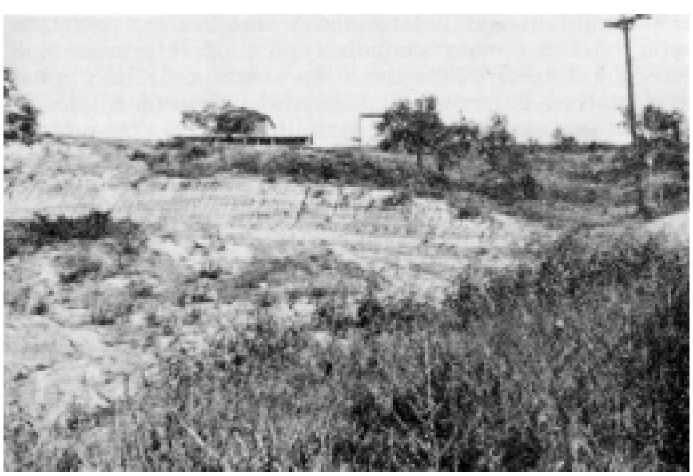

***Figure 35.*—This area is not suitable for use as a playground for intensive use, but it could be developed as an archery range or a wildlife sanctuary.**

Upland birds, such as quail, doves, and turkeys, need brush and trees for cover. For food they need grain crops, seed crops, grasses, legumes, and wild herbaceous upland plants. Wetness, productivity, slope, and degree of erosion are among the soil characteristics that determine the degrees of limitation. The soils that have slight or no limitation are well drained to imperfectly drained, are moderate to high in natural fertility, have slopes of no more than 12 percent, and are no more than moderately eroded. The most severely limited soils are low in natural fertility, severely or very severely eroded, marshy, or extremely rocky.

Ducks and other wetland birds need areas of water, in addition to food and cover. The soils should be suitable either for excavated ponds or for shallow impoundments. Wetness, slope, productivity, permeability, depth to bedrock, and nature of the parent material are among the soil characteristics that determine the degrees of limitation. The soils that have slight or no limitation are those that have very slowly permeable subsoils and are wet or marshy, level or depressional, and fertile enough to produce wetland plants for food and cover. Well-drained upland soils are not suitable.

Deer, the principal big game in this county, need an environment in which there are brush and trees for natural cover and grain crops, seed crops, grasses, legumes, and wild herbaceous forage crops for food. Wetness, productivity, and slope are among the soil characteristics that determine the degrees of limitation. The soils that have slight or no limitation are well drained to imperfectly drained, are moderately to highly productive, and have slopes of less than 35 percent. The soils most severely limited are those that are marshy and those that are flooded for long periods.

Small game, such as rabbits, squirrels, and opossums, need an environment that provides food and cover in the form of grain crops, seed crops, grasses, legumes, wild herbaceous upland plants, brush, and trees. Wetness, productivity, slope, and degree of erosion are among the soil characteristics that determine the degree of limitations. The soils considered to have slight or no limitation have slopes of less than 20 percent and are well drained to imperfectly drained, moderate to high in natural fertility, and no more than moderately eroded. The soils most severely limited are those that consist mostly of outcrops or escarpments and those that are marshy, severely eroded, or low in natural fertility.

Fishponds.—On-site investigation is needed in the selection of sites for fishponds. On the basis of table 10, some soils can be eliminated from consideration, but even within areas of soils that have little or no limitation, there are likely to be areas that would not be satisfactory for ponds. The soil material must be suitable both for the dam and for the bottom of the pond. Slope, permeability, texture, depth to bedrock, and nature of the parent material are among the soil factors that determine the degrees of limitation shown in table 10. Other factors that are important in the choice of a pond site but are not reflected in table 10 are the size of the drainage area, the hazard of siltation, the need for spillways, and the need for control of runoff and erosion.

Formation, Classification, and Morphology of Soils

In this section the factors that have affected the development and composition of the soils in Bexar County are considered, the soils are classified by higher categories according to the system of classification now in use in the United States, the main morphological characteristics of the soils are presented, and a typical profile of a soil of each soil series in the county is described. Complete physical and chemical data for these soils are not available.

Factors of Soil Formation

The characteristics of the soil at any one point on the earth are determined by climate, plant and animal life, type of parent material, relief and drainage, and time. All five of these soil-forming factors come into play in the genesis of every soil. The relative importance of each differs from place to place; sometimes one is more important and sometimes another.

Climate and plant and animal life are the active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effect of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of profile that will be formed and in extreme cases, as when the parent material consists of pure quartz sand, determines it almost entirely. Little can happen to quartz sand, and most soils derived from it have very faint horizons. Finally, time is required for the changing of the parent material into a soil profile. Usually, a very long time is required for the development of distinct horizons.

The interrelationships among the factors of soil formation are complex, and the effects of any one factor cannot be isolated and identified with certainty. It is convenient, however, to discuss the factors of soil formation separately and to indicate some of their probable effects. The reader should always remember that the factors interact continually in the processes of soil formation and that the interactions are important to the nature of every soil.

Climate

Bexar County has a modified subtropical climate, predominantly continental in winter and marine in summer. Precipitation is fairly well distributed throughout the year; it is heaviest in spring and early in fall. Evaporation is fairly high, and rainfall seldom wets the soil below the root zone. The amount of rainfall has been great enough to leach the calcium carbonate from the upper horizons of some soils, but not great enough to leach it entirely from the soil. Consequently, many of the soils have a layer in which calcium carbonate has accumulated. Many of the younger soils have free lime throughout the profile. In other soils, most of the plant nutrients have been leached from the root zone, and fine clay particles have been moved down in the profile and have accumulated to form a slowly permeable horizon.

Wind has been a minor factor in the development of the soils of the area, but it has affected soil development to some extent, particularly in the extreme southern part of the county. It has contributed to weathering of parent materials, has reworked some deposits, and has shifted material from place to place.

Living organisms

Vegetation, micro-organisms, macro-organisms, and other forms of life that live on and in the soil contribute to soil development. The type and amount of vegetation are important. They are determined partly by the climate and partly by the kind of parent material.

The climate of Bexar County was favorable to mid and tall grasses and hardwood trees. The nature of the parent material determined whether the vegetation would be the open savannah type of tall grasses and hardwood forest, as on the deep sands, or mid grasses and scattered hardwoods, as on the limestone hills.

The mixed vegetation contributed large amounts of organic matter to most soils of the area. Decaying grass leaves and stems were left on the soil surface, and fine roots were left throughout the solum. The network of tubes and pores left by these decaying roots hastened the passage of air and water through the soil and provided abundant food for bacteria, actinomycetes, fungi, and other micro-organisms.

Earthworms are the most conspicuous form of animal life in the soil. Despite the low rainfall in this area and periods when the solum is completely dry, earthworms have had an important part in soil development. Worm casts, which are common in the Austin, Willacy, Frio, and Lewisville soils, facilitate the movement of air, water, and roots in the soil.

The influence of man on the soil-forming factors should not be overlooked. At first, he fenced the range, stocked it, and permitted it to be overgrazed. Then he plowed the land and planted crops. By poorly timed tillage and the use of heavy machinery, he compacted the soil in some areas and reduced aeration and infiltration of water. By harvesting the crops, exposing the bare soil to the elements, and allowing runoff and wind erosion, he reduced the amount of organic matter and the proportion of silt and clay particles in the plow layer. In some areas he has changed the moisture regime by irrigating. These activities, most of which have taken place within the past 75 years, have had a marked effect on the soils of the county.

The way man treats the soil in future years will affect its further development.

Parent material

Bexar County is underlain by formations in the Trinity, Fredericksburg, Washita, Midway, Wilcox, and Claiborne geological groups and by formations in the Gulf and Recent series (*3*). These groups and series differ greatly. Each consists of one or more formations that contain limestone, chalky limestone, chalk, shaly clay, marly clay, sandy clay, calcareous clay, sand, or sandstone.

Most of the soils in the northern third of the county formed in material associated with the Trinity, Fredericksburg, and Washita groups. The Tarrant soils are underlain by hard limestone, generally of the Glen Rose formation in the Trinity group and of the Edwards formation in the Fredericksburg group. The Brackett soils are underlain by chalky limestone and marly clay of the Comanche Peak formation in the Fredericksburg group. The Crawford and the Bexar soils have developed over cherty limestone of the Georgetown formation in the Washita group and of the Edwards formation in the Fredericksburg group.

Material from formations in the Gulf series has influenced soil development in the central third of the county. The Austin and the Stephen soils developed over chalk and soft limestone rubble of the Austin chalk and Anacacho limestone formations. The Houston, the Houston Black, and the Sumter soils developed over the calcareous clay, shaly clay, and marl of the Navarro and Taylor formations.

The Midway, Wilcox, and Claiborne are the principal groups in the southern third of the county. The Wills Point clay formation in the Midway group consists mainly of sandy clay and underlies the San Antonio, the Orelia, and the Willacy soils and some of the Webb soils. The undifferentiated sand, clay, and sandstone formations in the Wilcox group underlie the Crockett, Leming, Hockley, Duval, and Webb soils and some of the San Antonio soils, all of which have a surface layer of sandy loam or loamy sand and a clay subsoil.

The Carrizo sand formation in the Claiborne group underlies the Eufaula soils, which have a deep profile of sand or loamy sand texture. Some of the Hockley, Duval, and Webb soils developed from material of the Mount Selman formation in the Claiborne group. This formation is inextensive. It is made up largely of fine sand, silty clay, and clay.

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Alluvial deposits of recent or ancient geologic time occur along the principal rivers and streams of the county. The lowest lying deposits constitute the parent material of soils on the flood plains. Many of these are reworked from time to time, and new sediments are deposited. Consequently, there is little soil development and the horizons are indistinct. There is, however, a textural profile composed of layers of clay, clay loam, or fine sandy loam. The Frio, Trinity, Gowen, and Zavala soils, all of which are on the flood plains, formed in this kind of parent material. The thicker, higher lying deposits of alluvium and some clayey outwash material constitute the parent material from which the Venus, Patrick, Karnes, and Lewisville soils formed. In some areas, ordinarily near the base of the formation, there are thick beds of gravel.

Relief

Relief, or the lay of the land, influences soil development through its effect on drainage and runoff. If other factors of soil formation are equal, the degree of profile development depends mainly upon the average amount of moisture in the soil. Soils on steep slopes absorb less moisture and normally have less well developed profiles than those on gentle or nearly level slopes. Some steep areas have so much runoff that geologic erosion almost keeps pace with the weathering of rocks and the formation of soils. Conversely, soils in the more nearly level areas generally absorb more of the water that falls and are less likely to erode. Depressions or concave areas receive extra water through runoff from adjacent slopes, and in these areas the soils may be wet for long periods. The wetness affects the rate of horizon development.

Thus, through the general influence of runoff and drainage, relief inhibits some processes of horizon differentiation and hastens others. Soils that form from the same kind of parent material but in different positions within the landscape are likely to have unlike profiles. Relief, then, is a local factor rather than a regional factor in soil formation.

The distinctness of horizons within a soil profile and the total thickness of the solum are closely related to relief. Ordinarily, soils that have a thick solum and distinct horizons occur on gentle slopes; soils on stronger slopes have a thinner solum and less distinct horizons. Except for sandy soils, which are permeable and generally well drained, the soils in level or nearly level areas are likely to be dense, slowly permeable, and poorly drained.

Time

Time is required for the formation of a mature soil from parent material. Some materials that have been in place for only a short time have not been influenced enough by climate, relief, and living organisms to have developed well-defined, genetically related horizons. The bottom-land soils, such as the Frio and Trinity soils, are good examples of soils that have weakly developed profiles.

Some deep soils that have indistinct horizons or in which the profile consists of A and C horizons are considered young and immature. The Venus, Karnes, and Austin soils are good examples of deep, immature soils.

Soils on steep slopes are generally immature, because geologic erosion resulting from relief has overcome the influence of other soil-forming factors. The Tarrant and Brackett soils are excellent examples of steep, immature soils. Soils that have been in place for a long time and have approached equilibrium with their environment are mature soils. These soils show marked horizon differentiation. Ordinarily they are well drained and occupy nearly level to gently sloping areas. The Crockett, San Antonio, and Webb soils are good examples of mature soils.

Classification and Morphology of Soils

Classification consists of an orderly grouping of defined kinds of soils into classes in a system designed to make it easier to remember soils, including their characteristics and interrelationships. Soils are placed in narrow classes or groups so that their behavior within farms, ranches, or counties can be studied. They are placed in broad classes so that the soils of continents or other large areas can be compared. In the comprehensive system of soil classification followed in the United States (*5*), the soils are placed in six categories. Beginning with the most inclusive, the six categories are the order, the suborder, the great soil group, the family, the series, and the type.

There are three orders and thousands of types. The suborder and family categories have not been fully developed and thus have been little used. Attention has been given largely to the classification of soils into soil types and series within counties or comparable areas and to the subsequent grouping of series into great soil groups and orders. The terms "soil series" and "soil type" are defined in the section "How This Soil Survey Was Made."

Classes in the highest category of the classification scheme are the zonal, intrazonal, and azonal orders (*4*). The zonal order is made up of soils having evident, genetically related horizons that reflect the predominant influence of climate and living organisms in their formation. In the intrazonal order are soils having evident, genetically related horizons that reflect the influence of topography or parent material over the effects of climate and living organisms. In the azonal order are soils that lack distinct, genetically related horizons, commonly because of youth, resistant parent material, or steep topography.

All three soil orders are represented in Bexar County. Soil of two orders, and even of all three, may occur within a single field.

A great soil group consists of a large number of soil series, the soils of which have many internal features in common. All of the soils in all series within one group will have the same number and kinds of horizons. The horizons may differ in thickness and distinctness, but they must be recognizable. The great soil group category also reflects a number of relationships in soil genesis and indicates to some degree the fertility of the soils and their suitability for crops.

The classification of the soil series of Bexar County by order and great soil group is shown in the following tabulation.

Order and great soil group	*Series*
Zonal—	
Reddish Chestnut	Duval, San Antonio, Webb, Willacy.
Reddish Prairie	Bexar, Crockett.
Red-Yellow Podzolic	Eufaula, Hockley.
Intrazonal—	
Grumusol	Austin, Crawford, Houston, Houston Black, Krum, Lewisville, Patrick.
Planosol	Leming, Orelia.
Rendzina	Stephen.
Azonal—	
Alluvial	Frio, Gowen, Trinity, Zavala.
Lithosol	Brackett, Tarrant.
Regosol	Karnes, Sumter, Venus.

Zonal order

The zonal soils in Bexar County are classified into three great soil groups: Reddish Chestnut soils, Reddish Prairie soils, and Red-Yellow Podzolic soils.

REDDISH CHESTNUT SOILS

Reddish Chestnut soils have a brown to reddish-brown surface horizon that is hard when dry. The subsoil is reddish brown to red and is firmer and finer textured than the surface soil. The lower part of the subsoil is calcareous. These soils developed under a mixture of grass and shrubs in a warm-temperate, subhumid climate.

The Reddish Chestnut great soil group is represented in this county by soils of the Duval, San Antonio, Webb, and Willacy series.

REDDISH PRAIRIE SOILS

Reddish Prairie soils have a dark reddish-brown, slightly acid to medium acid surface soil that grades through somewhat finer textured, reddish material to the parent material. These soils formed under tall grasses in a humid to subhumid, warm-temperate climate.

The Reddish Prairie great soil group is represented in this county by the soils of the Bexar and Crockett series. These soils (Bexar and Crockett) are at the westernmost edge of the Reddish Prairie range and are transitional toward the Reddish Chestnut soils.

RED-YELLOW PODZOLIC SOILS

Red-Yellow Podzolic soils have a thin surface layer of litter and acid humus; a thin organic-mineral A1 horizon; a thicker, light-colored, leached A2 horizon; a thick, red, yellowish-red, or yellowish-brown B horizon that shows some accumulation of clay and sesquioxides; and a relatively sandy C horizon. These soils formed under deciduous or coniferous or mixed forest in a humid, warm-temperate climate.

The Red-Yellow Podzolic great soil group is represented in this county by the soils of the Hockley and Eufaula series. These soils lie near the westernmost edge of the Red-Yellow Podzolic range, which covers the greater part of the southeastern United States. They are detached from the main body of the Red-Yellow Podzolic soils that extend eastward from eastern Texas.

Intrazonal order

The intrazonal soils in Bexar County are classified into three great soil groups: Grumusols, Planosols, and Rendzinas.

GRUMUSOLS

Grumusols have a profile that is rather high in clay and relatively uniform in texture. They are marked by signs of local movement resulting from shrinking and swelling as they become dry and then wet. Many of these soils have a thick, dark-colored A horizon over a limy C horizon; others are uniform in appearance except for signs of churning. The parent material is high in clay or in alkaline earths. Grumusols occur chiefly in a tropical or subtropical climate where wet and dry seasons alternate.

The Grumusol great soil group is represented in this county by the soils of the Austin, Crawford, Houston, Houston Black, Krum, Lewisville, and Patrick series. The Austin and Patrick soils are transitional toward Brunizems. They do not exhibit the high degree of shrinking and swelling that the Houston and Houston Black soils do. The peds are subangular blocky in shape, and slickensides have not been observed.

PLANOSOLS

Planosols have one or more horizons abruptly separated from and sharply contrasting with an adjacent horizon because of high clay content, cementation, or compactness. Some Planosols have a B horizon that is very high in clay, which is separated by an abrupt boundary from an A horizon that is comparatively low in clay. Other Planosols have a fragipan (a compact or brittle, seemingly cemented horizon) below a B horizon that contains some accumulated clay. Planosols form under either grass or trees in a temperate to subtropical, subhumid to humid climate.

The Planosols in Bexar County have a dark-gray to grayish-brown, eluviated A horizon that ranges from sandy clay loam to loamy fine sand in texture. They formed under grass-shrub vegetation on a nearly level to gently sloping, concave surface. They are underlain by sandy clay and some interbedded sandstone.

The Planosol great soil group is represented in this county by the soils of the Orelia and Leming series. Leming soils are transitional toward Reddish Chestnut soils.

RENDZINAS

Rendzinas have a brown or black, friable surface horizon underlain by light-gray or pale-yellow, soft, limy material. These soils formed under grass or a mixture of grass and trees in a humid to semiarid climate.

The Rendzina great soil group is represented in this county by soils of the Stephen series. Stephen soils are nearly level to moderately sloping and have a convex surface. They are moderately permeable and poorly drained to moderately well drained. The texture of the surface layer ranges from light clay to clay loam and silty clay loam.

Azonal order

The azonal soils in Bexar County are classified into three great soil groups: Alluvial soils, Lithosols, and Regosols.

ALLUVIAL SOILS

Alluvial soils consist of transported and relatively recently deposited material that has been only slightly modified by soil-forming processes.

The Alluvial great soil group is represented in this county by the soils of the Frio, Gowen, Trinity, and Zavala series. These soils are nearly level or gently sloping and occur on first bottoms or on low terraces along the main rivers, streams, and drains of the area.

LITHOSOLS

Lithosols have no clearly expressed soil morphology. They consist of freshly and imperfectly weathered masses of rock fragments.

The Lithosol great soil group is represented in this county by the soils of the Brackett and Tarrant series. Ordinarily, these soils are steep.

REGOSOLS

Regosols lack definite genetic horizons. They are developing from deep, unconsolidated or soft rocky deposits.

The Regosol great soil group is represented in this county by the soils of the Karnes, Venus, and Sumter series.

Detailed Descriptions of Soil Profiles

In the pages that follow, a typical profile of a soil of each series represented in Bexar County is described in detail, and the range in major characteristics within the limits of each series is discussed.

AUSTIN SERIES.—Austin soils are moderately deep, dark grayish-brown, well-drained silty clays that developed over the Austin chalk or the Anacacho limestone formation. Soils of this series occur in the northeastern and central parts of Bexar County. They are predominantly gently sloping, but the slope range is 1 to 6 percent.

Austin soils are lighter colored, are less clayey, have more free lime, and are more permeable than Houston Black soils; they are more deeply developed and lighter colored than Stephen soils and the Tarrant soils that have a chalk substratum; and they are more permeable and less clayey than Houston soils. They are similar to Lewisville soils, which developed from old alluvium and are typically less sloping.

A typical profile of a cultivated Austin silty clay is just off Stahl Road, about half a mile northwest of its intersection with Nacogdoches Road; the site is approximately 25 yards to the right of the road.

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silty clay; very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist, sticky when wet; contains a few, very fine, hard $CaCO_3$ concretions; a few worm casts; strongly calcareous; clear, smooth boundary.

A11—8 to 15 inches, dark grayish-brown (10YR 4/2) silty clay; very dark grayish brown (10YR 3/2) when moist; strong, fine, subangular blocky structure; hard when dry, firm but crumbly when moist, sticky when wet; contains a few, fine, hard $CaCO_3$ concretions; a few worm casts; strongly calcareous; gradual boundary.

A12—15 to 28 inches, grayish-brown (10YR 5/2) silty clay; dark grayish brown (10YR 4/2) when moist; strong, fine, subangular blocky structure; hard when dry, firm but crumbly when moist, sticky when wet; contains a few, fine and very fine, hard $CaCO_3$ concretions; a few worm casts; strongly calcareous; gradual boundary.

AC—28 to 45 inches, pale-brown (10YR 6/3) silty clay; brown (10YR 5/3) when moist; moderate, medium and fine, subangular blocky structure; very hard when dry, firm but crumbly when moist, sticky when wet; contains a few, fine, hard $CaCO_3$ concretions; strongly calcareous; clear, wavy boundary.

C—45 to 72 inches +, very pale brown (10YR 8/3), soft chalky marl; darker very pale brown (10YR 7/3) when moist; weak, fine, subangular blocky structure in the uppermost 10 inches, then grading to weak fragments and partings; firm when moist, hard when dry; very strongly calcareous; common to many, fine and medium, hard and soft $CaCO_3$ concretions and masses of limy material; many shale partings in the lower part.

The thickness of the A horizon ranges from 16 to 30 inches. The color ranges from very dark brown to grayish brown (hue of 10YR, dry values of 2 to 5.5, and chromas of 1.5 to 2). The texture is silty clay; the clay content is 40 to 48 percent.

The thickness of the AC horizon ranges from 12 to 26 inches. The color ranges from dark grayish brown to pale brown (hues of 10YR and 2.5YR, dry values of 4 to 6, and chromas of 2 to 3).

Depth to the C horizon is typically about 45 inches but ranges from 24 to 55 inches. The substratum is chalk or chalky marl and contains few to many shale partings.

Bexar Series.—Bexar soils are moderately deep, dark reddish-brown, well-drained cherty clay loams or gravelly loams. They developed under grass-forest vegetation over hard limestone of the Georgetown and Edwards formations. Soils of this series occur in the northern third of the county. They are predominantly gently sloping, but the slope range is 0 to 8 percent.

Bexar soils are redder, less clayey, and more cherty in the surface layer than Crawford soils; they are more deeply developed, redder, and less limy than Tarrant soils; and they are more deeply developed than the closely associated Yates soils, which are not mapped in Bexar County.

A typical profile of Bexar cherty clay loam is just off Redland Road, 1 mile north and northwest of its intersection with Jones-Maltsberger Road; the site is 50 feet west of the road, in a large pasture.

A11—0 to 8 inches, dark reddish-brown (5YR 3/2) cherty clay loam; dark reddish brown (5YR 2/2) when moist; moderate, fine and very fine, subangular blocky structure; sticky and plastic when wet, firm but crumbly when moist, hard when dry; contains angular chert fragments (approximately 15 percent by volume); pH 6.0; clear, smooth boundary.

A12—8 to 18 inches, dark reddish-brown (5YR 3/3) cherty clay loam; dark reddish brown (10YR 3/2) when moist; very fine and fine, subangular blocky structure; sticky and plastic when wet, firm but crumbly when moist, hard when dry; contains angular chert fragments (approximately 40 percent by volume); pH 6.0; abrupt, wavy boundary.

B2t—18 to 27 inches, dark reddish-brown (2.5YR 3/4) cherty clay; dark reddish brown (2.5YR 2/4) when moist; strong, very fine, blocky structure; peds have nearly continuous clay films: sticky and plastic when wet, very firm when moist, very hard when dry; contains very large, irregular fragments of chert and limestone (approximately 15 percent by volume); pH 6.5; abrupt, wavy boundary.

R—27 to 32 inches +, pinkish-white (5YR 8/2), calcareous, soft limestone and hard, crystalline limestone bedrock; pinkish gray (5YR 7/2) when moist.

The thickness of the A horizon ranges from 14 to 22 inches. The texture ranges from cherty clay loam to gravelly loam. The color ranges from dark brown to reddish brown (hues of 7.5YR and 5YR, dry values of 3 to 4, and chromas of 2 to 3).

The thickness of the B horizon ranges from 6 to 14 inches. The color ranges from red to dark reddish brown (hues of 2.5YR and 5YR, dry values of 3 to 4, and chromas of 4 to 6).

The thickness of the solum ranges from about 16 to 36 inches and not uncommonly covers this entire range within a distance of 50 feet or less. The reaction ranges from slightly acid to mildly alkaline. The fragments of chert and hard limestone range from ½ inch to 5 inches in diameter. They cover 3 to 25 percent of the surface and make up 15 to 50 percent of the solum, by volume.

Brackett Series.—Brackett soils are well-drained, grayish-brown, clayey, strongly calcareous Lithosols. They developed over soft limestone interbedded with hard limestone, mainly of the Comanche Peak formation. Soils of this series are extensive in Bexar County and occur as wide areas on the limestone prairies in the northern third of the county. The slope range is 2 to 30 percent. Moderately steep slopes predominate.

Brackett soils are lighter colored, less clayey, and less stony than Tarrant soils; they are less red, less clayey, more limy, and less deeply developed than Crawford soils; they are lighter colored and contain more lime than the Tarrant soils that developed over chalk; they are less deeply developed and lighter colored than Stephen soils; and they are lighter colored, less deeply developed, more limy, more crusty, and more sloping than Austin soils.

A typical profile of Brackett stony clay loam is just off Scenic Loop Drive, 1 mile north of its intersection with Babcock Road; the site is in a large pasture, approximately 600 feet west of the drive.

A1—0 to 4 inches, grayish-brown (2.5Y 5/2) stony clay loam; dark grayish brown (10YR 4/2) when moist; contains gravel and limestone fragments (approximately 20 percent by volume) ranging from 1/4 inch to 6 inches in diameter; weak, granular structure; crusty and hard when dry, friable when moist; very strongly calcareous; abrupt, irregular boundary.

AC—4 to 12 inches, light brownish-gray (2.5Y 6/2) clay loam; grayish brown (2.5Y 5/2) when moist; contains soft limestone and lenses of chalky marl (approximately 30 percent by volume); weak to moderate, fine, granular structure; hard when dry, friable when moist; very strongly calcareous; clear, smooth boundary.

R—12 to 20 inches +, thin-bedded to thick-bedded limestone containing lenses of chalky marl or calcareous clay; interbedded with strata of hard limestone.

The thickness of the A1 horizon ranges from 0 to 10 inches. The texture (excluding the gravel and stones) ranges from clay loam to light clay. Some areas are free of gravel and stones. The color of the A1 horizon ranges from gray to light brownish gray (hues of 10YR and 2.5Y, dry values of 4.5 to 6, and chromas of 1 to 2).

The thickness of the AC horizon ranges from 4 to 16 inches. The color ranges from light brownish gray to light gray (hues of 10YR and 2.5Y, dry values of 6 to

7, and chromas of 1 to 2). In places this horizon is lacking or very thin.

In the rocky phases, limestone rocks and fragments that range from 1/4 inch to 10 inches in diameter cover 12 to 80 percent of the surface. The amount of rock increases near the narrow ledges, where harder limestone crops out, and decreases on the wider benches. The amount increases where the benches get smaller and closer together on the upper part of the slopes.

CRAWFORD SERIES.—Crawford soils are moderately deep, well-drained, very dark brown stony clays or clays. They developed under the savannah and the forest types of vegetation, over hard limestone of the Georgetown and Edwards formations. Soils of this series occur in the northern third of the county. They are mainly nearly level to gently sloping, but the slope range is 0 to 8 percent.

Crawford soils are deeper, redder, and less limy than Tarrant soils; and they differ from Bexar soils in that they are more clayey and less red in the surface layer and lack a Bt horizon. As compared with Brackett soils, which are very shallow, they are deeper, are darker colored, are less limy, and developed over harder limestone.

A typical profile of Crawford stony clay is just off U.S. Highway No. 281 North, approximately 6 miles north of Loop 410; the site is in a pasture, 70 feet west of the highway.

A11—0 to 8 inches, very dark grayish-brown (10YR 3/2) stony clay; very dark brown (10YR 2/2) when moist; moderate, fine, granular and subangular blocky structure; sticky and plastic when wet, very firm but crumbly when moist; noncalcareous; pH 7.5; gradual boundary.

A12—8 to 22 inches, brown (7.5YR 4/2) stony clay; dark brown (7.5YR 3/2) when moist; moderate, fine, blocky (wedge-shaped) structure; sticky and plastic when wet, very firm but crumbly when moist; noncalcareous; pH 7.5; gradual boundary.

A13—22 to 34 inches, reddish-brown (5YR 5/3) stony clay; dark reddish brown (5YR 3/3) when moist; moderate, fine, blocky (wedge-shaped) structure; sticky and plastic when wet, very firm but crumbly when moist; noncalcareous; pH 8.0; abrupt, irregular boundary.

A13 and R—34 to 42 inches, weathered limestone; estimated to be 10 to 15 percent, by volume, yellowish-red (5YR 5/6) clay in the cracks, crevices, and interstices between the fractured strata; calcareous; pH 8.0; many roots.

R—42 to 50 inches +, relatively unfractured limestone bedrock.

The color of the A11 horizon ranges from very dark brown to dark reddish brown (hues of 10YR and 5YR, dry values of 2 to 4, and chromas of 2 to 3). The thickness ranges from 6 to 10 inches. The texture ranges from clay to coarse cherty clay. From 5 to 40 percent of this horizon consists of limestone and chert fragments that range in diameter from 1/4 inch to 24 inches. A nonstony phase of this soil occurs. Besides being almost free of coarse fragments, it is slightly redder than is typical of Crawford soils.

The color of the A13 horizon ranges from dark reddish brown to dark brown (hues of 5YR and 7YR, dry values of 3 to 4, and chromas of 3 to 4).

The reaction ranges from slightly acid to mildly alkaline. Depth to hard limestone bedrock ranges from 17 to 45 inches.

CROCKETT SERIES.—The Crockett series consists of well-drained, dark grayish-brown to brown soils of the Reddish Prairie group. They developed over calcareous sandy clay loam and sandy clay formations of the Wilcox group. Soils of this series occur in the southern third of Bexar County. They are nearly level to gently sloping; the slope range is 0 to 5 percent.

Crockett soils are less clayey than San Antonio soils, which have a browner surface layer and a redder, unmottled subsoil; they are less clayey in the surface layer and lighter gray than Orelia soils, which have a compact, unmottled subsoil; they are less red throughout the profile than Webb and Duval soils; and they have a thinner, less sandy surface layer and a less sandy, less permeable subsoil than Hockley soils.

A typical profile of Crockett fine sandy loam is near the intersection of Sulphur Springs Road and Stuart Road; the site is west of a small cemetery and across the road from the main entrance to East Central High School.

A11—0 to 5 inches, brown (10YR 5/3) fine sandy loam; dark brown (10YR 4/3) when moist; weak, fine, granular structure to structureless; very friable to loose when moist; noncalcareous; pH 6.0; clear, smooth boundary.

A12—5 to 10 inches, dark-brown (10YR 4/3) fine sandy loam; darker brown (10YR 3/3) when moist; slightly more clayey than the A11 horizon; weak, fine, granular structure to structureless; very friable when moist, hard when dry; noncalcareous; pH 6.0; abrupt boundary.

B21t—10 to 20 inches, brown (7.5YR 4/2) light sandy clay; dark brown (7.5YR 3/2) when moist; common, fine, distinct, red and gray mottles; moderate, medium and fine, blocky structure; extremely hard when dry, very firm when moist, sticky and plastic when wet; nearly continuous, slightly darker coatings on ped surfaces; noncalcareous; pH 6.5; gradual boundary.

B22t—20 to 26 inches, brown (10YR 5/3) light sandy clay; dark brown (10YR 4/3) when moist; common, fine, distinct, red and reddish-yellow mottles; moderate, medium and fine, blocky structure; extremely hard when dry, very firm when moist, sticky and plastic when wet; noncalcareous; pH 6.5; gradual boundary.

B3—26 to 44 inches, reddish-yellow (7.5YR 6/6) sandy clay loam; strong brown (7.5YR 5/6) when moist; few, fine, distinct, yellowish-red and grayish-brown mottles; moderate, medium and coarse, blocky structure; very hard when dry, very firm when moist, sticky when wet; slightly calcareous; pH 8.0; gradual boundary.

C1ca—44 to 56 inches, very pale brown (10YR 7/4) sandy clay; light yellowish brown (10YR 6/4) when moist; common, medium, prominent, reddish-yellow and gray mottles; estimated to be 10 to 15 percent of layer, by volume, medium and fine, hard and soft $CaCO_3$ concretions; moderate, medium, blocky structure; strongly calcareous; pH 8.0; gradual boundary.

C2—56 to 72 inches +, very pale brown (10YR 7/4) sandy clay; light yellowish brown (10YR 6/4) when moist; common, fine, distinct, reddish-yellow and gray mottles; contains a few, fine, hard $CaCO_3$ concretions and a few, medium and fine, sandstone partings; weakly calcareous in the upper part, noncalcareous below 60 inches; no structure observed.

The thickness of the A horizon ranges from 8 to 14 inches. The texture is mostly fine sandy loam, but in some places it is loamy fine sand. The color ranges from dark grayish brown to brown (hues of 10YR and 7.5YR, dry values of 3 to 5, and chromas of 2 to 3).

The texture of the B horizon ranges from sandy clay loam to sandy clay. The structure ranges from moderate, medium and fine, blocky to moderate, coarse, blocky. The color ranges from brown to dark brown (hues of 10YR and 7.5YR, dry values of 3 to 4, and chromas of 2 to 3). Mottles range from few to many, from fine to medium, and from faint to distinct. Colors include red, yellow, and gray.

Depth to the C1ca horizon, the horizon of carbonate accumulation, is ordinarily about 40 inches but ranges from 35 to 50 inches. This horizon is strongly to weakly calcareous; the lime content decreases with depth. Both of the C horizons are sandy clay loam or sandy clay in texture. In color they range from pale brown through yellowish brown to brownish yellow. The C2 horizon is weakly calcareous in the upper part and noncalcareous where it grades to unconsolidated shale and sandstone, which begin at a depth of 4 to 10 feet.

Duval Series.—Duval soils are well-drained Reddish Chestnut soils of the uplands. They developed over undifferentiated sand, clay, and sandstone formations of the Wilcox group. Soils of this series are inextensive in Bexar County. They occur as scattered areas in the southern third of the county. They are mainly gently sloping, but the slope range is 1 to 6 percent.

Duval soils are less slowly permeable and are less clayey in the B horizon than Webb soils. They are less brown, less clayey, and less slowly permeable than San Antonio soils, which have a distinct horizon of calcium carbonate accumulation within 60 inches of the surface. As compared with Hockley soils, they have a darker colored A horizon, are more permeable, and have a less clayey B horizon that lacks mottles.

A typical profile of Duval fine sandy loam is just off Farm-to-Market Road 1518 (Rockport Road), 0.3 mile west of U.S. Highway No. 281 South; the site is in a cultivated field, 100 feet north of the road.

Ap—0 to 7 inches, brown (7.5YR 5/4) light fine sandy loam; dark brown (7.5YR 4/4) when moist; structureless; nonsticky and nonplastic when wet, very friable when moist, soft and loose when dry and winnowed; pH 6.5; abrupt, smooth boundary.

A1—7 to 14 inches, reddish-brown (5YR 5/4) fine sandy loam; darker reddish brown (5YR 4/4) when moist; weak, granular structure; nonsticky and nonplastic when wet, very friable when moist, soft when dry; pH 6.5; abrupt, smooth boundary.

B2t—14 to 40 inches, yellowish-red (5YR 4.5/6) light sandy clay loam; yellowish red (5YR 4/6) when moist; weak, prismatic structure to weak, blocky structure; patchy clay films on peds; peds very porous; slightly sticky and slightly plastic when wet, friable when moist, hard when dry; pH 5.5; gradual, wavy boundary.

B3—40 to 54 inches, yellowish-red (5YR 5/6) light sandy clay loam; yellowish red (5YR 4/6) when moist; weak, prismatic structure to massive; very porous; slightly sticky and slightly plastic when wet, friable to firm but crumbly when moist, hard when dry; pH 6.0; gradual, wavy boundary.

C—54 to 62 inches +, very pale brown (10YR 7/4) light sandy clay loam to loam mixed with weakly cemented sandstone; light yellowish brown (10YR 6/4) when moist; massive and compacted; nonplastic and nonsticky when wet, very friable when moist, soft to slightly hard when dry; pH 6.0.

The color of the A horizon ranges from dark reddish brown to brown (hues of 2.5YR and 7.5YR, dry values of 3 to 5, and chromas of 2 to 4). The thickness is typically about 14 inches but ranges from 10 to 26 inches. The texture ranges from fine sandy loam to loamy fine sand.

The color of the B horizon ranges from reddish brown to yellowish red (hues of 2.5YR and 5YR, dry values of 4 to 5, and chromas of 5 to 6). The thickness of this horizon ranges from 20 to 44 inches. The texture ranges from heavy fine sandy loam to a light sandy clay loam; the clay content is 17 to 25 percent. The B horizon appears massive, but in open pits and road cuts it can be seen to have a weak, coarse, prismatic or a weak, coarse, blocky structure. The peds in the B2t horizon are partially coated with thin clay films. The peds are porous and have some dark stains on the surfaces.

The underlying material is yellowish to reddish sandy clay loam interbedded with soft, red and yellow, weakly cemented sandstone. The yellow strata are glauconitic.

Eufaula Series.—The Eufaula series consists of deep, loose, well-drained, pale-brown sandy soils that developed over the Carrizo sand formation. Soils of this series occur in the extreme southern part of Bexar County and are fairly extensive. The topography is gently sloping to billowy or undulating; the slope range is 1 to 10 percent.

Eufaula soils are sandier than either Hockley or Duval soils and have a thicker surface layer and a less clayey subsoil. They are more sloping, sandier, and less clayey than Crockett soils.

A typical profile of Eufaula fine sand is 2.4 miles south of the intersection of U.S. Highway No. 281 and Farm-to-Market Road 1518 (Rockport Road); the site is in a pasture, between 60 and 70 feet west of the highway.

A11—0 to 7 inches, light brownish-gray (10YR 6/2) fine sand; dark grayish brown (10YR 4/2) when moist; single grain; nonsticky and nonplastic when wet, loose when moist, loose when dry; pH 6.0; clear, wavy boundary.

A12—7 to 42 inches, very pale brown (10YR 7/3) fine sand; brown (10YR 5.5/3) when moist; single grain; nonplastic and nonsticky when wet, loose when moist, loose when dry; pH 6.0; abrupt, wavy boundary.

B and C1—42 to 80 inches, pale-brown (10YR 6/3) fine sand; nearly continuous, alternate bands of yellowish-red (5YR 5/6 dry) sandy loam, ¼ to ½ inch thick and 2 to 4 inches apart; structureless; fine sand strata slightly hard when dry; sandy loam strata hard when dry, very friable to friable when moist; pH 6.5; gradual, wavy boundary.

C2—80 to 120 inches, red (2.5YR 5/6) light sandy clay loam; red (2.5YR 5/6) when moist; massive; slightly sticky when wet, friable when moist, extremely hard when dry; pH 6.5 to 7.0.

The thickness of the A horizon ranges from 30 inches to more than 72 inches in thickness. The color of the thin A11 horizon ranges from grayish brown to pale brown (hue of 10YR, dry values of 4 to 6, and chromas of 2 to 3). The texture of this layer is fine sand.

The thickness of the B and C1 horizon ranges from 12 inches to more than 72 inches. The bands, or lenses, are ⅛ to ½ inch thick and 2 to 6 inches apart. The lenses are brittle when dry but are friable and easily crushed when moist.

Frio Series.—The Frio series consists of calcareous, nearly level, moderately deep, grayish-brown or dark grayish-brown, poorly drained to moderately well drained soils. These soils are on bottom lands and are subject to occasional overflow. They are developing from fine-textured and medium-textured alluvial sediments transported from nearby slopes. The vegetation consists of grass, brush, and trees.

Frio soils are more clayey, darker colored, less limy, and less sloping than Karnes soils; they are more deeply developed, more limy, and lighter colored than Gowen soils; and they are less brown, less clayey, and less deeply developed than Lewisville soils. Frio soils are similar to Venus soils, which occur on the higher terraces, but they are more stratified and receive accumulations of sediments. They are also similar to Patrick soils, which have gravel within 3 feet of the surface and are less deeply developed.

A typical profile of Frio clay loam is in the southwestern part of the county, on the flood plain where Pearsall Road crosses the Medina River; the site is about 200 feet northwest of the crossing.

A11—0 to 20 inches, grayish-brown (10YR 5/2) clay loam; dark grayish brown (10YR 4/2) when moist; weak, granular structure; slightly sticky when wet, friable when moist, hard when dry; numerous pores 1 millimeter in size; a few worm casts and fragments of snail shells; calcareous; pH 8.0; gradual boundary.

A12—20 to 25 inches, light brownish-gray (10YR 6/2) clay loam; grayish brown (10YR 5/2) when moist; weak, granular structure; slightly sticky when wet, firm but crumbly when moist, hard when dry; calcareous; pH 8.0; gradual boundary.

C1—25 to 35 inches, pale-brown (10YR 6/3) clay loam; brown (10YR 5/3) when moist; massive; slightly sticky when wet, firm but crumbly when moist, hard when dry; strongly calcareous; pH 8.0; gradual boundary.

C2—35 to 84 inches +, very pale brown (10YR 7/3) loam stratified with thin layers of clay loam and sandy loam; pale brown (10YR 6/3) when moist; massive; slightly sticky when wet, firm but crumbly when moist, hard when dry; strongly calcareous.

The thickness of the A11 horizon ranges from 8 to 25 inches. The texture, as a result of the deposition and reworking of sediments by floodwater, ranges from clay loam to loam. The color of this horizon ranges from grayish brown to dark grayish brown (hue of 10YR, dry values of 4 to 5, and chroma of 2).

The thickness of the A12 horizon ranges from 5 to 20 inches, and the texture from silty clay loam and clay loam to loam. The color ranges from light brownish gray to brown (hue of 10YR, dry values of 5 to 6, and chromas of 2 to 3).

Below a depth of 25 to 30 inches, the texture ranges from light loam to stratified loam and clay loam. Water-rounded limestone gravel occurs at a depth of 36 inches to more than 72 inches.

Gowen Series.—The Gowen series consists of deep, dark grayish-brown, noncalcareous soils on bottom lands. These soils are developing from fine-textured and medium-textured recent alluvium transported from nearby slopes. They are inextensive in Bexar County and occur as nearly level areas on the flood plains of the major creeks that drain the eastern and southeastern parts of the county. The vegetation is grass.

Gowen soils are lighter colored, less limy, and less clayey than Trinity soils; they are darker colored and less sandy than Zavala soils; and they are less alkaline than Frio soils.

A typical profile of a cultivated Gowen clay loam is just off Farm-to-Market Road 1346, about a quarter of a mile southeast of St. Hedwig; the site is in a field, approximately 300 yards west of the road.

Ap—0 to 7 inches, dark-brown (10YR 4/3) clay loam; very dark grayish brown (10YR 3/2) when moist; weak, granular structure; slightly sticky and plastic when wet, firm when moist, very hard when dry; pH 6.0; clear, smooth boundary.

A1—7 to 48 inches, dark grayish-brown (10YR 4/2) light clay loam; very dark brown (10YR 2/2) when moist; massive; porous; slightly sticky when wet, friable when moist, slightly hard when dry; pH 5.6.

C—48 to 60 inches +, grayish-brown (10YR 5/2) clay loam; dark grayish brown (10YR 4/2) when moist; thin strata of sandy loam and sandy clay; massive; porous; pH 7.0.

The thickness of the Ap horizon ranges from 6 to 10 inches. The color ranges from very dark grayish brown to brown (hue of 10YR, dry values of 2 to 5, and chromas of 1.5 to 3). The darker colors occur where the soils are slightly finer textured and are in native vegetation. The texture is predominantly light clay loam.

The thickness of the A1 horizon ranges from 36 to 54 inches. The texture ranges from heavy loam to clay loam; the estimated clay content is 22 to 35 percent. This horizon is medium acid to neutral and is noncalcareous.

The substratum below a depth of 48 to 54 inches is variable. The texture is likely to range from sandy clay, mottled in places, to stratified sandy loam and clay loam.

Hockley Series.—The Hockley series consists of deep, well-drained, pale-brown loamy fine sands that developed over undifferentiated sand and sandy clay of the Wilcox and Claiborne groups. Soils of this series occur on the sandy upland prairies in the southern third of the county. The slope range is 0 to 5 percent.

Hockley soils are associated with Crockett, San Antonio, Eufaula, Duval, and Webb soils. They are more sloping, more sandy, and lighter colored than Crockett soils, which have a well-defined layer of lime accumulation; they are lighter colored and have a less clayey surface layer and subsoil than San Antonio soils, which have an unmottled subsoil; and they have a thinner, less sandy, darker colored surface layer than Eufaula soils. Hockley soils are less red throughout the profile and have a less loamy, less permeable subsoil than Duval soils, which have a massive, unmottled subsoil. They are sandier and less red than Webb soils, which have a blocky, unmottled, red subsoil.

A typical profile of Hockley loamy fine sand is in the southeastern part of the county, just west of Elmendorf, near the intersection of Farm-to-Market Road 1518 and Borregas Road; the site is in a cultivated field, 120 feet south of the road.

Ap—0 to 8 inches, pale-brown (10YR 6/3) loamy fine sand; dark brown (10YR 4/3) when moist; weak, granular structure; nonsticky when wet, very friable when moist, loose when dry; pH 6.0; clear, smooth boundary.

A12—8 to 16 inches, pale-brown (10YR 6/3) loamy fine sand; dark brown (10YR 4/3) when moist; weak, granular structure; nonsticky when wet, very friable when moist, loose when dry; pH 6.0; abrupt, smooth boundary.

B21t—16 to 20 inches, yellowish-brown (10YR 5/4) sandy clay loam; dark yellowish brown (10YR 4/4) when moist; few, faint mottles of yellowish red (5YR 5/6 moist); massive to weak, blocky structure; sticky and slightly plastic when wet, firm when moist, very hard when dry; slightly darker coatings on ped surfaces; pH 5.5; clear, wavy boundary.

B22t—20 to 33 inches, yellowish-brown (10YR 5/4) sandy clay loam; slightly more clayey than the B21t horizon; dark yellowish brown (10YR 4/4) when moist; common, fine, distinct mottles of yellowish red (5YR 5/6 moist); moderate, fine, blocky structure; sticky and plastic when wet, firm when moist, very hard when dry; pH 5.6; gradual, wavy boundary.

B3—33 to 40 inches, yellowish-red (5YR 5/6) sandy clay loam; yellowish red (5YR 4/6) when moist; a few, fine, distinct mottles of red (10R 4/6 moist) and light yellowish brown (10YR 6/4 moist); moderate, medium, blocky structure; firm when moist, hard when dry; pH 6.5; gradual, wavy boundary.

C—40 to 60 inches +, reddish-yellow (7.5YR 6/6) sandy clay loam; strong brown (7.5YR 5/6) when moist; interbedded with weakly cemented sandstone; slightly sticky when wet, friable when moist; contains a few $CaCO_3$ concretions (less than 1 percent by volume); pH 7.0.

The thickness of the A horizon ranges from 12 to 25 inches. The texture is typically loamy fine sand, but in some areas the surface layer has been winnowed and the texture is almost fine sand. The color of this horizon ranges from pale brown to brown (hues of 7.5YR and 10YR, dry values 4 to 6, and chromas of 2 to 4).

The thickness of the B horizon ranges from 17 to 30 inches. The texture is sandy clay loam; the estimated clay content is 22 to 35 percent. The color ranges from brown to yellowish brown (hues of 7.5YR and 10YR, dry values of 4 to 5, and chromas of 2 to 6). The mottles in this horizon range from faint to prominent and are yellowish red, red, and brownish yellow. The peds in the B2t horizon have distinct coatings on their surface. On the gently sloping areas where Hockley soils are associated with Crockett soils, the ped surfaces are coated and stained with darker colors in the upper 2 to 4 inches of the B2t horizon.

The C horizon ranges from yellowish red to reddish yellow in color and from sandy clay loam to light sandy clay in texture.

Depth to the accumulation of calcium carbonate ranges from 46 to 84 inches. The amount of calcium carbonate ranges from a few concretions to an estimated 5 percent by volume. About 23 percent of the acreage has calcium carbonate accumulations within 60 inches of the surface.

Hockley soils are medium acid to slightly acid in the upper part of the profile and become more alkaline with depth.

HOUSTON SERIES.—The Houston series consists of well-drained, dark grayish-brown to brown Grumusols that developed over strongly calcareous clays of the Taylor and Navarro formations, under a cover of grass. Soils of this series occur in the northeastern, eastern, south-central, and southwestern parts of the county. The slope range is 0 to 10 percent.

Houston soils have a thinner, lighter colored surface layer than Houston Black soils; they are less sloping, more deeply developed, less limy, and somewhat darker colored than Sumter soils; they are more clayey, less limy, less granular, and less permeable than Austin soils; and they are more deeply developed, lighter colored, less granular, and less permeable than the very shallow Tarrant soils that have a chalk substratum.

A typical profile of Houston clay is just off Miller Road, 0.4 mile northwest of Gibbs-Sprawl Road; the site is in a pasture, approximately 90 feet south of Miller Road.

A11—0 to 14 inches, grayish-brown (2.5Y 4.5/2) clay; dark grayish brown (2.5Y 3.5/2) when moist; weak, fine and very fine, blocky structure; sticky and plastic when wet, extremely firm but crumbly when moist, extremely hard when dry; calcareous; pH 8.0; 1 to 2 percent of the surface is covered with rounded chert fragments and quartzite gravel ¼ inch to 2½ inches in diameter; gradual boundary.

A12—14 to 25 inches, grayish-brown (2.5Y 5/2) clay; dark grayish brown (2.5Y 4/2) when moist; moderate, fine, blocky (wedge-shaped) structure; sticky and plastic when wet, extremely firm but crumbly when moist, extremely hard when dry; calcareous; pH 8.0; contains a few, fine $CaCO_3$ concretions; gradual boundary.

AC—25 to 44 inches, light yellowish-brown (2.5Y 6/4) clay; light olive brown (2.5Y 5/4) when moist; common streaks of grayish brown (2.5Y 5/2 dry); moderate, fine, blocky (wedge-shaped) structure; sticky and plastic when wet, extremely firm when moist, extremely hard when dry; 5 to 8 percent, by volume, hard and soft $CaCO_3$ concretions; strongly calcareous; pH 8.0; gradual, wavy boundary.

C—44 to 62 inches +, pale-yellow (2.5Y 7/4), strongly calcareous clay; light yellowish brown (2.5Y 6/4) when moist; contains mottles of grayish brown (2.5Y 5/2 dry); massive; extremely firm when moist. extremely hard when dry; contains a few (1 percent or less by volume), very fine, hard $CaCO_3$ concretions and a few (less than 1 percent by volume) shale partings.

The combined thickness of the A11, A12, and AC horizons varies within short distances and ranges from 24 to 62 inches. The horizon boundaries are wavy, depending on the microrelief. The solum is thinner on the microridges than in the microdepressions.

The color of the A11 and A12 horizons ranges from very dark grayish brown to light olive brown (hues of 10YR and 2.5Y, dry values of 3 to 5, and chromas of 1 to 3). The lighter colors occur where Houston soils are associated with Austin and Tarrant soils, and the darker colors occur where they are associated with Houston Black soils.

The color of the AC horizon ranges from dark grayish brown to light yellowish brown (hues of 10YR and 2.5Y, dry values of 4 to 6, and chromas of 2 to 4). The thickness of this horizon ranges from 12 to 24 inches.

The color of the C horizon ranges from pale yellow to olive yellow (hue of 2.5Y). This horizon may be mottled with yellow and may contain altered shale fragments that retain the shape of the original cleavage plane. There are gypsum crystals in most places.

Houston soils are mildly to strongly calcareous. In places there are rounded fragments of chert and quartzite gravel. These fragments range from ¼ inch to 2½ inches in diameter and cover 1 to 3 percent of the surface.

HOUSTON BLACK SERIES.—The Houston Black series consists of well-drained, black or dark-gray, noncrusty Grumusols that developed in calcareous clay and marl of the Taylor and Navarro formations. Soils of this series occur mainly in the northeastern, south-central, and southwestern parts of the county. They are extensive and agriculturally important. They are predominantly gently sloping, but the slope range is 0 to 8 percent.

Houston Black soils are darker colored, less granular, less permeable, less limy, and more clayey than Austin soils; they are less brown and generally less sloping than Houston soils; they are darker colored than the very shallow, gravelly Tarrant soils that developed over chalk; and they are darker colored, more deeply developed, and typically less sloping than Sumter soils.

A typical profile of a cultivated Houston Black clay is just off Foster Road, three-quarters of a mile north of its intersection with Benz-Englemann Road; the site is in a field, approximately 100 feet west of Foster Road.

Ap—0 to 8 inches, very dark gray (10YR 3/1) clay; black (10YR 2/1) when moist; weak, very fine, blocky structure; sticky and plastic when wet, extremely firm and crumbly when moist, extremely hard when dry; calcareous; pH 8.0; 3 to 5 percent of the surface is covered with chert or quartzite gravel ¼ inch to 2½ inches in diameter; abrupt boundary.

A1—8 to 38 inches, very dark gray (10YR 3/1) clay; black (10YR 2/1) when moist; moderate, fine and very fine, blocky (wedge-shaped) structure; sticky and plastic when wet, extremely firm when moist, and extremely hard when dry; the lower 12 to 14 inches contains a few, fine, hardened $CaCO_3$ concretions; calcareous; pH 8.0; diffuse boundary.

AC—38 to 50 inches, gray (10YR 5/1) clay; dark gray (10YR 4/1) when moist; common streaks of grayish brown and olive brown; moderate, medium, blocky (wedge-shaped) structure; sticky and plastic when wet, extremely firm when moist, extremely hard when dry; contains a few, very fine crystals of gypsum and a few, fine, hard and soft $CaCO_3$ concretions; pH 8.0; gradual boundary.

C—50 to 62 inches +, very pale brown (10YR 7/4) clay; light yellowish brown (10YR 6/4) when moist; a few, fine, distinct mottles of olive brown and gray; weak, blocky structure; sticky and plastic when wet, extremely firm when moist, extremely hard when dry; common, medium, hard and soft $CaCO_3$ concretions and a few, very fine gypsum crystals.

The texture of the Ap, A1, and AC horizons is clay. The thickness of the solum ranges from 28 to 60 inches.

The color of the Ap and A1 horizons ranges from black to dark gray (hues of 10YR and 2.5Y, dry values of 2 to 4, and chroma of 1). The combined thickness of these horizons is 28 to 40 inches. Quartzite gravel or subrounded fragments of chert, ¼ inch to 3 inches in diameter, may cover as much as 8 percent of the surface. (If they cover more than 8 percent of the surface, the soil is mapped as Houston Black gravelly clay.)

The color of the AC horizon ranges from dark gray to grayish brown (hues of 10YR and 2.5Y, dry values of 4 to 5, and chromas of 1 to 2). The thickness ranges from 10 to 24 inches. A few, fine and very fine crystals of gypsum and concretions of calcium carbonate may occur in the lower part of this horizon.

About 20 percent of the acreage of Houston Black clay has a discontinuous layer, 10 to 24 inches thick, that is 30 to 60 percent gravel. The fragments are ½ inch to 3 inches in diameter.

The C horizon of Houston Black clay, which is an upland soil, differs from that of Houston Black clay, terrace. The C horizon of the upland soil consists of calcareous clay, marly clay, and shaly clay, and it ranges in color from light gray to light yellowish brown. In the C horizon of the terrace soil, the texture ranges from clay loam to sandy loam, the color ranges from reddish yellow through dark brown to light gray, and there is a stratum consisting of soft concretions of calcium carbonate that range from ¼ inch to 3 inches in diameter. A stratum of gravel may occur in some profiles at a depth of 6 to 12 feet.

Karnes Series.—The Karnes soils are well-drained, highly calcareous, light brownish-gray loams that developed in strongly calcareous loamy alluvium. Soils of this series are not extensive in Bexar County. They occur on high bottoms or stream terraces, some 5 to 30 feet above the present streambeds. They are predominantly nearly level to moderately sloping.

Karnes soils are more friable, are lighter colored, and contain more free lime than the nearby Frio soils; they are lighter colored and less clayey than the terrace phases of Houston Black soils; and they are lighter colored, have weaker horizonation, are less clayey, and have a less distinct horizon of lime accumulation than Lewisville soils.

A typical profile of a cultivated Karnes loam is in the southwestern part of the county, near the northwest corner of the intersection of Gross Lane and Mechler Road; the site is in a field, 50 feet from the corner.

Ap—0 to 8 inches, light brownish-gray (10YR 6/2) loam; grayish brown (10YR 5/2) when moist; weak, granular structure; slightly sticky when wet, very friable when moist, and slightly hard when dry; strongly calcareous; pH 8.0; clear, smooth boundary.

A11—8 to 20 inches, light brownish-gray (10YR 6/2) loam; grayish brown (10YR 5/2) when moist; moderate, fine, granular structure; slightly sticky when wet, very friable when moist, and slightly hard when dry; strongly calcareous; pH 8.0; gradual boundary.

A12—20 to 38 inches, light brownish-gray (10YR 6/2) loam; brown (10YR 5/3) when moist; weak to moderate, fine, granular structure; slightly sticky when wet, very friable when moist, slightly hard when dry; strongly calcareous; pH 8.0; contains fine, segregated threads of $CaCO_3$ (approximately 1 to 2 percent by volume); gradual or clear boundary.

IIC—38 to 60 inches +, very pale brown (10YR 7/4) loamy alluvium; light yellowish brown (10YR 6/4) when moist; strongly calcareous; pH 8.0.

The thickness of the solum ranges from 20 to 44 inches.

The color of the Ap and A11 horizons ranges from dark grayish brown to brown (hue of 10YR, dry values of 4.5 to 6, and chromas of 2 to 3). The texture is predominantly loam but ranges from light clay loam to silt loam and loam. The combined thickness of these horizons ranges from 8 to 24 inches.

The color of the A12 horizon ranges from light gray to yellowish brown (hue of 10YR, dry values of 5 to 7, and chromas of 2 to 4). The texture is the same as that of the Ap and A11 horizons. The thickness ranges from 10 to 25 inches.

The texture of the C horizon ranges from sandy clay loam through loam to sandy loam. The color ranges from yellow to very pale brown. If present, the gravel stratum is at a depth of 4 to 10 feet. Pebbles are water rounded, are coated with calcium carbonate, and range from ¼ inch to 2½ inches in diameter.

Krum Series.—The Krum series consists of well-drained, very dark gray to dark-brown, calcareous, granular soils that are developing under grass in slope alluvium washed from limestone prairies. Soils of this series occur in the northern third of the county. The slope range is 1 to 7 percent.

Krum soils are lighter colored and deeper than Tarrant soils; they are darker colored, more deeply developed, and less limy than Brackett soils; they resemble Lewisville soils but are typically more sloping and occur in different topographic positions; they are more deeply developed than Patrick soils, which have gravel within 3 feet of the surface; and they are more deeply developed, have stronger horizonation, and are less stratified than Trinity and Frio soils, frequently flooded.

A typical profile of Krum clay is just off Borgfeld Drive, 0.7 mile east of its intersection with Blanco Road; the site is about 400 feet south of the road, in a pasture.

A11—0 to 18 inches, very dark grayish-brown (10YR 3/2) clay; very dark brown (10YR 2/2) when moist; moderate, fine and very fine, granular structure; sticky and plastic when wet, firm but crumbly when moist; calcareous; pH 8.0; contains very fine (1 millimeter in diameter), subrounded fragments of limestone (approximately 1 to 2 percent by volume); gradual boundary.

A12—18 to 26 inches, dark grayish-brown (10YR 4/2) clay; very dark grayish brown (10YR 3/2) when moist; moderate, fine and very fine, granular structure; sticky and plastic when wet, firm but crumbly when moist; calcareous; pH 8.0; contains very fine (1 to 2 millimeters in diameter), subrounded fragments of limestone (approximately 2 to 3 percent by volume); wavy boundary.

A13—26 to 36 inches, grayish-brown (10YR 5/2) clay; dark grayish brown (10YR 4/2) when moist; moderate, fine and very fine, granular and subangular blocky structure; sticky and plastic when wet, firm but crumbly when moist; calcareous; pH 8.0; contains very fine (1 to 2 millimeters in diameter), subrounded fragments of limestone (approximately 2 to 3 percent by volume); gradual boundary.

AC—36 to 50 inches, dark yellowish-brown (10YR 4/4) clay; dark yellowish brown (10YR 3/4) when moist; weak, subangular blocky structure; sticky and plastic when wet, firm to very firm when moist; calcareous; pH 8.0; contains very fine (1 to 2 millimeters in diameter), subrounded fragments of limestone (approximately 3 to 5 percent by volume); gradual boundary.

C—50 to 62 inches +, yellowish-brown (10YR 5/4) clay; dark yellowish brown (10YR 4/4) when moist; weak, subangular blocky structure; sticky and plastic when wet, very firm when moist; strongly calcareous; pH 8.0; contains very fine and fine, subrounded fragments of limestone and hard concretions of $CaCO_3$ (approximately 5 to 7 percent by volume).

The A horizon ranges from 18 to 36 inches in thickness and from clay to clay loam in texture. In color it ranges from very dark brown to brown (hue of 10YR, dry values of 2 to 5, and chromas of 2 to 3).

The color of the AC horizon ranges from brown to light yellowish brown (hues of 10YR and 7.5YR, dry values of 4 to 6, and chromas of 3 to 4).

The C horizon is at a depth of 40 to 55 inches. It ordinarily consists of yellowish-brown clay to marl mixed with scattered, subrounded fragments of hard limestone.

There are scattered, large fragments of hard limestone on the surface in places.

LEMING SERIES.—The Leming series consists of well-drained, light-colored, sandy Planosols that intergrade toward Reddish Chestnut soils. These soils developed over calcareous sandy clay loam and sandy clay formations of the Wilcox group. They occur in the southern third of the county. They are nearly level and gently sloping.

Leming soils are associated with Eufaula, Hockley, Crockett, and Orelia soils. They are less sandy than Eufaula soils, which consist of fine sand to a depth of more than 30 inches; they have a blocky B2t horizon that is firmer and more clayey than that of Hockley soils; they are lighter colored throughout the solum than Crockett soils, which lack a lighter colored A2 horizon; and they have a less gray, less loamy A horizon and a more mottled Bt horizon than Orelia soils.

A typical profile of a cultivated Leming loamy fine sand is in the southwestern part of the county, near Somerset; the site is in a cultivated field, 150 feet south of Briggs Road and 1.3 miles west of its intersection with Kenny Road.

Ap—0 to 6 inches, light brownish-gray (10YR 6/2) loamy fine sand; dark grayish brown (10YR 4/2) when moist; structureless; nonsticky and nonplastic when wet, very friable when moist, loose when dry; medium acid; pH 6.0; clear, smooth boundary.

A1—6 to 19 inches, grayish-brown (10YR 5/2) loamy fine sand; very dark grayish brown (10YR 3/2) when moist; structureless; nonsticky and nonplastic when wet, very friable when moist, loose when dry; medium acid, pH 6.0; clear, wavy boundary.

A2—19 to 22 inches, light grayish-brown (10YR 6/2) loamy fine sand; grayish brown (10YR 5/2) when moist; structureless; nonsticky and nonplastic when wet, friable when moist, slightly hard when dry; medium acid; pH 6.0; abrupt boundary.

B21t—22 to 28 inches, grayish-brown (10YR 5/2) sandy clay; dark grayish brown (10YR 4/2) when moist; common, fine, distinct mottles of yellowish brown and gray; moderate, medium, blocky structure; extremely hard when dry, very firm and dense when moist; slightly darker coatings on ped surfaces; few fine pores; slightly acid; pH 6.5; gradual lower boundary.

B22t—28 to 42 inches, light brownish-gray (10YR 6/2) light sandy clay; brown (10YR 5/3) when moist; few, medium, yellowish-brown, strong-brown, and gray mottles; weak, blocky structure; extremely hard when dry, very firm and dense when moist; contains a few weakly cemented ferromanganese concretions in lower part; a few pores; pH 7.0; gradual lower boundary.

C1ca—42 to 46 inches, light-gray (10YR 7/2) heavy sandy clay loam; light brownish gray (10YR 6/2) when moist; few, distinct, coarse, strong-brown and grayish mottles; weak, blocky structure; very hard when dry, very firm when moist; contains fine, hard $CaCO_3$ concretions (approximately 5 percent by volume) and a few, soft ferromanganese concretions; weakly calcareous; pH 8.0; gradual lower boundary.

C2—46 to 60 inches +, light-gray (10YR 7/2) heavy sandy clay loam; light brownish gray (10YR 6/2) when moist; structureless; very hard when dry, very firm when moist; contains a few, fine, hard $CaCO_3$ concretions; alkaline to weakly calcareous; pH 8.0.

The combined thickness of the A horizons is typically about 20 inches but ranges from 13 to 30 inches.

The color of the Ap and A1 horizons ranges from grayish brown to light brownish gray (hues of 10YR and 2.5Y, values of 5 to 7, and chromas of 1 to 2). Reaction ranges from medium acid to neutral.

The A2 horizon ranges from light gray to light brownish gray in color when dry. If the combined thickness of the A horizons is less than 16 inches, the A2 horizon may be lacking. The boundary between the A2 and B21t horizons ranges from abrupt to clear.

The texture of the Bt horizon ranges from dense sandy clay loam to very firm sandy clay or light clay; the clay content is an estimated 30 to 48 percent. The color ranges from grayish brown through light brownish gray to light gray. Mottles are few to common and are yellowish brown to strong brown or pale olive. Accumulations of calcium carbonate range from none to about 10 percent by volume.

The parent material consists of noncalcareous to weakly calcareous, light-colored, faintly to prominently mottled sandy clay loam to sandy clay. Reaction is neutral to strongly alkaline.

LEWISVILLE SERIES.—The Lewisville series consists of deep, dark grayish-brown to brown, well-drained soils. These soils developed under grass from calcareous alluvial sediments of ancient age. They occur on nearly level to gently sloping terraces above the flood plains of the San Antonio and Medina Rivers and their main tributaries.

Lewisville soils are deeper than Patrick soils, which have beds of gravel within 3 feet of the surface; they are browner, less clayey, and more friable than Houston Black soils; they are more deeply developed and less clayey than Austin soils; and they are less gray, are less loamy, and contain less free lime than Venus soils.

A typical profile of a cultivated Lewisville silty clay is just off Schaefer Road, 0.85 mile east of Farm-to-Market Road 1518; the site is approximately 100 feet north of Schaefer Road.

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silty clay; very dark brown (10YR 2/2) when moist; weak, fine and very fine, granular and subangular blocky structure; crumbly and friable when moist, hard when dry; calcareous; few, very fine, hard $CaCO_3$ concretions; pH 8.0; clear, smooth boundary.

A1—6 to 24 inches, very dark grayish-brown (10YR 3/2) silty clay; very dark brown (10YR 2/2) when moist; moderate to strong, fine, blocky structure; firm and crumbly when moist, hard when dry; strongly calcareous; pH 8.0; contains a few, very fine and fine $CaCO_3$ concretions; gradual boundary.

AC—24 to 44 inches, brown (7.5YR 5/4) silty clay; dark brown (7.5YR 4/4) when moist; moderate, medium and fine, blocky structure; very firm but crumbly when moist, very hard when dry; strongly calcareous; pH 8.0; contains a few, fine $CaCO_3$ concretions; gradual or diffuse boundary.

C—44 to 62 inches +, reddish-yellow (7.5YR 6/6) silty clay; strong brown (7.5YR 5/6) when moist; weak, blocky structure; firm when moist, hard when dry; very strongly calcareous; contains common, medium and fine, hard $CaCO_3$ concretions and coarse masses of limy material.

The solum is 27 to 60 inches thick. The color of the surface layer ranges from very dark grayish brown to brown (hues of 10YR and 7.5YR, dry values of 3 to 5, and chromas of 2 to 3).

The combined thickness of the Ap and A1 horizons ranges from 14 to 28 inches. The texture ranges from light clay and clay loam to silty clay; the clay content is typically about 44 percent but ranges from 32 to 55 percent.

The color of the AC horizon ranges from reddish brown to pale brown (hues of 5YR and 10YR, dry values of 4 to 6, and chromas of 2 to 4). The thickness is about 20 inches but ranges from 16 to 38 inches.

The C horizon consists of highly calcareous alluvium. It contains common to many, medium to fine $CaCO_3$ concretions, and also lumps that are as much as 1 inch in diameter. The texture ranges from silty clay to gravelly loam. The color ranges from reddish brown to very pale brown (hues of 5YR and 10YR, dry values of 4 to 7, and chromas of 3 to 4). Strata or beds of water-rounded, limestone pebbles coated with calcium carbonate may occur in the lower part of this horizon, toward the base of the alluvial mantle.

ORELIA SERIES.—Orelia soils are dark-gray Planosols that developed over calcareous clay and marl of the Wills Point clay formation. The vegetation was grass. These soils are nearly level or gently sloping. They occur in the eastern, southeastern, and southwestern parts of the county.

Orelia soils are darker colored than Crockett soils and more clayey in the surface layer. Their subsoil is more compacted than that of Crockett soils and is unmottled. They are less clayey, less sloping, and darker colored than San Antonio soils; and they are less clayey, less limy, less deeply developed, and more slowly permeable than the terrace phases of Houston Black soils.

A typical profile of Orelia sandy clay loam is in the southwestern part of the county, just off Wheeler Road, 3.5 miles north of its intersection with Luckey Road; the site is approximately 50 feet east of Wheeler Road.

Ap—0 to 6 inches, dark-gray (10YR 4/1) sandy clay loam; very dark gray (3/1) when moist; weak, granular structure to massive; slightly sticky when wet, firm but crumbly when moist, hard when dry; a thin (¼ inch), hard crust forms at the surface when the soil is dry; noncalcareous; pH 7.5; clear, wavy boundary.

A1—6 to 12 inches, dark-gray (10YR 4/1) sandy clay loam; very dark gray (10YR 3/1) when moist; moderate, fine, irregular blocky structure; firm when moist, hard when dry; noncalcareous; pH 8.0; clear, wavy boundary.

B2t—12 to 28 inches, dark-gray (10YR 4/1) sandy clay; very dark gray (10YR 3/1) when moist; moderate, medium and coarse, blocky structure; sticky when wet, very firm when moist; noncalcareous; a few, fine $CaCO_3$ concretions (less than 1 percent by volume); pH 8.0; gradual boundary.

B3ca—28 to 38 inches, gray (2.5Y N 5/0) sandy clay; dark gray (2.5Y N 4/0) when moist; moderate, medium, blocky structure; sticky and plastic when wet, very firm when moist, extremely hard when dry; calcareous; common, fine $CaCO_3$ concretions (approximately 5 percent by volume); pH 8.0; gradual boundary.

C1—38 to 46 inches, gray (10YR 6/1) clay; gray (10YR 5/1) when moist; massive; sticky and plastic when wet, extremely hard when dry; weakly calcareous; fine $CaCO_3$ concretions (approximately 2 percent by volume); also a few, fine gypsum crystals; pH 8.0; gradual boundary.

C2—46 to 60 inches +, light-gray (2.5Y 7/2) clay; light brownish gray (2.5Y 6/2) when moist; a few distinct mottles of brownish yellow; massive; sticky and plastic when wet, extremely hard when dry; weakly calcareous; hard and soft $CaCO_3$ concretions (approximately 3 to 5 percent by volume); a few, fine gypsum crystals.

The thickness of the A horizon ranges from about 7 to 17 inches. The color ranges from very dark gray to gray (hues of 10YR and 2.5Y, dry values of 3 to 5, and chromas of 0 to 1). The structure is weak, fine, granular to subangular blocky. The surface is crusty.

The thickness of the B horizon ranges from 28 to 48 inches, and the texture from sandy clay to clay. The color ranges from dark gray to gray (hues of 10YR and

2.5Y, dry values of 4 to 5, and chromas of 0 to 1). The structure is blocky (irregular) and grades from moderate to strong and from fine to coarse.

The C horizons are calcareous clays or clay loams and range from light gray to yellowish brown in color. Depth to the calcium carbonate accumulation ranges from 26 to 50 inches. Gypsum crystals are few to common and range from fine to medium in size.

PATRICK SERIES.—Patrick soils are well drained, dark brown to very dark grayish brown, granular, and calcareous. They developed from ancient alluvium. The vegetation was grass. These soils occur on terraces of the streams that drain the limestone prairies of the county. They are underlain within a depth of 3 feet by porous beds of waterworn limestone gravel. They are nearly level to gently sloping.

Patrick soils are less deeply developed than Lewisville and Karnes soils; they are shallower, less clayey, and more permeable than the terrace phases of Houston Black soils; they are shallower, less friable, more clayey, and less limy than Frio and Venus soils; and they are less deeply developed and less clayey than Krum soils and occupy a lower topographic position.

A typical profile of a Patrick soil is in the northwestern part of the county, just off Babcock Road; the site is 100 yards north of the curve of Pembroke and Rochelle Roads.

A11—0 to 12 inches, very dark grayish-brown (10YR 3/2) clay loam; very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly sticky and plastic when wet, friable when moist, slightly hard when dry; calcareous; pH 8.0; contains very fine (1 millimeter in diameter) limestone fragments (up to 5 percent by volume); gradual, clear boundary.

A12—12 to 17 inches, brown (7.5YR 4/2) clay loam; dark brown (7.5YR 3/2) when moist; moderate, fine, granular structure; slightly sticky and plastic when wet, friable when moist, slightly hard when dry; calcareous; pH 8.0; very fine (1 millimeter in diameter) limestone fragments (2 or 3 percent by volume); abrupt, smooth boundary.

IIC—17 to 60 inches +, porous bed of water-rounded limestone gravel that ranges up to 2½ inches in diameter.

The thickness of the solum is ordinarily 16 to 18 inches but ranges from 10 to 30 inches.

The thickness of the A11 horizon ranges from 10 to 16 inches. The color ranges from very dark grayish brown to dark brown (hues of 7.5YR and 10YR, dry values of 2 to 4, and chromas of 2 to 3). The texture ranges from loam through gravelly clay loam to silty clay and light clay.

The thickness of the A12 horizon ranges from 5 to 14 inches, and the texture from loam to clay loam. The color ranges from dark brown to brown (hues of 7.5YR and 10YR).

The C horizon contains fragments that range in size from pebbles an eighth of an inch in diameter to cobblestones as much as 8 inches in diameter. The larger cobblestones occur near the base of the limestone prairies, from which they were derived. In places the gravel beds are weakly to strongly cemented with calcium carbonate in the uppermost 2 to 4 inches. In some areas, particularly along Cibolo Creek in the eastern part of the county, there is a horizon of white caliche about 2 to 3 feet above the porous gravel beds. This horizon occurs where there are second-level terraces, about 30 feet above the flood plains of the creeks. It is discontinuous, is weakly to very strongly calcareous in the uppermost 2 to 3 inches, and is underlain by alternate strata of porous gravel and sandy sediments.

SAN ANTONIO SERIES.—The San Antonio series consists of deep, well-drained, dark-brown to reddish-brown soils of the Reddish Chestnut group. These soils developed over calcareous clay loam, clay, and sandstone, under a cover of grass. Soils of this series occur in the eastern and southern parts of the county. The slope range is 1 to 6 percent.

San Antonio soils are associated with Crockett soils, but they are more clayey in the surface layer than those soils, and they have an unmottled subsoil; they are redder than Orelia soils; they have a more clayey surface layer and a denser, more clayey subsoil than Webb soils; and they are less sandy and darker colored than Hockley soils.

A typical profile of San Antonio clay loam is just off Foster Road, half a mile south of Boldtville, and then half a mile west on Lodi Road; the site is in a field, approximately 75 yards west of the road.

Ap—0 to 8 inches, dark-brown (10YR 4/3) clay loam; darker brown (10YR 3/3) when moist; a few fragments of iron or chert rock scattered on the surface; cloddy; slightly sticky when wet, firm when moist, very hard when dry; noncalcareous; pH 6.5; abrupt boundary.

B2t—8 to 20 inches, dark reddish-brown (5YR 3/2) clay; darker reddish brown (5YR 2/2) when moist; strong, medium, blocky structure; very firm when moist, extremely hard when dry; distinct, continuous coatings on peds; noncalcareous; pH 6.5; gradual, clear boundary.

B3—20 to 28 inches, reddish-brown (5YR 4/4) clay; dark reddish brown (5YR 3/4) when moist; weak, blocky structure; discontinuous clay films on peds; firm when moist, extremely hard when dry; few, fine $CaCO_3$ concretions; pH 7.5; gradual boundary.

C1ca—28 to 40 inches, light yellowish-brown (10YR 6/4) clay loam; yellowish brown (10YR 5/4) when moist; few, fine, faint, reddish-yellow and brown mottles; weak, blocky structure; firm when moist, very hard when dry; fine concretions and soft lumps of $CaCO_3$ (estimated 5 to 10 percent by volume); pH 8.0; gradual boundary.

C2—40 to 60 inches +, very pale brown (10YR 7/4) clay loam; light yellowish brown (10YR 6/4) when moist; few, fine, distinct mottles of reddish yellow and brown; few, fine $CaCO_3$ concretions and scattered lumps of limy material.

The thickness of the Ap horizon ranges from 6 to 15 inches. The texture ranges from fine sandy loam through loam to sandy clay loam and clay loam. The color ranges from very dark grayish brown to brown (hues of 7.5YR and 10YR, dry values of 3 to 5, and chromas of 2 to 3).

The thickness of the B horizon ranges from 17 to 30 inches but is ordinarily about 20 inches. The texture ranges from heavy clay loam to clay; the clay content is 35 to 50 percent. The color ranges from dark reddish brown to brown (hues of 5YR and 10YR, dry values of 3 to 5, and chromas of 3 to 6). Locally, this horizon may be faintly mottled.

The horizon of carbonate accumulation is weakly to strongly expressed and is at a depth of 26 to 45 inches.

The parent material consists of calcareous clay loam, which commonly becomes less clayey with depth and may be interbedded with limestone. Sandstone partings in the C horizon range from none to common. Sandstone boulders are scattered throughout the profile.

STEPHEN SERIES.—The Stephen series consists of shallow, well-drained, very dark grayish-brown, calcareous soils that developed over the Austin chalk and Anacacho limestone formations, under a cover of grass. Soils of this series occur in the northeastern, central, and northwestern parts of the county. The slope range is 1 to 7 percent.

Stephen soils are associated with Austin, Brackett, and Houston Black soils, and Tarrant soils, chalk substratum. Stephen soils are shallower than Austin soils; they are deeper than Tarrant soils; they are darker colored than Brackett soils; and they are browner, less clayey, more limy, and less deeply developed than Houston Black soils. All of these associated soils formed from the same kind of material as Stephen soils.

A typical profile of Stephen silty clay is just off Randolph Boulevard, 0.2 mile west of the O'Connor Road intersection and the road into Robards Development; the site is in an idle field, approximately 75 yards southeast of the boulevard.

A11—0 to 15 inches, very dark grayish-brown (10YR 3/2) silty clay; very dark brown (10YR 2/2) when moist; few, fine fragments of hardened chalk; moderate, fine, granular structure; no distinct ped coatings; slightly sticky when wet, friable when moist; calcareous; gradual, lower boundary.

A12—15 to 18 inches, dark grayish-brown (10YR 4/2) silty clay; very dark grayish brown (10YR 3/2) when moist; few fragments of hardened chalk; strong, medium and fine, granular structure; slightly sticky when wet, friable when moist; calcareous; abrupt, irregular boundary.

R and A12—18 to 24 inches, rubble consisting of platy fragments of hardened chalk (stained top and bottom with fine earth); fragments are several inches in diameter; fine earth also in interstitial areas between the platy, hardened fragments. The fine earth is a dark grayish-brown (10YR 4/2) silty clay; very dark grayish brown (10YR 3/2) when moist; abrupt, lower boundary (bedding plane).

R—24 to 30 inches +, alternate beds of hard and soft, white (10YR 8/2) chalk; light gray (10YR 7/2) when moist; very hard cap at the top. The cap can be broken with a crowbar, and the underlying chalk can be cut with ditching machinery.

The thickness of the A horizon ranges from 12 to 22 inches. The color ranges from very dark gray to grayish brown (hues of 7.5YR and 10YR, dry values of 3 to 5, and chromas of 1 to 3). The texture ranges from light silty clay to heavy clay loam (about 35 to 45 percent clay). The $CaCO_3$ content of the A horizon ranges from 5 to 40 percent, and the content of chalk fragments from 0 to 15 percent, by volume.

The R and A12 horizon is 2 to 12 inches thick. The fragments in this horizon are ¼ inch to 10 inches in diameter.

SUMTER SERIES.—The Sumter series consists of well-drained, grayish-brown to yellowish-brown, calcareous, clayey Regosols that developed over strongly calcareous clay or marl of the Taylor and Navarro formations. Soils of this series occur in the northeastern, eastern, and central parts of the county. They are of minor extent. The slope range is 5 to 10 percent.

Sumter soils are lighter colored, more sloping, and less deeply developed than Houston and Houston Black soils; they are lighter colored than the Tarrant soils that developed over chalk or chalk rubble; and they are lighter colored, less deeply developed, and more strongly sloping than Stephen soils.

A typical profile of Sumter gravelly clay is just off Toepperwein Road, 1 mile east from Randolph Boulevard; the site is the steep gravelly slope to the right of the road.

A1—0 to 8 inches, grayish-brown (2.5Y 5/2) gravelly clay; dark grayish brown (2.5Y 4/2) when moist; moderate, medium, granular structure; estimated to be 5 to 8 percent chert fragments that are as much as 3 inches in diameter; slightly hard when dry, crumbly and friable when moist, sticky and slightly plastic when wet; strongly calcareous; clear or gradual boundary.

C—8 to 84 inches +, pale-yellow (2.5Y 7/4) marl or clay; light yellowish brown (2.5Y 6/4) when moist; numerous, soft and hard $CaCO_3$ concretions; many plant roots; massive; very strongly calcareous.

The thickness of the A horizon ranges from 5 to 12 inches. The texture is gravelly clay or clay. The color ranges from dark grayish brown to light olive brown (hue of 2.5Y, dry values of 4 to 5, and chromas of 2 to 4). The darker colors are on the more gentle slopes. The proportion of gravel on the surface and within the solum ranges from less than 2 percent to 15 percent, by volume. The fragments are from ¼ inch to 3 inches in diameter.

The C horizon may extend to a depth of many feet. Numerous roots extend down into this calcareous clay or marly clay.

TARRANT SERIES.—The Tarrant series consists of well-drained, very dark grayish-brown, calcareous, clayey Lithosols that developed over hard limestone of the Glen Rose and Edwards formations. These soils are extensive in Bexar County and occur throughout the limestone prairies in the northern part of the county. They are gently undulating to moderately steep; the slope range is 3 to 30 percent.

Tarrant soils are darker colored, less limy, and more clayey than Brackett soils, which developed over softer limestone; they are less deeply developed and less clayey than Crawford soils, which are noncalcareous; and they are shallower, less red, and more clayey than Bexar soils.

A typical profile of Tarrant stony clay loam is just off Tezel Road, 1 mile south of its intersection with Guilbeau Road; the site is approximately 50 feet east of Tezel Road.

A11—0 to 10 inches, very dark grayish-brown (10YR 3/2) stony clay loam; about 20 percent, by volume, angular limestone fragments that range from ¼ inch to 24 inches in diameter; very dark brown (10YR 2/2) when moist; compound moderate, fine, subangular blocky and granular structure; crumbly and friable when moist, sticky when wet; weakly calcareous; pH 7.5; abrupt, irregular boundary.

R and A12—10 to 18 inches, limestone; dark grayish-brown (10YR 4/2) clay loam (approximately 8 to 10 percent by volume) in cracks and interstitial spaces between the thin limestone strata; roots common in these filled cracks.

R—18 to 25 inches, fractured limestone.

The thickness of the A horizon ranges from 5 to 12 inches, and the texture, excluding the limestone fragments, from clay to clay loam. The color ranges from black to very dark grayish brown (hue of 10YR, dry values of 2 to 3, and chromas of 1 to 2).

Limestone fragments cover 20 to 50 percent of the surface and make up 10 to 60 percent of the solum, by volume. The fragments range from 1/4 inch to 25 inches in diameter.

TRINITY SERIES.—The Trinity series consists of deep, dark-gray clayey soils on bottom lands. These soils are developing under grass, from calcareous, fine-textured recent alluvium transported from nearby slopes. They occur along the flood plains of the major streams in the eastern and southwestern parts of the county. They are nearly level.

Trinity soils are more clayey and more slowly permeable than the lime-free Gowen soils; they are less sandy, contain less free lime, and are less permeable than Zavala soils; they are similar to the terrace phases of the Houston Black soils but are on bottom lands and are flooded occasionally; and they are darker colored, less limy, and less friable than Frio soils.

A typical profile of Trinity clay is along the north bank of Martinez Creek where Farm-to-Market Road 1516 crosses the creek; the site is about 150 feet east of the road.

A11—0 to 50 inches, dark-gray (10YR 4/1) clay; very dark gray (10YR 3/1) when moist; moderate, medium, blocky structure; sticky and plastic when wet, very firm when moist, very hard when dry; calcareous; pH 8.0; gradual boundary.

A12—50 to 65 inches +, gray (10YR 5/1) clay; dark gray (10YR 4/1) when moist; weak, blocky structure; sticky and plastic when wet, very firm when moist; calcareous; pH 8.0.

The thickness of the A horizon ranges from 40 to 70 inches. The color ranges from black to grayish brown (hues of 10YR and 2.5Y, dry values of 2 to 5, and chromas of N to 2). The texture is clay. In places there are strata of waterworn gravel 4 to 12 feet below the surface. In some places the material below a depth of 30 inches is slightly mottled.

VENUS SERIES.—The Venus series consists of deep, moderately dark colored, well-drained, calcareous Regosols that developed in loamy material containing an appreciable amount of calcium carbonate. These soils usually occupy terraces or alluvial fans. They are extensive in this county.

Venus soils are grayer, less clayey, and more permeable than Lewisville soils; they are more clayey, less sloping, and less calcareous than Karnes soils; they are similar to Frio soils, which occur on the flood plains, but they are not stratified and they have more lime accumulations than those soils; they are lighter gray, less clayey, and less slowly permeable than Houston Black clay, terrace; and they are similar to Patrick soils, which are less deeply developed and have beds of gravel within 3 feet of the surface.

A typical profile of Venus loam is about 1.4 miles east of the headquarters of Randolph Air Force Base; the site is in a cultivated field, 100 feet north of Schaefer Road and 1.10 miles northeast of Farm Road 1518.

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) heavy loam; very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; hard when dry, friable when moist; a few, fine fragments of snail shells; calcareous; pH 8.0; clear, smooth boundary.

A1—7 to 14 inches, dark grayish-brown (10YR 4/2) heavy loam; very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist; a few, fine fragments of snail shells; calcareous; pH 8.0; gradual boundary.

AC—14 to 30 inches, brown (10YR 5/3) heavy loam; dark brown (10YR 4/3) when moist; moderate, fine and very fine, subangular blocky structure and fine, granular structure; hard when dry, firm but crumbly when moist; a few worm casts and threads of $CaCO_3$; calcareous; pH 8.0; diffuse boundary.

C—30 to 62 inches, light yellowish-brown (10YR 6/4) heavy loam; yellowish brown (10YR 5/4) when moist; weak, subangular blocky structure; very hard when dry, firm but crumbly when moist; concretions and soft lumps of $CaCO_3$ (about 5 percent by volume); calcareous; pH 8.0.

The thickness of the A horizon is typically about 14 inches but ranges from 7 to 20 inches. The color ranges from dark brown to grayish brown (hues of 7.5YR and 10YR, and values of less than 3.5 when soil is moist and 5.5 when soil is dry). Reaction in the A1 horizon ranges from neutral to moderately alkaline.

The texture of the AC horizon ranges from loam to sandy clay loam or clay loam; the clay content is about 18 to 35 percent. Concretions, lumps, or threads of $CaCO_3$ in the AC and C horizons range up to 10 percent, by volume. The $CaCO_3$ equivalent of the C horizon ranges from about 10 percent to 50 percent or more. Gravel beds, some of which are several feet thick, occur at a depth of more than 36 inches in many profiles.

WEBB SERIES.—The Webb series consists of well-drained, moderately deep, reddish-brown soils of the Reddish Chestnut group. These soils developed over sandy clay, calcareous clay, and interbedded sandstone formations in the Wilcox group. They occur throughout the southern third of the county and are fairly extensive. The slope range is 0 to 7 percent.

Webb soils have a more clayey subsoil than Duval soils, which developed over similar parent material; they are less clayey in the surface layer and are lighter colored and less dense than San Antonio soils; they are lighter colored throughout the profile than Crockett soils, which have a clayey, mottled subsoil; and they are darker colored and less sandy than Hockley soils and have a thinner surface layer.

A typical profile of a cultivated Webb fine sandy loam is just off Ladd Road, 0.6 mile east of Wisdom Road and 0.2 mile west of Miles Road; the site is in a field, approximately 100 feet north of the road.

Ap—0 to 6 inches, reddish-brown (5YR 4/4) fine sandy loam; dark reddish brown (5YR 3/4) when moist; weak, fine, granular structure; hard when dry, very friable when moist, nonsticky when wet; noncalcareous; pH 7.0; clear boundary.

A1—6 to 12 inches, reddish-brown (5YR 4/3) fine sandy loam; dark reddish brown (5YR 3/3) when moist; weak, fine, granular structure; very friable when moist, slightly hard when dry; porous; noncalcareous; pH 7.0; gradual boundary.

AB—12 to 18 inches, dark reddish-brown (5YR 3/4) clay loam; darker reddish brown (5YR 3/3) when moist; weak, subangular blocky structure; friable when moist, hard when dry; noncalcareous; pH 7.0; gradual boundary.

B2t—18 to 26 inches, reddish-brown (5YR 5/4) sandy clay; reddish brown (5YR 4/4) when moist; moderate, medium and fine, blocky structure; firm when moist, very hard when dry; slightly calcareous; pH 7.5; gradual boundary.

C1ca—26 to 38 inches, light yellowish-brown (10YR 6/4) light sandy clay; yellowish brown (10YR 5/4) when moist; weak, blocky structure; extremely hard when dry, firm when moist; medium and fine, hard $CaCO_3$ concretions (approximately 30 percent by volume); common partings of fine and medium sandstone; strongly calcareous; pH 8.0; gradual boundary.

C2—38 to 48 inches +, yellow (10YR 7/6) sandy clay and interbedded sandstone; brownish yellow (10YR 6/6) when moist; soft lumps of $CaCO_3$ (5 percent by volume); calcareous.

The thickness of the A horizon is typically about 12 inches but ranges from 5 to 18 inches. The color ranges from dark reddish brown to brown (hues of 5YR and 7.5YR, dry values of 3 to 5, and chromas of 2 to 4). The texture is ordinarily fine sandy loam, but in a few places it is very fine sandy loam.

The texture of the transitional, or AB, horizon ranges from heavy fine sandy loam to sandy clay loam. The color of this horizon resembles that of the A horizon in some places and that of the B horizon in others. In some profiles the transitional horizon is lacking.

The texture of the B horizon ranges from heavy sandy clay loam through sandy clay to clay; the clay content ranges from 32 to 55 percent. The color of this horizon ranges from dark reddish brown to red (hues of 5YR to 2.5YR, dry values of 3 to 5, and chromas of 4 to 6). The B3 horizon, if present, is similar to the B2t horizon in color but is mottled locally with grayish brown to yellowish brown.

The horizon of calcium carbonate accumulation ranges from weak to prominent. The parent material ranges from reddish-yellow sandy clay loam to stratified beds of soft sandstone and yellowish-brown to yellow sandy clay. The reaction is alkaline. Locally, a few reddish sandstone fragments occur in all horizons.

Willacy Series.—The Willacy series consists of deep, well-drained, very dark grayish-brown Reddish Chestnut soils that developed from old alluvium or outwash sediments of ancient age. Soils of this series occur in the south-central part of the county. They are not extensive. They are nearly level, but the slope range is 0 to 3 percent.

Willacy soils are darker colored, less friable, and less permeable than the nearby Frio and Karnes soils; they are similar to Lewisville soils but are less clayey than those soils and are lime free in the surface layer; and they are less clayey and less slowly permeable than the terrace phases of Houston Black soils.

A typical profile of a cultivated Willacy loam is just off Mauermann Road, 1 mile west of its intersection with Old Pleasanton Road; the site is approximately 50 yards north of the road.

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) loam; very dark brown (10YR 2/2) when moist; weak, granular and subangular blocky structure; slightly sticky when wet, friable when moist; noncalcareous; pH 7.0; gradual boundary.

A1—6 to 15 inches, very dark grayish-brown (10YR 3/2) loam; very dark brown (10YR 2/2) when moist; weak, subangular blocky structure; slightly sticky when wet, friable when moist; noncalcareous; pH 7.5; gradual boundary.

B2t—15 to 34 inches, dark-brown (7.5YR 3/2) sandy clay loam; slightly more clayey than the A1 horizon; very dark brown (7.5YR 2/2) when moist; moderate to weak, fine, subangular blocky structure; friable when moist, hard when dry; pH 7.5; noncalcareous, but becomes weakly calcareous in lower part; few, fine, soft and hard $CaCO_3$ concretions; gradual boundary.

B3—34 to 54 inches, yellowish-brown (10YR 5/4) sandy clay loam; dark yellowish brown (10YR 4/4) when moist; moderate, weak, medium and fine, subangular blocky structure; firm when moist, hard when dry; strongly calcareous; contains fine, hard and soft $CaCO_3$ concretions (approximately 3 to 5 percent by volume); pH 8.0; gradual boundary.

Cca—54 to 62 inches +, very pale brown (10YR 7/4) heavy loam; light yellowish brown (10YR 6/4) when moist; weak, blocky structure; very strongly calcareous; contains hard and soft $CaCO_3$ concretions that are as much as 1 inch in diameter (approximately 20 to 25 percent by volume).

The thickness of the A horizon ranges from 12 to 20 inches, and the texture from loam to sandy clay loam. The color ranges from very dark brown to dark grayish brown (hue of 10YR, dry values of 2 to 4, and chromas of 2 to 3).

The texture of the B2t horizon ranges from loam to sandy clay loam, and the thickness from 12 to 25 inches. The color ranges from dark brown to grayish brown (hues of 10YR and 7.5YR, dry values of 3 to 5, and chromas of 2 to 4). The combined thickness of the B2t and B3 horizons is 25 to 44 inches.

The depth to the Cca horizon ranges from 35 to 56 inches. The texture of this layer ranges from heavy loam to clay loam and silty clay loam.

Zavala Series.—The Zavala series consists of deep, grayish-brown to brown soils that are developing from recent alluvial sediments transported from nearby soils. Soils of this series occur as scattered areas in the southern third of the county. They are predominantly nearly level, but the slope range is 0 to 3 percent.

Zavala soils are less clayey, lighter colored, and more sandy than Gowen soils; they are less clayey, lighter colored, and less deeply developed than Trinity soils; and they are sandier, less limy, and more permeable than Frio and Karnes soils.

A typical profile of Zavala fine sandy loam is near the county line on U.S. Highway No. 181 South, where the highway crosses Calaveras Creek; the site is 100 feet west of the highway, in a pasture south of the creek.

A11—0 to 16 inches, grayish-brown (10YR 5/2) fine sandy loam; very dark grayish brown (10YR 3/2) when moist; moderate, fine and medium, granular structure; nonplastic when wet, very friable when moist, hard when dry; slightly acid; pH 6.5; clear, smooth boundary.

A12—16 to 24 inches, gray (10YR 5/1) fine sandy loam; very dark gray (10YR 3/1) when moist; moderate, medium, granular structure; nonplastic when wet, very friable when moist, hard when dry; slightly acid; pH 6.5; gradual, smooth boundary.

C1—24 to 56 inches, dark-gray (10YR 4/1) sandy clay loam; very dark gray (10YR 3/1) when moist; massive; porous; slightly sticky when wet, friable when moist, hard when dry; slightly acid; pH 6.5; gradual boundary.

C2—56 to 62 inches +, dark-gray (10YR 5/1) light sandy clay to heavy sandy clay loam; very dark gray (10YR 3/1) when moist; massive; porous; slightly sticky and slightly plastic when wet, friable to firm when moist, hard when dry; slightly acid; pH 6.5.

The thickness of the A11 horizon ranges from 14 to 25 inches. The color ranges from dark grayish brown to brown (hue of 10YR, dry values of 4 to 5, and chromas of 2 to 3). The texture is predominantly fine sandy loam but in some small areas it is loamy fine sand and loam. The reaction ranges from alkaline to slightly acid. This horizon is noncalcareous.

The A12 horizon in some places appears to be slightly cemented when dry, but it is permeable and it softens when moistened. The color ranges from gray to brown and yellowish brown (dry value of 5, and chromas of 1 to 4). The thickness of this horizon ranges from 7 to 20 inches, and the texture from fine sandy loam through loam to sandy clay loam.

The parent material, or C horizon, consists of noncalcareous, recent alluvium. In places it is stratified with layers of loam, clay loam, or light sandy clay.

Additional Facts About the County

The recorded history of Bexar County begins in the early part of the 18th century, though Spanish explorers had camped at the site of San Antonio as early as 1600. The mission of San Antonio de Valera (the Alamo) was founded in 1718. San Antonio, then known as San Fernando de Bexar, was the first municipality in the Spanish province of Texas, and in 1772 it became the seat of government of Spanish Texas.

When Texas became independent, in 1836, Bexar County extended from the Panhandle to the Rio Grande and west to El Paso. In this area there are now 128 counties, and the present Bexar County has an area of 1,247 square miles.

San Antonio was at first a military stronghold and then the center of a livestock industry. Around 1840, new settlers, of German origin, introduced more intensive methods of farming, but livestock raising continued to dominate in the economy of the county. After the Civil War, cattle from the ranges of Southern Texas were assembled at San Antonio for the drive to midwestern markets. Railroad service, established in 1877, brought many new settlers and added to the importance of the city as a livestock center.

By 1900, the population of San Antonio was 53,000 and the population of Bexar County was 69,000. Industries related to agriculture, such as flour milling and the manufacture of farm implements, began to flourish. Lumber was brought in, and woodworking became an important industry.

Since 1900, overall expansion of the economy has been rapid. Oil has contributed indirectly to this growth, although Bexar County itself has relatively small deposits of petroleum. Since 1899, only about 17 million barrels of crude oil (approximately 1 percent of the total for the State) has been produced in this county. But there are large deposits in surrounding counties, and many producers and operators make their headquarters in Bexar County. Refineries in the county can handle about 6,000 barrels a day. Approximately 3 million cubic feet of natural gas is produced annually.

Deposits of stone, clay, sand, and gravel of commercial value are common in the county. Clay suitable for use in the manufacture of building brick, ceramic tile, and heavy clay products is mined from open pits. Limestone suitable for use in the production of cement is plentiful. Crushed limestone is prepared for use in roadbuilding, in the manufacture of concrete, and as railroad ballast.

Climate [5]

The location of Bexar County on the edge of the Gulf Coastal Plain results in a modified subtropical climate, predominantly continental in winter and marine in summer. Winters are mild, and summers are hot. Rainfall is fairly well distributed through the year, and the total is sufficient for the needs of most crops. From April through September, rain generally falls during thunderstorms, and fairly large amounts fall in a short time. In winter, most of the precipitation is in the form of light rains or drizzle, but thunderstorms and heavy rains may occur in any month. Hail of damaging intensity is infrequent, but light hail often falls during thunderstorms in spring. A measurable amount of snow falls only once in 3 or 4 years.

Table 11 gives data on average and extreme temperatures and on average, maximum, and minimum amounts of rain and snow. These data are from records kept at the local station of the U.S. Weather Bureau. Since 1942, the station has been at the San Antonio International Airport. From 1939 to 1942, it was at Stinson Field. Before 1939, it was in downtown San Antonio. Data recorded at the previous locations have been adjusted in accordance with observations made at the present site.

Northerly winds prevail during most of the winter, and southeasterly winds from the Gulf of Mexico prevail during the summertime and sometimes for long periods during the winter. No tornadoes of any consequence have been experienced in the immediate area. Tropical storms from the Gulf of Mexico, 140 miles away, occasionally cause strong winds and heavy rains in the county. A wind of 74 miles per hour, the greatest velocity recorded in the county, occurred as a tropical storm moved inland over the eastern part of the county in August 1942.

Relative humidity is close to 80 percent during the early hours of the day throughout the year and drops to around 50 percent late in the afternoon.

In San Antonio, the sun shines for about 50 percent of the daylight hours in winter, and for more than 70 percent in summer. Skies are clear more than 35 percent of the time and cloudy about 30 percent. Low stratus clouds often develop during the latter part of the night, but usually the clouds dissipate before noon and the skies are clear during the afternoon.

Temperature is affected by variations in topography, proximity to bodies of water, differences in air drainage, and differences in wind velocity and wind direction. In Bexar County, variations in topography result in significant differences in the length of the freeze-free season from one part of the county to another.

In the northern part of the county, the period between the last 32° temperature in spring and the first in fall averages 245 days, and the period between the last 28° temperature in spring and the first in fall averages 275

[5] Climatological data in this section supplied by U.S. Weather Bureau, San Antonio, Tex.

days. The average date of the last 32° temperature in spring is March 16, and the average date of the first in fall is November 16. The chance is 1 in 5 that a temperature of 32° will occur after March 31 in spring or before November 11 in fall.

In the southern part of the county, the period between the last 32° temperature in spring and the first in fall averages 275 days, and the period between the last 28° temperature in spring and the first in fall averages 305 days. The average date of the last 32° temperature in spring is March 1, and the average date of the first in fall is December 1. The chance is 1 in 5 that a temperature of 32° will occur after March 16 in spring or before November 14 in fall.

Relief and Drainage

Three physiographic resource areas are represented in Bexar County: the Edwards Plateau, the Blacklands, and the Rio Grande Plain.

The northern third of the county is part of the Edwards Plateau, a rugged, hilly area that ranges from 1,100 to 1,900 feet in elevation. The bedrock in this area consists of beds of limestone that dip slightly toward the southeast. The plateau is dissected by many small streams and is drained by Cibolo Creek and Balcones Creek. It is the location of the headwaters of Culebra Creek, Leon Creek, and Salado Creek, all of which flow southeastward.

Extending southwestward across the central part of the county is the Balcones fault zone, which makes up most of the area known as the Blacklands. This zone is underlain by fault blocks of limestone, chalk, shale, and marl. The bedrock dips gently toward the southeast. The elevation ranges from 700 to 1,000 feet, and the topography is undulating and hilly. The San Antonio River, which rises within the city limits of San Antonio and flows southeastward, drains part of the Blacklands. Other parts are drained by tributaries of the Medina River and of Cibolo Creek.

The Rio Grande Plain is a nearly level or undulating prairie. It is underlain by beds of marl, clay, sandy clay, and poorly consolidated sand that dip sharply toward the southeast. The altitude ranges from 450 to 700 feet, and the slope is toward the southeast. This area is drained by the Medina River, the San Antonio River, and Cibolo Creek, and their tributaries.

The general soil map, which is at the back of this report, shows the major drainageways of the county.

Water Supply

Underground water is abundant in most parts of Bexar County. Water to supply farms and municipalities is generally drawn from wells that tap the water stored in the Edwards limestone formation and in associated limestone formations of the Balcones fault zone. This underground reservoir is recharged partly by direct infiltration of rainwater and partly by seepage from surface streams, but mainly by underflow from streams in counties to the west. The major sources are the streams that originate in Medina, Uvalde, Bandera, Real, and Kinney Counties and that cross the limestone outcrops immediately below the Balcones escarpment. The average rate of recharge is estimated to be 465,000 acre-feet per year, or 415 million gallons per day. Approximately 200 million gallons per day is available for withdrawal in Bexar County.

The quality of the underground water stored in the limestone formations differs significantly on opposite sides of a line that starts east of Randolph Air Force Base, runs southwest, intersects U.S. Highway No. 81 south of San Antonio, and parallels that highway southwestward to the county line. Northwest of this line, the water, although hard, is chemically suitable for consumption and for irrigation. It is free of hydrogen sulfide and contains less than 500 parts per million of dissolved solids. Southeast of the line, the water contains hydrogen sulfide and generally has more than 1,000 parts per million of dissolved solids. The concentration of hydrogen sulfide increases with distance from the line. This water is not satisfactory for most uses, but it can be used for irrigation if the content of dissolved solids is moderate.

Water for livestock comes mostly from farm ponds, perennial streams and rivers, or wells. If the soil is too sandy or too shallow to permit the construction of ponds and there are no perennial streams, all water for livestock has to come from wells (*3*).

Some farmers and homeowners, mainly in the northeastern and eastern parts of the county, have to haul water or use cistern water.

Agriculture

In 1959, there were 1,950 farms in Bexar County, almost 30 percent fewer than in 1954. A total of 577,478 acres, more than 70 percent of the county area, was in farms. The average size of farms was just over 296 acres, which was less than one-third of the average for the State.

Livestock.—More than half of the acreage in farms is range, and livestock, mainly beef cattle, are a major source of agricultural income. The numbers of the principal kinds of livestock on farms in the county in 1959 were as follows:

	Number
Cattle and calves	76, 807
Milk cows	11, 995
Horses and mules	1, 457
Hogs and pigs	17, 905
Sheep and lambs	7, 948
Goats and kids	16, 506
Chickens (4 months old and over)	157, 538

Most of the beef cattle are locally raised animals of high quality. Most herds consist of purebred bulls and grade cows, but there are some purebred herds. The herds are generally culled annually, and the old or inferior animals are sold. This practice brings about a gradual improvement in the quality of the herds.

Most of the large ranches are in the northern and northwestern parts of the county. At least a few cattle are kept on almost all farms, because crop production is risky and the livestock furnish some income if a crop fails.

Beef cattle ordinarily are kept on range or improved pasture all year. During winter, cottonseed cake and bundle feed are provided to supplement the forage. Dur-

TABLE 11.—*Temperature*

[From records kept at the local station of the U.S. Weather Bureau. During the periods

Month	Temperature							Average heating-degree-days [1] [4]
	Average daily maximum [1]	Average daily minimum [1]	Monthly average [1]	Record high [2] [3]	Year	Record low [2]	Year	
	°F.	°F.	°F.	°F.		°F.		
January	62.3	41.6	52.0	87	1943	0	1949	428
February	66.1	44.7	55.4	92	1959	6	1951	268
March	72.4	49.6	61.0	97	[9] 1950	21	[9] 1948	195
April	78.8	57.6	68.2	99	1951	34	1945	39
May	85.2	65.4	75.3	101	1955	44	1954	0
June	91.6	72.2	81.9	103	1960	58	[9] 1955	0
July	94.0	73.9	84.0	106	1954	65	1942	0
August	94.2	73.4	83.8	106	1953	62	1961	0
September	88.5	68.7	78.6	102	1951	41	1942	0
October	81.5	59.6	70.6	95	1956	34	1957	31
November	70.4	48.5	59.5	91	[9] 1951	23	1959	204
December	65.4	42.0	53.7	90	1955	14	1950	263
Year	79.2	58.1	68.7	106	[9] 1954	0	1949	1,549

[1] Based on records for the period 1931–60 and adjusted to reflect observations made at present location of station.

[2] Based on a 20-year record, 1942 to 1962.

[3] Exceeded at prior location by temperature of 107° F., recorded in August 1909.

[4] Calculated from a base of 65° F.

[5] Based on a 19-year record.

ing summer, cattle may be pastured on sudangrass or other introduced grasses, in order to allow the native range grasses to rest during part of the growing season.

Cattle are sold mainly at the San Antonio stockyards, the major marketing center for the south and south-central Texas ranching country.

Dairying is of commercial importance because of the proximity of the large local market of San Antonio and the nearby military bases. Local dairies do not produce enough dairy products to supply this market, and much of the needed supply has to be shipped in from other areas. Most of the dairy herds are of high quality.

Hogs are the only livestock raised on some farms, but hog production has never been high, largely because of a shortage of suitable feed. Most of the hogs raised are marketed locally.

Horses and mules have declined sharply in numbers since the use of tractors became widespread. A few horses are still used in ranching, but most of the horses in the county are owned by riding stables or riding clubs and used solely for recreational activities.

Sheep are raised mostly on ranches in the northern and northwestern parts of the county, commonly as part of livestock enterprises that depend mainly on beef cattle. Some sheep are marketed locally for meat, but generally sheep are raised for their wool.

On many ranches, goats have replaced sheep. They are commercially valuable chiefly for mohair, but a few herds of Spanish goats are kept to supply goat milk. Some kids are marketed locally for meat. The largest goat market in the State is at the San Antonio stockyards.

Some chickens are kept on most farms and ranches. The few commercial poultry enterprises are fairly large. They partly supply the local market for poultry and poultry products.

Many kinds of crops are grown in Bexar County. The 1959 acreages of the main crops were as follows:

	Acres
Corn for grain	22,966
Corn for silage	1,333
Sorghum for grain or seed	36,540
Sorghum for silage	5,311
Small grain [1] for grain or seed	5,110
Flax for seed	519
Cotton	1,983
Potatoes (Irish)	[2] 684
Cabbage	611
Carrots	872
Sweet corn	933
Squash	146
Watermelons	505
Peanuts	2,816
	Number of trees of bearing age
Pecans (improved orchards)	3,334
Pecans (wild trees or seedlings)	9,722

[1] Oats, wheat, and barley.

[2] Does not include acreage for farms with less than 20 acres harvested.

Corn is grown on most soils of Bexar County, but it grows best on the fine-textured and medium-textured soils. Land that is to be planted to corn is generally prepared in January and February by plowing or bedding and harrowing. Planting begins in February and continues through the middle of May. Corn is planted in rows. It is usually cultivated, by tractor, two or three times before it is about 18 inches high. The crop is harvested between the latter part of August and the end of October, by mechanical pickers or by hand. Most of the corn grown in Bexar County is either sold on the local markets and milled into cornmeal or flour or is used to feed cattle on farms or local feedlots.

Sorghum is grown on all soils in the county. Unless irrigated, it does best on fine-textured and medium-tex-

and precipitation data

of records, the station has been at three different locations in the San Antonio area]

Precipitation							Snow and sleet				
Average total [1]	Maximum for month [5]	Year	Minimum for month [5]	Year	Maximum in 24-hr. period [5,6]	Year	Average total [5]	Maximum for month [5,7]	Year	Maximum in 24-hr. period [5,8]	Year
In.	*In.*		*In.*		*In.*		*In.*	*In.*		*In.*	
1.74	4.57	1958	0.25	1951	2.83	1945	0.4	4.7	1949	4.7	1949
1.65	3.90	1945	.03	1954	2.27	1958	.1	1.2	1958	1.2	1958
1.67	4.19	1957	.03	[9] 1961	2.36	1945	([10])	([10])	[9] 1959	([10])	[9] 1959
2.87	9.32	1957	.14	1955	2.77	1946	0	0	--------	0	--------
3.45	8.22	1957	.17	1961	4.29	1957	0	0	--------	0	--------
2.95	8.26	1949	.27	1956	6.18	1951	0	0	--------	0	--------
2.09	8.19	1942	([10])	1944	6.97	1958	0	0	--------	0	--------
2.36	6.15	1950	0	1952	5.57	1950	0	0	--------	0	--------
3.49	15.78	1946	.06	1947	6.87	1946	0	0	--------	0	--------
2.50	9.56	1942	([10])	1952	5.29	1942	0	0	--------	0	--------
1.37	4.47	1952	.13	[9] 1950	1.92	1952	([10])	.3	1957	.3	1957
1.75	4.16	1944	.03	1950	2.89	1944	([10])	([10])	[9] 1960	([10])	[9] 1960
27.89	15.78	1946	0	1952	6.97	1958	.5	4.7	1949	4.7	1949

[6] Exceeded at prior location by precipitation of 7.08 inches in a 24-hour period, recorded in October 1913.

[7] Exceeded at prior location by a monthly total snowfall of 6.4 inches, recorded in January 1926.

[8] Exceeded at prior location by a maximum of 24 inches in a 24-hour period, recorded in January 1940.

[9] Also occurred in earlier years.

[10] Trace.

tured soils. Land to be planted to grain sorghum is generally prepared in January and February, usually by plowing or bedding and harrowing. Grain sorghum is ordinarily planted in rows but may be drilled. Planting begins late in February and continues through April, and hegari may be planted as late as July. The crop is cultivated two or three times to kill weeds and other undesirable vegetation. Most of the crop is harvested by combine in June, July, and August. Some is cut and used for silage or is harvested in bundles for feed.

Small grains grow best on the fine-textured and medium-textured soils. The land is usually plowed and harrowed, and then, if there has been enough rainfall, the seed is planted by drilling in October and November. Oats is the small grain most extensively grown in this county, but wheat and barley are grown also. Oats and wheat are usually grazed in winter or early in spring. Both mature in May and are harvested with combines. Some of the oats is cut for hay and baled to be used for feeding livestock.

Vegetables, peanuts, watermelons, and various legumes (vetch, winter peas, Hubam clover, and others) are minor crops. The soils on which vegetables are grown undergo intensive preparation before seeding and are cultivated many times, either by tractor or by hand, while the crop is growing. Harvest is at various times of the year; the objective is to have the crop ready for harvesting at the time when its market value will be greatest. Peanuts and watermelons are planted on the coarser textured soils. The seedbed is prepared by plowing and harrowing, and the seed is planted in rows. Peanuts are cultivated once or twice while they are growing. Some are harvested as early as May or June, but under dryland farming most are harvested in August and September. Watermelons are harvested in June and July.

Industry

San Antonio is the marketing and shipping center for the south Texas agricultural region, which produces livestock, fruits and vegetables, pecans, cotton, grain sorghum, and other grains in large quantities. Food processing is the county's main nonfarm industry. Meatpacking is the most important component of this industry, economically, and brewing is second. Also significant in the economy are flour milling, pecan shelling and packaging, and the manufacture of bakery products and of Mexican foods. A substantial local garment industry produces mainly work clothing and sportswear for men and boys but also turns out uniforms and children's and infants' outerwear. Other industries include printing and publishing; the manufacture of stone, clay, glass, and fabricated metal products; and the production of machinery for road construction, of refrigerators and air conditioners, and of assorted other types of machinery.

Transportation and Markets

Bexar County is served by three major rail lines, which provide direct connections to the eastern, northeastern, and western sections of the United States. In addition, two of these lines provide connections with the principal cities in Mexico through the border cities of Laredo, Eagle Pass, and Brownsville.

Services of five airlines link Bexar County directly to the East and West Coasts and to South America, and complete connecting services facilitate rapid transport of cargo and passengers to all major points in the United States.

Approximately 30 truck lines that have terminals in San Antonio serve all the State and connect with lines serving all parts of the Nation. Truck service between San Antonio and the coastal ports of Houston, Galveston, and Corpus Christi is especially important in terms of volume. Major highways, including five United States highways, extend in all directions from San Antonio.

The network of farm-to-market roads and rural roads is excellent. Very few roads are impassable in bad weather. Most of the improved roads are of earth and gravel. Each year more are improved and hard surfaced.

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Glossary

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

Available moisture capacity. The capacity of a soil to hold water in a form available to plants. Amount of moisture held in soils between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more of less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Clay. As a soil separate, mineral soil particles that are 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. (See also Texture, soil.)

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.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors that consist of concentrations of compounds or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate ($CaCO_3$) 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; will 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.

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

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

Hardpan. A hardened or cemented soil layer.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state. In engineering, a high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Poorly graded, soil. 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; and alkaline soil is one that is alkaline in reaction. In words, the degree of acidity or alkalinity is 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	9.0 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Sand. As a soil separate, individual rock or mineral fragments 0.05 to 2.0 millimeters in diameter. Most sand grains consist of quartz, but sand may be any mineral composition. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a textural class, soil that is 80 percent or more silt and less than 12 percent clay.

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 soils includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. 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 subangluar), and *granular*. *Structureless* soils are (1) *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 profile below plow depth.

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

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," or "very fine."

Topsoil. A presumed fertile soil or soil material, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

GUIDE TO MAPPING UNITS

[See table 1, page 9, for acreage and proportionate extent of soils; see table 2, page 53, for estimates of average yields of the major crops; see table 3, page 64, table 4, page 74, and table 5, page 82, for engineering properties of the soils]

Map symbol	Mapping unit	Page	Capability unit: Dryland Symbol	Dryland Page	Irrigated Symbol	Irrigated Page	Range site Name	Range site Page
AuB	Austin silty clay, 1 to 3 percent slopes	10	IIe-3	42	IIe-3	42	Rolling Blacklands	59
AuC	Austin silty clay, 3 to 5 percent slopes	10	IIIe-5	46	IIIe-5	46	Rolling Blacklands	59
BpC	Brackett clay loam, 1 to 5 percent slopes	12	IVe-7	50	(None)	--	Adobe	56
BrD	Brackett soils, 5 to 12 percent slopes	12	VIIs-1	52	(None)	--	Adobe	56
BrE	Brackett soils, 12 to 30 percent slopes	11	VIIs-2	52	(None)	--	Steep Adobe	57
BsC	Brackett-Austin complex, 1 to 5 percent slopes	12	-----	--	------	--	-----------	--
	Brackett	--	IVe-7	50	(None)	--	Adobe	56
	Austin	--	IVe-7	50	(None)	--	Rolling Blacklands	59
BtE	Brackett-Tarrant association, hilly	12	------	--	------	--	-----------	--
	Brackett	--	VIIs-2	52	(None)	--	Steep Adobe	57
	Tarrant	--	VIs-3	52	(None)	--	Low Stony Hill	55
Ca	Crawford clay	13	IIIe-2	44	IIIe-2	44	Redland	57
Cb	Crawford and Bexar stony soils	13	------	--	------	--	-------	--
	Crawford	--	VIs-1	51	(None)	--	Redland	57
	Bexar	--	VIs-1	51	(None)	--	Redland	57
CfA	Crockett fine sandy loam, 0 to 1 percent slopes	14	IIIs-1	47	IIIs-3	47	Tight Sandy Loam	60
CfB	Crockett fine sandy loam, 1 to 3 percent slopes	14	IIIe-1	44	IIIe-1	44	Tight Sandy Loam	60
CkC2	Crockett soils, 2 to 5 percent slopes, eroded	14	VIe-1	51	(None)	--	Tight Sandy Loam	60
DmC	Duval loamy fine sand, 1 to 5 percent slopes	15	IIIe-9	47	IIIs-2	47	Deep Sand	60
DnB	Duval fine sandy loam, 1 to 3 percent slopes	14	IIe-1	42	IIe-1	42	Sandy Loam	60
DnC	Duval fine sandy loam, 3 to 5 percent slopes	15	IIIe-4	45	IIIe-3	45	Sandy Loam	60
DsC2	Duval soils, 3 to 5 percent slopes, eroded	15	IVe-5	49	IIIe-7	49	Deep Sand	60
EuC	Eufaula fine sand, 0 to 5 percent slopes	16	IVe-6	50	IIIs-4	50	Sandy Savannah	58
Fr	Frio clay loam	16	IIw-1	43	IIw-1	43	Loamy Bottomland	59
Go	Gowen clay loam	17	IIw-1	43	IIw-1	43	Bottomland	61
Gu	Gullied land	17	VIIs-3	52	(None)	--	Clay Loam	59
HgD	Hilly gravelly land	17	VIIs-3	52	(None)	--	Shallow Ridge	61
HkB	Hockley loamy fine sand, 0 to 3 percent slopes	18	IIIe-8	46	IIIs-1	46	Deep Sand	60
HkC	Hockley loamy fine sand, 3 to 5 percent slopes	18	IVe-5	49	IIIe-7	49	Deep Sand	60
HkC2	Hockley loamy fine sand, 3 to 5 percent slopes, eroded	18	VIe-4	51	(None)	--	Deep Sand	60
HnB	Houston clay, 1 to 3 percent slopes	19	IIIe-2	44	IIIe-2	44	Rolling Blacklands	59
HnC2	Houston clay, 3 to 5 percent slopes, eroded	19	IIIe-3	45	(None)	--	Rolling Blacklands	59

GUIDE TO MAPPING UNITS--CONTINUED

Map symbol	Mapping unit	Page	Capability unit: Dryland Symbol	Dryland Page	Irrigated Symbol	Irrigated Page	Range site Name	Range site Page
HnC3	Houston clay, 3 to 5 percent slopes, severely eroded--------	19	IVe-3	49	(None)	--	Rolling Blacklands	59
HoD3	Houston-Sumter clays, 5 to 10 percent slopes, severely eroded------------------------	19	-----	--	------	--	-----------------	--
	Houston---------------------	--	VIe-2	51	(None)	--	Rolling Blacklands	59
	Sumter----------------------	--	VIe-2	51	(None)	--	Shallow Ridge	61
HsA	Houston Black clay, 0 to 1 percent slopes-------------------	20	IIs-1	43	IIs-2	43	Rolling Blacklands	59
HsB	Houston Black clay, 1 to 3 percent slopes-------------------	20	IIIe-2	44	IIIe-2	44	Rolling Blacklands	59
HsC	Houston Black clay, 3 to 5 percent slopes-------------------	21	IIIe-3	45	(None)	--	Rolling Blacklands	59
HtA	Houston Black clay, terrace, 0 to 1 percent slopes--------------	21	IIs-1	43	IIs-2	43	Rolling Blacklands	59
HtB	Houston Black clay, terrace, 1 to 3 percent slopes--------------	21	IIIe-2	44	IIIe-2	44	Rolling Blacklands	59
HuB	Houston Black gravelly clay, 1 to 3 percent slopes--------------	21	IIIe-2	44	IIIe-2	44	Rolling Blacklands	59
HuC	Houston Black gravelly clay, 3 to 5 percent slopes--------------	22	IIIe-3	45	(None)	--	Rolling Blacklands	59
HuD	Houston Black gravelly clay, 5 to 8 percent slopes----------------	22	IVe-3	49	(None)	--	Rolling Blacklands	59
KaB	Karnes loam, 1 to 3 percent slopes-------------------------	23	IIe-3	42	IIe-3	42	Clay Loam	59
KaC	Karnes loam, 3 to 5 percent slopes-------------------------	23	IIIe-5	46	IIIe-5	46	Clay Loam	59
KcC2	Karnes clay loam, 3 to 5 percent slopes, eroded-----------------	23	IIIe-6	46	IIIe-5	46	Clay Loam	59
Kr	Krum complex---------------------	24	IIIe-10	47	(None)	--	Valley	58
LfB	Leming loamy fine sand, 0 to 3 percent slopes------------------	24	IIIe-8	46	IIIs-1	46	Deep Sand	60
LvA	Lewisbille silty clay, 0 to 1 percent slopes------------------	25	IIc-2	41	I-2	41	Clay Loam	59
LvB	Lewisville silty clay, 1 to 3 percent slopes--------------------	25	IIe-3	42	IIe-3	42	Clay Loam	59
LvC	Lewisville silty clay, 3 to 5 percent slopes--------------------	25	IIIe-5	46	IIIe-5	46	Clay Loam	59
OrA	Orelia clay loam, 0 to 1 percent slopes-------------------------	26	IIIs-1	47	IIIs-3	47	Hardland	61
OrB	Orelia clay loam, 1 to 3 percent slopes-------------------------	26	IVe-1	48	IVs-1	48	Hardland	61
PaA	Patrick soils, 0 to 1 percent slopes-------------------------	27	IIIs-2	48	IIs-2	48	Shallow	61
PaB	Patrick soils, 1 to 3 percent slopes-------------------------	27	IIIe-7	46	IIIe-6	46	Shallow	61
PaC	Patrick soils, 3 to 5 percent slopes-------------------------	27	IVe-7	50	(None)	--	Shallow	61
Pt	Pits and Quarries-----------------	27	-----	--	------	--	--------	--
SaB	San Antonio clay loam, 1 to 3 percent slopes-----------------	28	IIIe-1	44	IIIe-1	44	Hardland	61

GUIDE TO MAPPING UNITS--CONTINUED

Map symbol	Mapping unit	Page	Capability unit: Dryland Symbol	Dryland Page	Irrigated Symbol	Irrigated Page	Range site Name	Range site Page
SaC	San Antonio clay loam, 3 to 5 percent slopes	28	IVe-2	48	(None)	--	Hardland	61
SaC2	San Antonio clay loam, 3 to 5 percent slopes, eroded	28	VIe-1	51	(None)	--	Hardland	61
ScB	Stephen silty clay, 1 to 3 percent slopes	29	IIIe-7	46	IIIe-6	46	Shallow Ridge	61
ScC	Stephen silty clay, 3 to 5 percent slopes	29	IVe-7	50	(None)	--	Shallow Ridge	61
TaB	Tarrant association, gently undulating	30	VIs-2	52	(None)	--	Rocky Upland	55
Tb	Tarrant soils, chalk substratum, undulating	31	VIs-2	52	(None)	--	Rocky Upland	55
TaC	Tarrant association, rolling	30	VIs-3	52	(None)	--	Low Stony Hill	55
TaD	Tarrant association, hilly	31	VIs-3	52	(None)	--	Steep Rocky	56
Tc	Trinity clay	32	IIw-2	44	(None)	--	Bottomland	61
Tf	Trinity and Frio soils, frequently flooded	32	-----	--	------	--	----------	--
	Trinity	--	Vw-1	50	(None)	--	Bottomland	61
	Frio	--	Vw-1	50	(None)	--	Loamy Bottomland	59
VaA	Venus loam, 0 to 1 percent slopes	32	IIc-2	41	I-2	41	Clay Loam	59
VaB	Venus loam, 1 to 3 percent slopes	33	IIe-3	42	IIe-3	42	Clay Loam	59
VcA	Venus clay loam, 0 to 1 percent slopes	33	IIc-2	41	I-2	41	Clay Loam	59
VcB	Venus clay loam, 1 to 3 percent slopes	33	IIe-3	42	IIe-3	42	Clay Loam	59
VcC	Venus clay loam, 3 to 5 percent slopes	33	IIIe-5	46	IIIe-5	46	Clay Loam	59
WbB	Webb fine sandy loam, 1 to 3 percent slopes	34	IIe-1	42	IIe-1	42	Tight Sandy Loam	60
WbC	Webb fine sandy loam, 3 to 5 percent slopes	34	IIIe-4	45	IIIe-3	45	Tight Sandy Loam	60
WeC2	Webb soils, 3 to 5 percent slopes, eroded	34	IVe-4	49	(None)	--	Tight Sandy Loam	60
WeC3	Webb soils, 3 to 5 percent slopes, severely eroded	35	VIe-1	51	(None)	--	Tight Sandy Loam	60
WmA	Willacy loam, 0 to 1 percent slopes	35	IIc-1	41	I-1	41	Clay Loam	59
WmB	Willacy loam, 1 to 3 percent slopes	35	IIe-2	42	IIe-2	42	Clay Loam	59
Za	Zavala fine sandy loam	36	IIw-1	43	IIw-1	43	Loamy Bottomland	59
Zg	Zavala and Gowen soils, frequently flooded	36	-----	--	-----	--	----------------	--
	Zavala	--	Vw-2	51	(None)	--	Loamy Bottomland	59
	Gowen	--	Vw-2	51	(None)	--	Bottomland	61

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