

SOIL SURVEY

Brazos County Texas



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

How to Use THE SOIL SURVEY REPORT

THE soil survey of Brazos County was made to find out the nature and extent of each kind of soil. Soil scientists walked across the fields and through the woodlands. Wherever each one went, he examined surface soils and subsoils; he measured slopes with a hand level; looked closely at the lay of the land; and watched for differences in the crops, weeds, brush and trees that were growing on the different soils. He carried an aerial photograph, and on it he plotted boundaries of the soils. He placed a symbol in each area to tell what kind of soil he saw there.

This report contains a description of each soil and statements about what the soil will do under different kinds of use and treatment. Soil maps of the entire county have been printed on a background made of aerial photographs, which were pieced together to make a mosaic. Roads, houses, streams, other important landmarks, and place names have been marked on the aerial mosaic. You can also see the woodlands, the open fields, and something about how the fields are arranged. Remember, however, that the photographs were made in 1951, and that if woodlands have been cleared or if fields have been rearranged since, the map will not show these changes.

Find Your Farm on the Map

Look at the small map of the county in the back of this report. It shows the main roads and streams and several place names. Look at the part of the county where your farm is located and notice the big red number in the rectangle. That number tells you the map sheet on which you will find your farm. If your farm is near the edge of a sheet you will have to check its exact location on the large-scale maps.

Take a little time to become acquainted with the aerial photograph. See if you can pick out your farm and locate its boundaries. Your county agent or Soil Conservation Service representative will help you.

Look at the red lines that are boundaries of the different kinds of soil. Each kind of soil is marked by a letter symbol, also printed in red. Usually the letter symbol is inside the area it identifies, but if the area is too small, the symbol is outside and connected to the area by a straight red line.

Make a list of the different symbols on your farm and then turn to the Soil Legend in the back of this report, where each symbol is followed by the name of the soil it identifies. You are now ready to learn about the strong points and shortcomings of your soils and what you can do to take care of your soils and get best returns year after year.

Suppose you have found soil Ld, Lufkin fine sandy loam, 1 to 3 percent slopes, on your farm. How does this soil look in the field? How is it used? What does

it need to reduce runoff and erosion? How much will it produce? These questions are answered in the report.

Lufkin fine sandy loam, 1 to 3 percent slopes, and all the other soils mapped in Brazos County are described in the section, Soils of Brazos County. After you have read about the Lufkin soil, you will want to know how much it can produce. For this information, turn to table 2 in the section, Soil Management. This table gives expected yields under two levels of management—the prevailing management, and improved management. You will notice that yields of most crops increase on this soil if improved management is used.

What should be done to take care of the soil and get the better yields given in table 2? In the last part of this description there is a reference to group III-1 in the section, Capability Groups of Soils. Group III-1 consists of Lufkin fine sandy loam, 1 to 3 percent slopes, and several other soils, all of which need about the same kind of management.

Make a Farm Plan

Study your soils, see whether you have been cultivating any that usually do not produce well, and compare the yields you have been getting with those you could expect under different management. Then, decide whether or not you should change your methods of farming or the use of these soils. The choice, of course, must be yours. You may need help to make your own farm plan if you decide to change your methods. This report will help you in planning, but it is not a plan of management for your farm or any other single farm in the county.

If you find that you need help in farm planning, consult members of the Soil Conservation Service, or the county agricultural agent. Members of your State experiment station staff and others familiar with farming in your county will also be glad to help you.

Soils of The County as a Whole

Many users of the report will want to know something about the kinds of soils that occur in each part of the county. The section, Soil Associations, will be useful to them. Information about climate, agriculture, and several other topics, appears in the section, Additional Facts About the County. A technical discussion of the soils is given in the section, Morphology, Genesis, and Classification of Soils.

This publication on the soil survey of Brazos County, Tex., is a cooperative contribution from the—

SOIL CONSERVATION SERVICE and the TEXAS AGRICULTURAL EXPERIMENT STATION

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SOIL SURVEY OF BRAZOS COUNTY, TEXAS

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United States Department of Agriculture in cooperation with the Texas Agricultural Experiment Station

BRAZOS County is on the whole gently sloping, and the slope is to the southeast. The large areas of bottom land and some of the river terraces are nearly level. Cotton is the dominant crop. Crops grown to less extent are corn, alfalfa and other hay crops, sorghum, and oats. Livestock farming has increased greatly since 1940. Industries other than agriculture are of minor importance. The types of agriculture prevailing in the county are closely connected with the different kinds of soils. To learn about agricultural uses of the land, this cooperative soil survey was made by the United States Department of Agriculture and the Texas Agricultural Experiment Station. Fieldwork was completed in 1951, and all statements in this report refer to conditions at that time.

General Facts About the Area

Brazos County, an area of 583 square miles, or 373,120 acres, is in east-central Texas in the forks of the Brazos and Navasota Rivers (fig. 1). Elevations in the county range from about 190 to 400 feet above sea level. Bryan is the county seat and principal town. It is 100 miles northwest of Houston, a deepwater seaport, and 105 miles east-northeast of Austin, the State capital.

Settlement of the county began about 1830. The settlers came from Alabama, Georgia, Mississippi, and Tennessee; a few were from Mexico. Italian and German immigrants later settled in rural parts of the county. In 1950 the population of Brazos County was 38,390.

Agriculture has always been the principal industry and cotton the main crop. Many farmers in the county raise only enough feed for their own livestock. On the flood plain of the Brazos River, however, most farmers raise only cotton and buy feed for livestock. This area has been choice farmland from the time it was cleared, and land prices are high at all times.

A more diversified agriculture is practiced on the less fertile upland soils. Many acres of upland soils have been retired from cultivation because of low fertility and poor physical condition. The volunteer cover of grass and weeds is grazed by livestock.

The cultivated acreage of the county is now only about 45 percent of what it was at one time. Some farmers are improving their cropland by using proper kinds and amounts of fertilizers, green-manure crops, better rotations, and erosion-control measures. Pastures are being

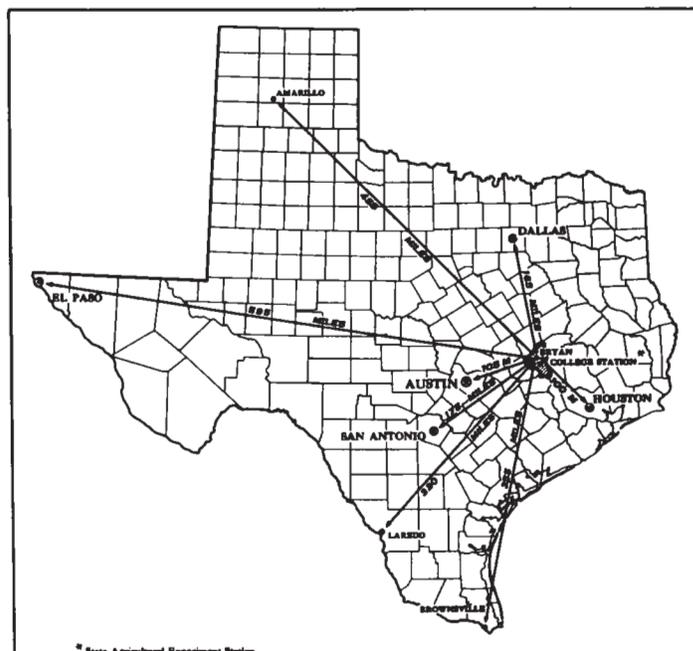


Figure 1.—Location of Brazos County in Texas.

improved by seeding with desirable grasses and legumes and by fertilizing, mowing, and controlled grazing.

The Texas Agricultural and Mechanical College was opened in 1876. This is the second largest State educational institution in the State.

The Soil Survey

A soil survey was made of Brazos County in 1914, and the map and report were subsequently published. A resurvey was made in 1949–51 to provide a map of larger scale and bring the old survey up to date. The resurvey was made on aerial photograph base maps at a scale of 4 inches equals 1 mile. In the resurvey, 52 soil types, phases, and land types were separated.

The approximate acreage of each soil in various uses at the time of the survey and its total acreage are shown in table 1.

¹ Fieldwork was done while Soil Survey was part of the Bureau of Plant Industry, Soils, and Agricultural Engineering. Soil Survey was transferred to the Soil Conservation Service November 15, 1952.

TABLE 1.—Approximate acreage in various uses and total acreage and proportionate extent of the soils mapped in Brazos County, Tex.

Soil unit	Cropland	Open pasture	Woodland pasture	Total	Proportionate extent
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Percent</i>
Axtell fine sandy loam, 1 to 3 percent slopes	400	4,800	1,200	6,400	1.7
Bastrop fine sandy loam, 0 to 2 percent slopes	100	700		800	.2
Bonham clay loam, 0 to 2 percent slopes		300		300	.1
Bonham fine sandy loam, 0 to 2 percent slopes	200	200		400	.1
Burleson clay, 0 to 1 percent slopes	900	3,000		3,900	1.0
Crockett clay loam 1 to 3 percent slopes	2,100	3,100		5,200	1.4
Crockett clay loam, eroded, 3 to 6 percent slopes	400	1,200		1,600	.4
Crockett fine sandy loam, 1 to 3 percent slopes	4,600	13,700		18,300	4.9
Crockett fine sandy loam, eroded, 3 to 6 percent slopes	100	2,400		2,500	.7
Crockett soils, severely eroded, 5 to 12 percent slopes		300		300	.1
Derby loamy fine sand, 0 to 2 percent slopes	100	300		400	.1
Edge fine sandy loam, 1 to 3 percent slopes	100	1,500	3,300	4,900	1.3
Edge fine sandy loam, 3 to 8 percent slopes	200	5,800	13,400	19,400	5.2
Gowen clay loam, 0 to 1 percent slopes	100	10,400	14,600	25,100	6.7
Gowen fine sandy loam, 0 to 1 percent slopes		800	1,200	2,000	.5
Gravel pits		200		200	.1
Gullied land		5,820		5,820	1.6
Houston-Hunt clays, 1 to 3 percent slopes	200	500		700	.2
Houston-Hunt clays, 3 to 6 percent slopes	200	1,900		2,100	.6
Houston-Hunt clays, severely gullied, 3 to 8 percent slopes		800		800	.2
Irving clay loam, 0 to 1 percent slopes	700	2,000		2,700	.7
Irving-Axtell loams, 0 to 1 percent slopes	100	700	300	1,100	.3
Kaufman clay, 0 to 1 percent slopes	100	300		400	.1
Lakeland loamy fine sand, 1 to 4 percent slopes	400	2,300	4,900	7,600	2.0
Lakeland loamy fine sand, 4 to 12 percent slopes		1,100	4,300	5,400	1.4
Lufkin fine sandy loam, 1 to 3 percent slopes	2,700	41,400	10,100	54,200	14.5
Lufkin fine sandy loam, 0 to 1 percent slopes	100	2,700	4,100	6,900	1.8
Lufkin-Edge complex, 1 to 3 percent slopes	100	3,300	9,300	12,700	3.4
Lufkin-Edge complex, 3 to 8 percent slopes	100	8,200	23,200	31,500	8.4
Mixed alluvial land, 0 to 8 percent slopes		300	1,400	1,700	.4
Miller clay, 0 to 1 percent slopes	19,000	2,600	3,400	25,000	6.7
Miller clay, 3 to 8 percent slopes	300	600	300	1,200	.3
Miller silt loam, 0 to 1 percent slopes	2,100	900	300	3,300	.9
Navasota clay, 0 to 1 percent slopes		200	16,100	16,300	4.4
Norwood silt loam, 0 to 1 percent slopes	6,300	1,000	100	7,400	2.0
Norwood silt loam, 3 to 8 percent slopes	700	700	300	1,700	.4
Norwood silty clay loam, 0 to 1 percent slopes	2,300	500	100	2,900	.8
Ochlockonee fine sandy loam, 0 to 1 percent slopes		2,400	3,400	5,800	1.6
Ochlockonee loamy fine sand, 0 to 2 percent slopes			600	600	.2
Ochlockonee-Gowen complex, 0 to 2 percent slopes			800	800	.2
Payne clay loam, 0 to 2 percent slopes		300		300	.1
Roebuck clay, 0 to ½ percent slopes	500	700	1,000	2,200	.6
Sawyer loamy fine sand, 1 to 3 percent slopes		900	900	1,800	.5
Tabor fine sandy loam, 1 to 3 percent slopes	2,300	26,900	10,200	39,400	10.6
Tabor gravelly loamy sand, 2 to 6 percent slopes		800	900	1,700	.4
Tabor loamy fine sand, 1 to 3 percent slopes	1,100	14,500	10,300	25,900	6.9
Travis fine sandy loam, 1 to 3 percent slopes	200	500	100	800	.2
Travis-Axtell fine sandy loams, 3 to 6 percent slopes	200	1,700	1,400	3,300	.9
Travis-Axtell soils, eroded, 6 to 12 percent slopes		600	300	900	.3
Wilson clay loam, 0 to 1 percent slopes	1,500	2,500		4,000	1.1
Wilson clay loam, 1 to 3 percent slopes	100	1,500		1,600	.4
Yahola fine sandy loam, 0 to 1 percent slopes	400	300	200	900	.2
Totals	51,000	180,120	142,000	373,120	99.8

How the Soil Survey Was Made

The scientist who makes a soil survey examines soils in the field, classifies the soils in accordance with facts that he observes, and maps their boundaries on an aerial photograph or other map.

Field study.—The soil scientist bores or digs many holes to see what the soils are like. The holes are not spaced in a regular pattern; they are located according to the lay of the land. Usually they are not more than a quarter

of a mile apart and sometimes they are much closer. In most soils such a boring or hole reveals several distinct layers, called horizons, which collectively are known as the soil profile. Each layer is studied to see how it differs from others in the profile and to learn the things about this soil that influence its capacity to support plant growth. Some of the characteristics observed are discussed below.

Color is usually related to the amount of organic matter. The darker the surface soil, as a rule, the more organic

matter it contains. Streaks and spots of gray, yellow, and brown in the lower layers generally indicate poor drainage and poor aeration.

Texture, or the content of sand, silt, and clay, is determined by the way the soil feels when rubbed between the fingers and is later checked by laboratory analysis. Texture determines how well the soil retains moisture, plant nutrients, and fertilizer, and whether it is easy or difficult to cultivate.

Structure, which is the way the individual soil particles are arranged in larger grains and the amount of pore space between grains, gives us clues to the ease or difficulty with which the soil is penetrated by plant roots and by moisture and air.

Consistence, or the tendency of the soil to crumble or to stick together, indicates whether it is easy or difficult to keep the soil open and porous under cultivation.

Other characteristics observed in the course of the field study and considered in classifying the soil include the following: The depth of the soil over bedrock or compact layers; the presence of gravel or stones in quantities that will interfere with cultivation; the steepness and pattern of slopes; the degree of erosion; the nature of the underlying rocks or other parent material from which the soil has developed; and the acidity or alkalinity of the soil as measured by chemical tests.

Classification.—On the basis of the characteristics that are observed or are determined by laboratory tests, soils are placed in phases, types, and series. The soil type is the basic classification unit. A soil type may consist of several phases. Types that resemble each other in most of their characteristics are grouped into soil series.

Soils similar in kind, thickness, and arrangement of soil layers are classified as one soil type.

Because of differences other than those of kind, thickness, and arrangement of layers, some soil types are divided into two or more phases. Slope variations, frequency of rock outcrops, degree of erosion, depth of soil over the substratum, or difference in natural drainage, are examples of characteristics that are used in dividing a soil type into phases.

The soil phase (or the soil type if it has not been subdivided) is the unit shown on the soil map. It is the unit that has the narrowest range of characteristics. Use and management practices, therefore, can be specified more easily for it than for a soil series or yet broader groups that contain more variation.

Two or more soil types that differ in surface-soil texture but are otherwise similar in kind, thickness, and arrangement of soil layers are normally designated as a soil series. Each series may include several types and phases. In a given area, however, it frequently happens that a soil series is represented by only one soil type. Each series is named for a place near which the soil was first mapped.

As an example of soil classification, consider the Norwood series. This series is made up of two soil types, which are subdivided into phases, as follows:

Series	Type	Phase
Norwood	{ silt loam.....	{ 0 to 1 percent slopes.
		{ 3 to 8 percent slopes.
	{ silty clay loam.....	0 to 1 percent slopes.

Fresh mixed stream deposits, or rough, stony, or severely gullied land that have little true soil are not

classified into types and series but are identified by descriptive names, such as Gullied land or Mixed alluvial land.

When two or more soils are so intricately associated in small areas that it is not feasible to show them separately on the soil map, they are mapped together and called a soil complex. An example in Brazos County is Houston-Hunt clays.

Soils of Brazos County

The soil series and each soil shown on the map are described in this section. Some of the soil mapping units are nearly uniform; others have variations that are noted in the descriptions. Specific use and management for the individual soils are also discussed, but the main discussion of use and management is in the section, *Capability Groups of Soils*. Characteristics of the soils are further described in the section on morphology, genesis, and classification of soils.

Axtell Series

The only member of the Axtell series in the county is a crusty light-colored soil of low productivity that occurs on gently sloping upland near the Brazos River. The parent material consists of old sediments deposited by floodwaters of the Brazos River. The soil is now above overflow. The natural vegetation consists of scrubby hardwood trees and bunchgrasses.

Axtell fine sandy loam, 1 to 3 percent slopes (Aa).—A characteristic profile of this soil is as follows:

- 0 to 10 inches, very pale brown, slightly acid fine sandy loam that is friable when moist and crusty and hard when dry; changes abruptly to the subsoil below.
- 10 to 21 inches, mottled yellowish-red, pale-brown, and yellowish-brown acid clay; the red color decreases with depth; very slowly permeable; very firm when moist, very sticky when wet, and extremely hard when dry.
- 21 to 45 inches, light brownish-gray, neutral to alkaline clay mottled with light gray and a few brown spots; very firm when moist and extremely hard when dry; some calcium carbonate concretions in the lower part.
- 45 to 56 inches, pale-brown calcareous clay with few to many yellowish-red mottles; not as firm and hard as layers above.
- 56 to 66 inches, or more, yellowish-red calcareous sandy clay, the parent material.

This soil is fair for crops and pasture. Cotton, sorghums, oats, and vetch are the most suitable crops. Natural fertility is low. The moisture supply for crops is erratic. During wet periods, the supply is excessive because of the low permeability of the soil. During dry periods, available moisture is low because much of the supply is tightly held by the soil. Probably this soil can best be used for a combination of field-crop and livestock farming. Refer to management group III-1, in the section, *Capability Groups of Soils*, for suggestions on management.

Bastrop Series

The soil of the Bastrop series is moderate in productivity but has high potentialities. It is a loamy soil that

occurs on very gently sloping low river terraces adjacent to the Brazos River flood plain. The parent material consists of sandy calcareous sediments deposited by floodwaters of the Brazos River, although the soil is now above overflow. The natural vegetation originally consisted of tall bunchgrasses and scattered trees.

Bastrop fine sandy loam, 0 to 2 percent slopes (Ba).—The following is a characteristic profile of this soil:

- 0 to 15 inches, light-brown, slightly acid fine sandy loam; weakly granular; friable and crumbly.
- 15 to 34 inches, yellowish-red, slightly acid, permeable, light sandy clay; weakly granular; friable and crumbly when moist and slightly sticky when wet.
- 34 to 58 inches, yellowish-red, slightly acid, permeable sandy clay; friable when moist and moderately sticky when wet.
- 58 to 96 inches, or more, yellowish-red stratified calcareous sandy clay loam and fine sandy loam, the parent material.

This is one of the best soils for crops in the county. Although it is good for pasture, it has greater value for crops. It is suited to a variety of crops, including cotton, corn, melons, peanuts, vegetables, and orchard fruits. The soil is moderately fertile and very responsive to fertilizers and good management. Refer to management group I-1 in the section, Capability Groups of Soils, for other suggestions on use and management.

Bonham Series

The soils of the Bonham series have high natural productivity. They occur on nearly level to gently sloping upland in the western part of the county. The parent material is alkaline to weakly calcareous clay and sandy clay. The original vegetation consisted of prairie grasses, mostly coarse bunchgrasses.

Bonham fine sandy loam, 0 to 2 percent slopes (Bc).—The following profile is characteristic of this soil:

- 0 to 10 inches, grayish-brown, slightly acid friable fine sandy loam.
- 10 to 18 inches, pale-brown, acid light clay loam splotched with yellowish brown; permeable, friable, porous, and granular.
- 18 to 34 inches, mottled red, brownish-yellow, and light-gray, acid clay; slowly to very slowly permeable; very firm when moist and very hard when dry.
- 34 to 48 inches, mottled brownish-yellow and light-gray slightly acid to neutral clay; very slowly permeable; very firm when moist and very hard when dry.
- 48 to 84 inches, or more, brownish-yellow alkaline sandy clay streaked with light gray, the parent material.

This soil is very good for crops and good for pasture. Cotton, corn, sorghums, oats, and vetch are the most suitable crops. Natural fertility is moderate, but the soil responds well to fertilizers and good management. Refer to management group II-3 in the section, Capability Groups of Soils, for other suggestions on management.

Bonham clay loam, 0 to 2 percent slopes (Bb).—The following is a characteristic profile of this soil:

- 0 to 10 inches, dark grayish-brown slightly acid clay loam; granular; friable when moist and moderately sticky when wet.
- 10 to 16 inches, very dark grayish-brown slightly acid light clay mottled with dark brown; permeable; granular; friable; crumbly when moist but sticky and plastic when wet.
- 16 to 30 inches, mottled yellowish-red, olive-yellow, and light olive-brown slightly acid clay; granular; friable; crumbly when moist but sticky and plastic when wet.

30 to 44 inches, yellow, slightly acid clay mottled with yellowish red; very slowly permeable; very firm when moist and very sticky when wet.

44 to 65 inches, mottled yellow and pale-yellow, very slightly acid clay with small brownish-yellow spots; same consistence as layer above.

65 to 75 inches, or more, yellowish-brown alkaline clay with faint splotches of strong brown, which is the parent material.

Crop adaptations and fertilizer requirements are similar to those of Bonham fine sandy loam, 0 to 2 percent slopes. Refer to management group II-2 in the section, Capability Groups of Soils, for other management suggestions.

Burleson Series

The only member of the Burleson series in the county is a dark clay soil of moderate productivity that occurs on level terraces near the Brazos River. The parent material consists of old calcareous clayey sediments deposited by floodwaters of the Brazos River. The soil is now above overflow. The natural vegetation is mostly tall bunchgrasses and scattered elm and mesquite trees.

Burleson clay, 0 to 1 percent slopes (Bd).—The following is a characteristic profile of this soil:

0 to 44 inches, dark-gray, slightly acid crusty clay; very firm when moist, extremely sticky when wet, and extremely hard when dry; the surface of native areas has a distinct microrelief of shallow depressions and knolls (hog wallowed), and this dark-gray layer is much thinner on the microknolls.

44 to 58 inches, gray alkaline clay with a few yellowish-red particles of unweathered alluvium; very slowly permeable, very firm when moist, extremely sticky when wet, and extremely hard when dry.

58 to 62 inches, transition to parent material below.

62 to 96 inches, or more, parent material of reddish-brown calcareous clay.

A depressional area of about 12 acres lying 400 yards southwest of the southwest corner of the Bryan Army Air Field is unlike the Burleson clay, but is included with it. This area consists of 9 to 15 inches of dark-brown, crumbly and friable calcareous clay underlain by pale-brown calcareous loamy sand. Small areas that are calcareous to the surface and granular in the upper 15 to 18 inches are included with the Burleson clay in Brazos County, although they belong to the Bell series.

Burleson clay, 0 to 1 percent slopes, is only moderately suitable for crops or pasture. Drought-resistant and early-maturing crops are the most suitable. Natural fertility is moderate, and crops are affected by drought because the compact clay restricts root growth and development. This soil has poor plant-soil moisture relationships. Its best use is probably for a combination of field-crop and livestock farming. For additional management recommendations, refer to management group II-2 in the section, Capability Groups of Soils.

Crockett Series

Members of the Crockett series are moderately productive somewhat crusty soils that occur on gently sloping to sloping upland in the western part of the county. The parent material is alkaline to weakly calcareous clay and sandy clay. The natural vegetation consists mostly of

tall bunchgrasses and occasional post oak, elm, and mesquite trees.

Crockett fine sandy loam, 1 to 3 percent slopes (Cc).—The following profile is representative of this soil:

- 0 to 7 inches, grayish-brown, slightly acid fine sandy loam; friable when moist, crusty and very hard when dry.
- 7 to 22 inches, reddish-brown acid clay, mottled with yellowish brown; becomes less reddish and more yellowish in the lower part; very slowly permeable; stiff and sticky when wet and extremely hard when dry.
- 22 to 58 inches, pale-olive alkaline clay mottled with light yellowish brown but otherwise similar to the layer above; a few calcium carbonate concretions in the lower part.
- 58 to 90 inches, or more, parent material of yellow alkaline clay slightly mottled with brownish yellow and light gray.

Some small areas have much chert gravel on the surface.

This soil is moderately good for crops and pasture. Cotton, sorghums, oats, and vetch are the most suitable crops. The soil is moderately fertile but responds to additional fertilizers and good management. Crop plants are affected by the heavy compact clay subsoil, which is droughty and restricts root growth. Probably the best use is for a combination of field-crop and livestock farming. Refer to management group III-2 in the section, Capability Groups of Soils, for more detailed suggestions on management.

Crockett fine sandy loam, eroded, 3 to 6 percent slopes (Cd).—This phase of Crockett fine sandy loam is susceptible to erosion. The soil profile is similar to the profile of Crockett fine sandy loam on 1 to 3 percent slopes except that the surface and subsoil layers are thinner. About two-thirds of the unit is eroded and cut by numerous shallow gullies, mostly less than 100 feet apart, and by a few deep gullies.

This soil is poor for crops but fair for pasture. Oats, vetch, and sorghums are the most suitable crops. Natural fertility is moderate, but the soil is droughty because of thin surface soil, the very slowly permeable subsoil, and the rapid runoff. Moderate yields can be produced by management that includes terracing, fertilizing, and almost continuous use of broadcast or close-growing crops. The best use is for pasture. Refer to management group IV-1 in the section, Capability Groups of Soils, for suggestions on management.

Crockett clay loam, 1 to 3 percent slopes (Ca).—A representative profile of this soil is as follows:

- 0 to 7 inches, dark grayish-brown, slightly acid clay loam; friable when moist, moderately sticky when wet, and hard and crusty when dry; some small areas have a clay surface.
- 7 to 27 inches, mottled yellowish-brown and red acid clay; slowly permeable; very firm when moist, very stiff and sticky when wet, and extremely hard when dry.
- 27 to 38 inches, brownish-yellow slightly acid clay mottled with light brownish-gray and a few yellowish-red spots; very slowly permeable; very firm when moist and extremely hard when dry.
- 38 to 66 inches, olive-brown alkaline clay slightly mottled with brownish yellow; otherwise similar to the layer above.
- 66 to 88 inches, or more, parent material of mottled brown, brownish-yellow, and gray alkaline clay.

Some small areas have much chert gravel on the surface.

This soil is moderately good for crops and pasture. The most suitable crops are cotton, sorghum, oats, and vetch. Natural fertility is moderate, but the soil responds to fertilizers and to good management. Its best use is probably for a combination of field-crop and livestock farming.

Refer to management group III-2 in the section, Capability Groups of Soils, for suggested management.

Crockett clay loam, eroded, 3 to 6 percent slopes (Cb).—This is similar to the Crockett clay loam on 1 to 3 percent slopes except that it is more sloping and in most areas, especially those cultivated, has been eroded. The soil layers in the profile are thinner. Cultivated areas are eroded and cut by many shallow gullies, generally less than 100 feet apart, and by a few deep gullies. In some spots the surface soil is greatly thinned by erosion or completely lacking, so that tillage implements turn up the subsoil.

This soil is poor for crops and fair for pasture. Oats, vetch, and sorghums are the most suitable crops. Natural fertility is moderate, but productivity is low because of droughtiness. Moderate productivity can be obtained in a few years by terracing to reduce erosion and runoff, fertilizing, and almost continuous use of broadcast or close-growing crops, including legumes. The best use is for pasture. Refer to management group IV-1 in the section, Capability Groups of Soils, for additional suggestions on management.

Crockett soils, severely eroded, 5 to 12 percent slopes (Ce).—This unit is composed of strongly sloping areas of Crockett soils on which severe sheet and gully erosion has occurred. The surface soil ranges from a fine sandy loam 3 to 8 inches deep on the ridges between gullies to sandy clay loam or clay in small areas where the surface soil has been completely washed away. Surface gradients are irregular but average between 7 and 10 percent. Numerous deep gullies that are 3 to 25 feet wide and 3 to 13 feet deep occur at intervals of about 150 feet. There are many smaller gullies and eroded spots between the larger gullies. The red coloration in the substratum is quite variable from place to place, and the substratum is calcareous in places. Probably most of the acreage has been cropped. However, it is now unsuitable for cultivation and is all in pasture. Refer to management group VII-1 in the section, Capability Groups of Soils, for suggested management.

Derby Series

Only one member of the Derby series is mapped in the county. It is a deep sandy soil of low natural fertility. It occurs on gently undulating low river terraces adjacent to the Brazos River flood plain, but above overflow. The parent material consists largely of water-lain unconsolidated loamy sands that probably have been shifted and reworked by wind. The native vegetation was coarse grasses, shrubs, and some hardwood trees.

Derby loamy fine sand, 0 to 2 percent slopes (Da).—A representative profile of this soil is as follows:

- 0 to 18 inches, grayish-brown, slightly acid loamy fine sand; very friable and loose.
- 18 to 30 inches, reddish-yellow, slightly acid loamy fine sand; very friable and loose.
- 30 to 50 inches, or more, lighter colored reddish-yellow slightly acid loamy fine sand; very friable and loose.

This soil is only fair for crops and pasture. Special crops, including melons, peas, small fruits, vegetables, and nursery stock, are most suitable. The soil has low natural fertility but is very responsive to fertilizers and good management. It would be especially well suited

as a site for growing nursery stock. Refer to management group III-7 in the section, Capability Groups of Soils, for additional suggestions on management.

Edge Series

The Edge series consists of light-colored acid soils of low productivity that occur on gently sloping to sloping upland. These soils occur in all parts of the county except the flood plains. They were developed from acid shaly clay and sandy clay. The natural vegetation is scrub woodland made up of hardwoods and a little grass.

Edge fine sandy loam, 1 to 3 percent slopes (Ea).—A characteristic profile of this soil is as follows:

- 0 to 4 inches, light brownish-gray acid fine sandy loam; friable when moist and slightly hard when dry.
- 4 to 8 inches, very pale brown, strongly acid fine sandy loam; friable when moist and hard when dry; change to subsoil below is abrupt.
- 8 to 14 inches, red strongly acid clay weakly mottled with yellowish brown and gray; blocky and very slowly permeable; very firm when moist, very sticky when wet, and extremely hard when dry.
- 14 to 44 inches, mottled yellowish-red, brownish-yellow, and light brownish-gray, strongly acid clay; very slowly permeable; very firm when moist, very sticky when wet, and extremely hard when dry.
- 44 to 52 inches, brown strongly acid clay, mottled with brownish yellow but otherwise like layer above.
- 52 to 72 inches, or more, parent material of pale-brown acid shaly clay streaked with yellow.

This soil is fair for crops and pasture. It is best suited to drought-resistant, early-maturing, or cool-season crops, such as cotton, sorghums, oats, and vetch. The soil has low natural fertility but is responsive to fertilizers. Droughtiness restricts the productivity and kinds of crops that can be grown. Woodland pasture is probably the best use for this soil. Refer to management group III-1 in the section, Capability Groups of Soils, for additional suggestions on management.

Edge fine sandy loam, 3 to 8 percent slopes (Eb).—This soil is similar to Edge fine sandy loam, 1 to 3 percent slopes, except that its slopes are greater and its sandy surface soil is thinner. Some areas have been cultivated and are eroded.

This soil is unsuitable for cultivation and is poor for pasture. It has low natural fertility and cannot be improved much for pasture. Its most practical use is probably woodland pasture, for which it is now used. Refer to management group VI-1 in the section, Capability Groups of Soils, for additional information on management.

Gowen Series

The Gowen series consists of fertile and productive loamy soils of the flood plains along local streams. These soils are made up of sediments washed from the nearby uplands, largely from the local prairies. They are mostly forested with elm, oak, hackberry, and pecan.

Gowen fine sandy loam, 0 to 1 percent slopes (Gb).—The following is a characteristic profile of this soil:

- 0 to 20 inches, grayish-brown, slightly acid fine sandy loam weakly mottled with yellowish brown; friable when moist but moderately hard when dry.

- 20 to 48 inches, or more, grayish-brown slightly acid clay loam weakly mottled with dark gray; friable when moist but moderately hard when dry.

This soil is not favorably situated for use as cropland. It occurs in small irregular areas that are flooded once or twice a year, usually in spring. Cotton, corn, and sorghums are the most suitable crops. Where suitable for cultivation, this soil has moderate to high natural fertility and is one of the best soils in the county for improved pasture. Refer to management group II-5 in the section, Capability Groups of Soils, for additional suggestions on management.

Gowen clay loam, 0 to 1 percent slopes (Ga).—A typical profile of this soil is as follows:

- 0 to 24 inches, gray, slightly acid clay loam; friable when moist, sticky when wet, and hard when dry.
- 24 to 54 inches, or more, gray alkaline heavy clay loam weakly stratified with lighter textured material; firm when moist, sticky when wet, and hard when dry.

Uses, adaptabilities, and possibilities are similar to those of Gowen fine sandy loam. Refer to management group II-5 in the section, Capability Groups of Soils, for suggested management.

Gravel Pits

Gravel pits (Gc) include excavations and other areas where gravel and other material have been mined for road surfacing. The areas are essentially worthless for agriculture, although in some places they support some grass. Some areas probably can be made to produce grass or trees if properly managed. The principal areas are about 5 miles west of Bryan. Refer to management group VIII-1 in the section, Capability Groups of Soils, for suggested uses.

Gullied Land

Gullied land (Gd) consists of areas that are severely cut by gullies. Less than 10 percent of the total area delineated is not affected. Some areas consist of a single deeply entrenched channel with short gullies cutting back on the sides. Others consist of a series of gullies 3 to 15 feet deep and 3 to 30 or 40 feet wide; only narrow remnants of the original landscape remain between the gullies.

Gullied land has practically no economic value. The landowner's problem is to stop further gullying and to attempt reclamation. Although most areas of Gullied land have no vegetation, a few are stabilizing and vegetation is becoming established. A practical use, as well as a control measure, is to build earthen dams across the gullies at feasible locations. Water for livestock and fishponds can thus be impounded.

This land type occurs throughout the county, and no differentiation is made for gullies cut into different types of soil material. See management group VIII-1 in the section, Capability Groups of Soils, for suggestions on use.

Houston-Hunt Clays

The Houston-Hunt clays is a complex composed principally of two soils—Houston clay and Hunt clay. The

individual soils occur in areas too small to map separately. They are fertile, moderately productive, clayey soils occurring on gently sloping to sloping upland, mostly in the western part of the county. The parent material is calcareous clay. The native vegetation consisted of a rather dense stand of coarse bunchgrasses and scattered elm, hackberry, and mesquite trees.

Houston-Hunt clays, 1 to 3 percent slopes (Ha).—The following is a characteristic profile of Houston clay:

- 0 to 5 inches, light olive-brown calcareous clay; granular and crumbly; very firm when moist, extremely sticky when wet, and very hard when dry; contains numerous small calcium carbonate concretions.
- 5 to 30 inches, light yellowish-brown, strongly calcareous clay; blocky; otherwise same as layer above.
- 30 to 44 inches, or more, mottled pale-olive and pale-yellow strongly calcareous clay, the parent material.

The following is a characteristic profile of Hunt clay:

- 0 to 8 inches, very dark gray, slightly acid clay; granular and crumbly; very firm when moist, very hard when dry, and extremely sticky when wet.
- 8 to 18 inches, olive-gray neutral clay; blocky; otherwise similar to layer above.
- 18 to 40 inches, olive-gray alkaline clay; massive; otherwise similar to top layer.
- 40 to 48 inches, or more, pale-olive calcareous clay, the parent material.

The two soils occupy about equal proportions of the unit. They occur as small intermixed rounded or oblong areas that are a few square yards to as much as a quarter of an acre in size.

This unit is good for crops and pasture. Cotton, sorghums, oats, vetch, and possibly corn are the most suitable crops. The soils of this complex have moderate to high natural fertility, but they respond to additional fertilizer and to good management. The best use for this complex of soils is probably for field crops. The more sloping associated soils could be used for pasture in a combination of field-crop and livestock farming. Refer to management group II-2 in the section, Capability Groups of Soils, for additional suggestions on management.

Houston-Hunt clays, 3 to 6 percent slopes (Hb).—This complex of the Houston-Hunt clays is similar to that on 1 to 3 percent slopes, except that it is more sloping and is eroded in nearly all areas. The soil profile is similar, but all the soil layers are thinner. Houston clay occupies about 70 percent of the complex.

This mapping unit is poor for crops but fair for pasture. Natural fertility is moderate to high, but immediately available fertilizers will increase yields. The best use is for pasture. Refer to management group III-3 in the section, Capability Groups of Soils, for other suggested management.

Houston-Hunt clays, severely gullied, 3 to 8 percent slopes (Hc).—This unit is similar to the unit on 3 to 6 percent slopes but has deeper and more numerous gullies. Houston clay, which occupies 70 to 80 percent of the complex, has a 2- to 5-inch, brownish-yellow surface layer. The Hunt clay occurs as a few very dark gray spots. The calcareous clay parent material lies 15 to 25 inches below the surface. All areas of this soil complex were once cultivated but now have numerous shallow and deep gullies and are now unsuitable for crop use. They afford very little pasturage in the present condition but with

proper management can produce fair pastures. Refer to management group VII-1 in the section, Capability Groups of Soils, for suggestions on management.

Irving Series

The Irving series consists of moderately fertile and moderately productive soils on nearly level terraces lying a few feet above the flood plain of the Brazos River. The parent material is old calcareous sediments deposited by floodwaters of the Brazos River. The native vegetation consisted of coarse bunchgrasses and occasional post oak, elm, hackberry, and mesquite trees.

Irving-Axtell loams, 0 to 1 percent slopes (Ib).—This is a complex of the two soils—Irving loam and Axtell fine sandy loam. The two soils occur together in such small tracts that it is not feasible to separate them individually on the map. The Axtell soil occurs, usually as low mounds or ridges, in slightly higher positions than the Irving. A characteristic profile of Axtell is described under Axtell fine sandy loam.

The following profile is representative of Irving loam:

- 0 to 8 inches, gray strongly acid loam; friable when moist but extremely hard and crusty when dry.
- 8 to 11 inches, light-gray friable loam.
- 11 to 30 inches, dark-gray alkaline clay; very slowly permeable; blocky; very compact; very firm when moist, extremely hard when dry, and very sticky when wet.
- 30 to 44 inches, light-gray alkaline clay; massive; otherwise similar to layer above.
- 44 to 54 inches, very pale brown alkaline clay with a few small spots of reddish yellow; not as compact and hard as layer above.
- 54 to 84 inches, or more, parent material of stratified reddish-yellow alkaline clay loam and silt loam.

The soils of this unit are fair for crops and pasture. They are droughty, however, and best suited to drought-resistant, early maturing, or cool-season crops. The soils are moderately fertile. They show some response to mixed fertilizer, but their droughtiness restricts crop production. Refer to management group II-1 in the section, Capability Groups of Soils, for other suggestions on management.

Irving clay loam, 0 to 1 percent slopes (Ia).—The following is a representative profile of this soil:

- 0 to 4 inches, gray slightly acid clay loam; friable when moist but extremely hard and crusty when dry.
- 4 to 10 inches, dark-gray, slightly alkaline clay loam similar to that above.
- 10 to 36 inches, dark-gray, slightly acid clay; blocky; very slowly permeable; very firm when moist, very sticky when wet, and extremely hard when dry.
- 36 to 45 inches, gray, alkaline clay; massive; otherwise like the layer above.
- 45 to 82 inches, pale-brown alkaline clay with small particles of pink unweathered alluvium in the lower part; not as compact and sticky as layer above.
- 82 to 120 inches, or more, parent material of pink calcareous clay and reddish-yellow calcareous silty clay.

This soil is moderately good for crops and pasture. It is moderately fertile but is droughty because of the compact subsoil. Drought-resistant, early-maturing, and cool-season crops are therefore the most suitable. Refer to management group II-2 in the section, Capability Groups of Soils, for other suggestions on management.

Kaufman Series

The soil of the Kaufman series consists of fertile, productive, clayey alluvium on the edge of the Brazos River flood plain. It consists of sediments washed from nearby dark soils of local prairies. The natural vegetation consisted of a dense growth of pecan, elm, hackberry, and oak trees and an understory of shrubs and vines.

Kaufman clay, 0 to 1 percent slopes (Ka).—The following is a representative profile of this soil:

- 0 to 18 inches, very dark gray neutral clay; firm when moist, sticky when wet, and very hard when dry.
- 18 to 38 inches, dark-gray alkaline clay; more compact and sticky than layer above.
- 38 to 54 inches, or more, weakly stratified dark-gray alkaline clay and grayish-brown alkaline clay loam.

This soil is very good for crops and pasture. Cotton, sorghums, corn, oats, vetch, and alfalfa are the most suitable crops. The soil is fertile and responds little to fertilizers. Yields of some crops, especially corn, are increased somewhat by nitrogenous fertilizers, but best results are obtained by plowing under legumes for green manure. The best use for this soil is for crops. Refer to management group I-3 in the section, Capability Groups of Soils, for other suggestions on management.

Lakeland Series

The Lakeland series consist of infertile sandy soils of low productivity. They occur on gently sloping to sloping upland, mostly near the Navasota and Brazos River bottoms. The soils were developed from acid sandy clay loam. The native vegetation consists of scrubby hardwoods, mostly oaks.

Lakeland loamy fine sand, 1 to 4 percent slopes (La).—The following is a representative profile of this soil:

- 0 to 7 inches, light brownish-gray, slightly acid loamy fine sand; very friable and loose.
- 7 to 46 inches, very pale brown, slightly acid loamy fine sand mottled with yellow and reddish yellow in lower 8 to 10 inches; very friable and loose.
- 46 to 53 inches, very pale brown acid fine sandy loam mottled with yellow and yellowish red; friable when moist but slightly hard when dry.
- 53 to 97 inches, parent material of white strongly acid sandy clay loam mottled with red in the lower part.

This soil is poor for crops and pasture. Special crops, such as melons, peanuts, peas, and small fruits, are most suitable. The soil is very low in natural fertility, and although responsive to fertilizers and good management, it is not very desirable for crops. Refer to management group III-7 in the section, Capability Groups of Soils, for more suggestions on management.

Lakeland loamy fine sand, 4 to 12 percent slopes (Lb).—This soil has a profile similar to that described for Lakeland loamy fine sand, 1 to 4 percent slopes. However, gully erosion has occurred in a few cleared areas where runoff water from above has concentrated. This unit is unsuitable for crops and is very poor for pasture. It is very low in natural fertility. Improved pastures are impractical on this unit, although bermudagrass and bur-clover produce some grazing if they are fertilized. The best use is probably for woodland pasture. Refer to management group VII-1 in the section, Capability Groups of Soils, for other suggested management.

Lufkin Series

The Lufkin series consists of moderately fertile, crusty, claypan soils. They occur on nearly level to sloping upland throughout most of the county and are the most extensive soils in the area. The soils were developed from alkaline to weakly calcareous clay and sandy clay. The native vegetation is post oak-savannah woodland with a thin undergrowth of coarse bunchgrass.

Lufkin fine sandy loam, 0 to 1 percent slopes (Lc).—The following profile is characteristic of this soil:

- 0 to 7 inches, gray slightly acid fine sandy loam; friable when moist but very hard and crusty when dry.
- 7 to 8 inches, light-gray, slightly acid fine sandy loam; change to the subsoil below is abrupt but the contact with the subsoil is generally wavy.
- 8 to 20 inches, gray acid clay; very compact and very slowly permeable; very firm when moist, very sticky when wet, and extremely hard when dry; some areas have brownish-yellow or reddish-brown mottlings in the upper part.
- 20 to 34 inches, gray neutral clay; otherwise the same as layer above.
- 34 to 40 inches, light brownish-gray alkaline clay; otherwise the same as layer above.
- 40 to 64 inches, or more, very pale brown alkaline sandy clay, which is the parent material.

Some areas are flat or weakly depressional and need drainage for successful cropping or pasture development. Sandy mounds occur in many areas but seldom occupy more than 10 percent of the total area. These mounds range from 1 to 3 feet in height and from 20 to 60 feet in diameter.

The soil is fair for crops and pasture. Since the compact claypan is almost impervious to water, plants suffer from lack of water during the hot dry summer months. Crops that are drought resistant or early maturing, or that grow during the cool season, are the most suitable for this soil. Examples of these are cotton, sorghums, oats, and vetch. Natural fertility is moderate, but crops usually respond to additional fertilizer when moisture is adequate. Probably the best use is for production of the suitable crops along with livestock farming. Refer to management group III-1 in the section, Capability Groups of Soils, for additional suggestions on management.

Lufkin fine sandy loam, 1 to 3 percent slopes (Ld).—This soil differs from Lufkin fine sandy loam, 0 to 1 percent slopes, in having greater slope and in being susceptible to erosion (fig. 2). The profiles of the two soils are



Figure 2.—Rough gullied land in Lufkin fine sandy loam; original surface had gradient of about 5 percent.

essentially the same, although the surface soil of this phase has been thinned in some areas by erosion.

This unit is fair for crops and pasture. Drought-resistant, early maturing, or cool-season crops are the most suitable. Crops usually respond to added fertilizers, but the soil is droughty. The best use is probably for production of suitable crops along with livestock farming. Refer to management group III-1 in the section, Capability Groups of Soils, for additional information on management.

Lufkin-Edge complex, 3 to 8 percent slopes (Lf).—This is a complex of highly erodible claypan soils. Although it is dominantly on 3 to 8 percent slopes, the range is from 1 to 12 percent. These soils as a whole are unsuitable for cultivation and are mostly in pastured native woodland. The woodland consists principally of scrubby post oak, blackjack oak, and small yaupon trees. Such vegetation indicates the low productivity of the soils. Components of the complex consist principally of Lufkin and Edge soils; but minor percentages of other soils, some of which are not in established series, are included. The component soils are of such little agricultural value and occur mostly in such small areas that they are not separated individually. All mapped areas contain at least two members of the complex; however, Lufkin or Edge soils, or both, occupy at least 65 percent of each area.

Lufkin fine sandy loam (about 45 percent of the complex):

- 0 to 5 inches, light-gray, slightly acid fine sandy loam; friable when moist.
- 5 to 20 inches, brown, strongly acid clay; very firm; very stiff and sticky when wet.
- 20 to 34 inches, white tuffaceous sandstone, in some places stratified with clay.
- 34 to 48 inches, or more, light brownish-gray sandy clay, the parent material.

In some areas the sandstone is so near the surface that it outcrops in places and only a thin layer of fine sandy loam is present. In other areas the sandstone occurs in typical Edge soil. The shallow areas occupy about 3 percent of the complex.

Lufkin clay (about 1 percent of the complex):

- 0 to 6 inches, dark grayish-brown acid clay; compact; very hard when dry and very stiff and sticky when wet.
- 6 to 30 inches, dark grayish-brown, strongly acid clay; compact; very hard when dry, and very stiff and sticky when wet.
- 30 to 38 inches, pale-brown, slightly acid clay; otherwise similar to layer above.
- 38 to 42 inches, or more, white fine sandy loam streaked with yellow.

A minor part of the complex (about 2 percent) consists of a soil resembling Lufkin sandy loam. This included soil has the following characteristics:

- 0 to 4 inches, grayish-brown light fine sandy loam; very friable.
- 4 to 20 inches, gray light fine sandy loam; porous; very friable.
- 20 to 30 inches, or more, light yellowish-brown sandy clay; moderately hard and compact; moderately stiff and sticky when wet.

Edge fine sandy loam, as described under the Edge series, occupies about 34 percent of the complex. The other main soils are members of the Tabor series, on about 12 percent of the complex; Travis and Gowen soils, each on less than 1 percent; and Gullied land, on about 2 percent.

This complex is unsuitable for crops and is fair to poor for pasture. It has moderate to low natural fertility.

Grasses show some response to fertilizers, but the soils are droughty. Woodland pasture, the present use, is probably the most practical use for this complex. Refer to management group VI-1 in the section, Capability Groups of Soils, for other suggestions on management.

An area of the Lufkin-Edge complex, with dominant slopes of 3 to 8 percent, occurs along Texas Highway 6, about 12 miles southeast of Texas Agricultural and Mechanical College. A detailed map of part of this area is shown in figure 3.

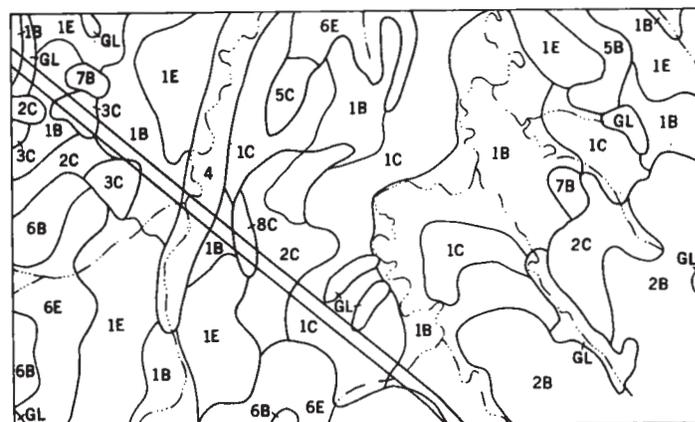


Figure 3.—Detailed soil map of small area of the Lufkin-Edge complex, 3 to 8 percent slopes (Lf). Scale: 1 inch equals 660 feet. Symbols on this detailed map indicate the following soils, some of which do not occupy enough area to be described separately or to be shown on soil maps for the county.

- 1B Lufkin fine sandy loam, 1 to 3 percent slopes.
- 1C Lufkin fine sandy loam, 3 to 8 percent slopes.
- 1E Lufkin fine sandy loam, 8+ percent slopes.
- 2B Edge fine sandy loam, 1 to 3 percent slopes.
- 2C Edge fine sandy loam, 3 to 8 percent slopes
- 3C Lufkin fine sandy loam, shallow phase.
- 4 Gowen loam.
- 5B Thick-surface phase of a soil resembling Lufkin fine sandy loam, 1 to 3 percent slopes.
- 5C Thick-surface phase of a soil resembling Lufkin fine sandy loam, 3 to 8 percent slopes.
- 6B Tabor gravelly loamy fine sand, 1 to 3 percent slopes.
- 6E Tabor gravelly loamy fine sand, 3 to 8 percent slopes.
- 7B Lufkin clay, 1 to 3 percent slopes.
- 8C Travis fine sandy loam, 3 to 8 percent slopes.
- GL Gullied land.

Lufkin-Edge complex, 1 to 3 percent slopes (Le).—This unit of the complex is similar to the one on 3 to 8 percent slopes in all respects except surface gradient. A few areas have slopes of 4 percent. The same soils, and the same approximate proportions of each, occur in this unit as in the more sloping unit. Surface drainage is less rapid, and susceptibility to erosion is less. All of this unit occurs in the south end of the county and has a native cover of scrubby hardwood trees (fig. 4).

This complex of soils is poor for crops and fair for pasture. Drought-resistant, early maturing, or cool-season crops, such as sorghums and oats, are the most suitable. Natural fertility is low. Crops and grasses respond to additional fertilizers, but productivity is restricted by droughtiness. Woodland pasture, the present use, is probably the most practical use for this unit. Clearing of underbrush to permit desirable grasses to become established may be practical. Refer to manage-



Figure 4.—Landscape of Lufkin-Edge complex. Gently sloping terrain in foreground has cover of needlegrass, and sloping terrain in background has extensive cover of scrubby post oak.

ment group III-1 in the section, Capability Groups of Soils, for additional suggestions on management.

Miller Series

The Miller series consists of fertile productive soils in the Brazos River flood plain. These soils are made up of relatively recent sediments that were desposited by floodwaters of the river and that may occasionally be flooded. The natural vegetation is forest consisting mostly of ash, pecan, elm, hackberry, and oak, with an understory of shrubs and vines.

Miller silt loam, 0 to 1 percent slopes (Md).—A representative profile of this soil is as follows:

- 0 to 15 inches, light-brown calcareous silt loam; friable and crumbly.
- 15 to 54 inches, or more, reddish-brown, strongly calcareous clay; crumbly; very firm when moist, very sticky when wet, and very hard when dry.

This soil is excellent for crops and pasture. The most suitable crops are cotton, sorghum, corn, alfalfa, oats, vetch, winter peas, small fruits, and vegetables. The soil is fertile, although increased yields are obtained from additional nitrogen and phosphorus. Refer to management group I-2 in the section, Capability Groups of Soils, for further suggestions on management.

Miller clay, 0 to 1 percent slopes (Mb).—The following is a characteristic profile of this soil:

- 0 to 18 inches, dark reddish-brown calcareous clay; granular; very firm when moist, very sticky when wet, and very hard when dry.
- 18 to 50 inches, or more, reddish-brown, strongly calcareous clay; massive; otherwise similar to layer above.

This soil is very good for crops and excellent for pasture (fig. 5). Cotton, sorghums, corn, alfalfa, oats, vetch, and winter peas are the most suitable crops. Natural fertility is high, but yields are increased by adding nitrogen, especially if the nitrogen is added through legumes. Refer to management group I-3 in the section, Capability Groups of Soils, for additional suggestions on management.

Miller clay, 3 to 8 percent slopes (Mc).—Except for slope, this soil is essentially the same as the associated

Miller clay, 0 to 1 percent slopes. It occupies narrow sloping areas adjacent to intermittent streams and drains that originate in or cross large areas of Miller clay, 0 to 1 percent slopes. It also occurs on short slopes leading down to the Brazos and Little Brazos Rivers. This soil receives excess water from the surrounding level areas of Miller clay. Nearly all of the cultivated areas have been eroded, as evidenced by rills and gullies.



Figure 5.—Alfalfa field on Miller clay.

This soil can be cultivated by using intensive management, but its best use is for pasture. Practically all the pasturage needed for the few livestock on the farms in the Brazos River bottom can be produced on these sloping areas. In consequence most of the smooth highly productive land can be cultivated. However, small areas of this soil can be more practically and conveniently cultivated along with the large smooth areas of adjacent soils than they can be retired to pasture. Refer to management group III-4 in the section, Capability Groups of Soils, for other suggested management.

Mixed Alluvial Land

Mixed alluvial land, 0 to 8 percent slopes (Ma), is a land type consisting of more or less mixed and stratified sandy and clayey alluvium on the lowest part of the flood plain of the Brazos River. It occurs in bends of the river on narrow and irregular areas 100 to 300 yards wide and 8 to 20 feet above the normal waterline. It also includes adjacent river sandbars that were recently deposited. Mixed alluvial land is separated from the higher lying bottoms by short steep escarpments 10 to 20 feet high. The areas are subject to overflow at least once each year. During each overflow they receive some new deposits or they are shifted or removed. Consequently, the surfaces are generally very uneven, although some are nearly level. In most areas, the vegetation consists of a dense growth of cottonwood and willow trees and weeds. A thick stand of bermudagrass occurs in open areas where deposition is not too recent. The river sandbars are without vegetation.

The soil consists of a light reddish-brown loamy sand stratified with silt loam and lenses of silty clay loam. It is structureless and strongly calcareous. There is no uniformity of texture and color; texture ranges from clay to sand, and color ranges from light reddish brown to brown. The thickness of this material is more than 5 feet.

This land type is nonarable because of floods, uneven surfaces, and the shifting and deposition of fresh material. Good pastures can be established on the better areas, but the unit as a whole is only moderately good for pastures. Refer to management group V-1 in the section, Capability Groups of Soils, for other suggestions on management.

Navasota Series

The soil of the Navasota series occupies clayey, poorly drained bottom lands along the Navasota River. It is flooded one to four times a year and usually remains under water for weeks during late winter and early spring. The soil was developed in relatively recent sediments deposited by floodwaters of the Navasota River. The natural vegetation consists of an open forest of elm, ash, and hackberry (fig. 6) and, in low areas, swamp-privet.



Figure 6.—Native hardwood forest on Navasota clay.

Navasota clay, 0 to 1 percent slopes (Na).—A characteristic profile of this soil is as follows:

0 to 8 inches, dark-gray, slightly acid clay; very firm when moist, very sticky and plastic when wet, and very hard when dry.

8 to 12 inches, gray strongly acid silty clay to silty clay loam mottled with yellowish brown; not as firm and hard as layer above.

12 to 54 inches, or more, gray strongly acid clay; very firm when moist, very sticky when wet, and very hard when dry.

This soil is unsuitable for crops because of extended flooding. It is moderate to good for pasture, which is its best use. Pastures can be improved by some clearing and then seeding with adapted pasture plants. Refer to management group V-1 in the section, Capability Groups of Soils, for other suggestions on management.

Norwood Series

The soils of the Norwood series are loamy, fertile, and very productive. They occur on the Brazos River bottoms and were developed in relatively recent sediments deposited by floodwaters of the Brazos River. They are rarely flooded. The native vegetation consisted of a dense forest of pecan, elm, oak, and hackberry and an understory of shrubs and vines.

Norwood silt loam, 0 to 1 percent slopes (Nb).—A characteristic profile of this soil is as follows:

0 to 15 inches, light-brown calcareous silt loam; very crumbly and friable.

15 to 70 inches, or more, light reddish-brown, strongly calcareous silt loam stratified with thin layers of clay loam and fine sandy loam; very crumbly and friable.

This soil is excellent for crops and pasture. It is fertile, but crop yields are increased by adding nitrogen and phosphorus. The phosphorus is more readily available if applied to a legume, and the legume will furnish enough nitrogen for the succeeding one or two crops. This is probably the choicest farmland in the county. The most suitable crops are cotton, corn, alfalfa, oats, vetch, winter peas (fig. 7), vegetables, and small fruits. Refer to management group I-2 in the section, Capability Groups of Soils, for other suggestions on management.

Norwood silt loam, 3 to 8 percent slopes (Nc).—This soil differs from Norwood silt loam, 0 to 1 percent slopes, in slope and extent of erosion. It has a similar profile, but the surface layer is thinner.

The soil is fertile, but productivity can be increased by using nitrogen and phosphorus fertilizer. Although most



Figure 7.—Austrian winter peas grown on Norwood silt loam for plowing under as a green-manure crop.

cultivated areas are eroded, the soil can be used as cropland. Oats, sorghum, and vetch are the most suitable crops. The most practical use for this soil, however, is for pasture. High-yielding pastures can be established. See management group III-4 in the section, Capability Groups of Soils, for other suggestions on management.

Norwood silty clay loam, 0 to 1 percent slopes (Nd).—The following profile is characteristic of this soil:

- 0 to 24 inches, brown calcareous silty clay loam; crumbly and friable when moist, hard when dry, and sticky when wet.
- 24 to 84 inches, or more, calcareous, stratified, pink silt loam and reddish-brown silty clay loam; friable and crumbly when moist, hard when dry, and slightly sticky when wet.

This soil is excellent both for crops and pasture, but it is too valuable for crops to be used for pasture. The most suitable crops are cotton, corn, sorghum, alfalfa, oats, vetch, and winter peas. The soil is fertile, but crop yields can be increased by fertilizing with nitrogen and phosphorus. Refer to management group I-2 in the section, Capability Groups of Soils, for other suggestions on management.

Ochlockonee Series

The members of the Ochlockonee series are productive, well-drained, bottom-land soils. They occur mainly along small local streams and consist of recent sandy sediments washed into the stream bottoms from local upland areas. They are generally flooded once or twice annually. The native vegetation is a dense cover of oak, elm, hackberry, and ash trees and an understory of shrubs and vines.

Ochlockonee loamy fine sand, 0 to 2 percent slopes (Ob).—The following profile is characteristic of this soil:

- 0 to 20 inches, grayish-brown, slightly acid loamy fine sand; very friable and loose.
- 20 to 72 inches, or more, very pale brown acid loamy fine sand; very friable and loose.

This soil occurs as low ridges on the edge of the Navasota River bottom in the northern part of the county. It is above normal overflow but is surrounded by lower bottom land that overflows and remains inundated for long periods. It is therefore generally inaccessible for cultivation. It is poor for crops and moderate to good for pasture. Natural fertility is moderate. The best use is probably for woodland pasture, but clearing the soil and establishing adapted grasses may be feasible. Refer to management group V-1 in the section, Capability Groups of Soils, for additional suggestions on management.

Ochlockonee fine sandy loam, 0 to 1 percent slopes (Oa).—A characteristic profile of this soil is as follows:

- 0 to 8 inches, brown medium acid fine sandy loam with small dark yellowish-brown spots; friable when moist.
- 8 to 25 inches, light yellowish-brown, slightly acid light fine sandy loam with yellowish-brown spots; very friable when moist; stratified in places with clay loam and loamy fine sand.
- 25 to 52 inches, or more, yellow slightly acid loamy fine sand stratified with clay loam and fine sandy loam; very friable when moist.

This soil is very good for crops and excellent for pasture. The most suitable crops are cotton, corn, and sorghum. Natural fertility is moderate, and additional fertilizers give increased yields. The best use is for pasture, because most areas are too small for practical use as cropland.

Refer to management group II-5 in the section, Capability Groups of Soils, for additional suggestions on management.

Ochlockonee-Gowen complex, 0 to 2 percent slopes (Oc).—This complex of soils consists of areas of Gowen clay loam and Ochlockonee loamy fine sand that are too intermixed for separation on the map. It occurs in the Navasota River bottom lands where small drains carrying sandy sediments enter. The soils extend in the direction of streamflow as a series of parallel low ridges and shallow valleylike depressions. The low ridges are Ochlockonee loamy fine sand, and the shallow valleys are Gowen clay loam. When floodwaters of the smaller swifter streams meet the more slowly moving waters of the Navasota River, the sandy materials carried by the smaller streams are deposited to form the ridges.

This unit is unsuitable for cultivation because of extended flooding, especially of the valleylike depressions. For management recommendations, refer to management group V-1 in the section on Capability Groups of Soils.

Payne Series

The moderately productive loamy soil of the Payne series occurs on gently sloping upland near the Brazos River. The parent material consists of alkaline old sediments deposited by floodwaters of the Brazos River. The soil, however, is now above overflow. The native vegetation was prairie grasses, mostly coarse bunchgrass.

Payne clay loam, 0 to 2 percent slopes (Pa).—A characteristic profile of this soil is as follows:

- 0 to 8 inches, dark grayish-brown, slightly acid clay loam; friable when moist but very hard when dry.
- 8 to 22 inches, dark-brown neutral clay loam; slowly permeable; firm when moist and very hard when dry.
- 22 to 36 inches, reddish-brown neutral clay; more friable and permeable than layer above.
- 36 to 54 inches, or more, parent material of yellowish-red alkaline sandy clay with a few calcium carbonate concretions.

This is good soil for crops and for pasture. Cotton, sorghums, oats, vetch, and possibly corn are the most suitable crops. The soil is moderately fertile, but crop yields can be increased somewhat by the use of mixed fertilizers or by plowing under fertilized legumes. The best use for this soil is for crops. Refer to management group II-2 in the section, Capability Groups of Soils, for additional suggestions on management.

Roebuck Series

The soil of the Roebuck series occurs on poorly drained depression areas in the Brazos River bottom. The areas are subject to local flooding and are unfit for crops unless artificially drained. The parent material consists of calcareous recent sediments deposited by floodwaters of the Brazos River. The native vegetation is forest of elm, hackberry, oak, willow, pecan, and ash trees.

Roebuck clay, 0 to 1/2 percent slopes (Ra).—A typical profile of this soil is as follows:

- 0 to 12 inches, brown calcareous clay; granular; firm when moist, very sticky and plastic when wet, and very hard when dry.

- 12 to 24 inches, reddish-brown calcareous clay; very firm when moist, very sticky and plastic when wet, and very hard when dry.
- 24 to 54 inches, or more, reddish-brown calcareous clay mottled with gray; otherwise same as layer above.

This soil is unfit for cultivation and is poor for pasture unless drained. When drained, it is a good soil for crops and pasture. For additional suggestions on management, refer to management group V-1 in the section, Capability Groups of Soils.

Sawyer Series

Only one soil of the Sawyer series occurs in the county. It is sandy and low in productivity. It occurs entirely in the north end of the county on gently sloping upland. The parent material is alkaline sandy clay with some strata of sandy clay loam. The native vegetation is scrubby hardwood forest with an understory of shrubs and vines.

Sawyer loamy fine sand, 1 to 3 percent slopes (Sa).—
The following is a typical profile of this soil:

- 0 to 12 inches, pale brown, slightly acid loamy fine sand; very friable when moist.
- 12 to 16 inches, very pale brown, slightly acid loamy fine sand; very friable when moist.
- 16 to 32 inches, brownish-yellow acid sandy clay loam mottled with yellowish brown; permeable, friable, and crumbly when moist; hard when dry.
- 32 to 40 inches, mottled light brownish-gray and brown acid clay with red spots; friable to firm and slowly permeable when moist, and very hard when dry.
- 40 to 68 inches, mottled red and light-gray acid clay with brownish-yellow spots; slowly permeable; compact; firm when moist and hard when dry.
- 68 to 88 inches, or more, parent material of mottled light-gray, brownish-yellow, and yellowish-red, alkaline sandy clay stratified with sandy clay loam; more friable and less hard than layers above.

This soil is moderate to good for crops and moderate for pasture. Corn, melons, peas, peanuts, small fruits, and cotton are the most suitable crops. Natural fertility is low, but the soil is very responsive to fertilizers and good management and is drought resistant. Refer to management group III-6 in the section, Capability Groups of Soils, for additional management practices.

Tabor Series

The soils of the Tabor series are of moderate to low productivity and occur on gently sloping upland in most parts of the county. They were developed from alkaline to slightly acid sandy clay. The native vegetation consists of a scrubby hardwood forest and an understory consisting of shrubs and vines and a thin stand of bunchgrass.

Tabor loamy fine sand, 1 to 3 percent slopes (Tc).—
The following is a typical profile of this soil:

- 0 to 8 inches, pale-brown, slightly acid loamy fine sand; very friable when moist.
- 8 to 22 inches, very pale brown acid loamy fine sand; very friable and loose.
- 22 to 42 inches, light yellowish-brown acid clay mottled with red and a few spots of pale brown; very slowly permeable; very firm when moist, very sticky when wet, and very hard when dry.

- 42 to 50 inches, mottled light-gray and light yellowish-brown slightly acid clay with a few red spots; otherwise same as layer above.
- 50 to 60 inches, or more, parent material of mottled light-gray, light yellowish-brown, and red, slightly acid sandy clay.

This soil is moderately good for crops and fair for pasture. Natural fertility is moderate to low, but the soil is very responsive to fertilizers and good management, and is drought resistant. The most suitable crops are corn, melons, peas, peanuts, small fruits, and cotton. The soil is best suited to crops. Refer to management group III-6 in the section, Capability Groups of Soils, for additional suggestions on management.

Tabor fine sandy loam, 1 to 3 percent slopes (Ta).—
A characteristic profile of this soil is as follows:

- 0 to 7 inches, pale-brown, slightly acid fine sandy loam; friable when moist, slightly hard when dry.
- 7 to 10 inches, very pale brown, acid fine sandy loam; very friable when moist.
- 10 to 26 inches, light yellowish-brown, strongly acid clay mottled with yellow and with a few yellowish-red spots; very slowly permeable; very firm when moist, very sticky and plastic when wet, and extremely hard when dry.
- 26 to 38 inches, mottled light-gray and brownish-yellow acid clay with a few brown spots; otherwise same as the layer above.
- 38 to 46 inches, mottled very pale brown and light yellowish-brown neutral clay with small red spots; otherwise same as layer above.
- 46 to 54 inches, or more, parent material of white alkaline sandy clay with very pale brown (a few strong brown) spots.

This soil is fair for crops and pasture. Natural fertility is low. The soil responds to fertilizers and good management, but its productivity is limited by droughtiness. Drought-resistant, early maturing, or cool-season crops are the most suitable. A combination of suitable field crops and livestock farming is the most practical use for the soil. Refer to management group III-1 in the section, Capability Groups of Soils, for other suggestions on management.

Tabor gravelly loamy sand, 2 to 6 percent slopes (Tb).—
A characteristic profile of this soil is as follows:

- 0 to 8 inches, light brownish-gray slightly acid gravelly loamy sand; gravel (about 15 percent of the mass) is rounded and ranges from the size of coarse sand up to 2 inches in diameter.
- 8 to 20 inches, very pale brown, slightly acid gravelly loamy sand; gravel is about 60 percent of the mass.
- 20 to 68 inches, light-gray acid sandy clay mottled with dark red; very slowly permeable, very compact; very firm when moist, very sticky and plastic when wet, and extremely hard when dry.
- 68 to 86 inches, or more, parent material of stratified, light-gray, mottled with red, acid clay and yellowish-red acid heavy fine sandy loam, mottled with very pale brown.

This soil is unfit for crops and is poor to fair for pasture. Refer to management group VI-1 in the section, Capability Groups of Soils, for suggestions on management.

Travis Series

The Travis series consists of moderately productive loamy soils on gently sloping upland near the Brazos River bottom land. The parent material is alkaline old sandy sediments deposited by floodwaters of the Brazos

River. The native vegetation consists of a hardwood forest, mostly post oak, and an understory of shrubs and vines.

Travis fine sandy loam, 1 to 3 percent slopes (Td).—The following profile is typical of this soil:

- 0 to 7 inches, pale-brown, slightly acid fine sandy loam; very friable.
- 7 to 12 inches, pink slightly acid light fine sandy loam; very friable.
- 12 to 30 inches, red slightly acid heavy sandy clay; slowly permeable; firm when moist, sticky when wet, and hard when dry.
- 30 to 46 inches, red and yellowish-red acid heavy sandy clay; otherwise same as layer above.
- 46 to 54 inches, or more, red acid light sandy clay or clay loam; friable to firm but becomes more sandy and friable with depth, the parent material.

This soil is very good for crops and good for pasture. It has moderate natural fertility and is very responsive to fertilizers and good management. Cotton, corn, sorghum, melons, peas, and peanuts are the most suitable crops. The most practical use for this soil is for crops. Refer to management group II-4 in the section, Capability Groups of Soils, for additional suggestions on management.

Travis-Axtell fine sandy loams, 3 to 6 percent slopes (Te).—This complex consists of Travis and Axtell fine sandy loams. It is dominantly Travis soil, but Axtell soil covers as much as 20 percent of some areas. Except for slope, the Travis and Axtell soils in this complex are similar, respectively, to the Travis and the Axtell fine sandy loams on 1 to 3 percent slopes. About half of this complex has been cleared and cultivated. Gullies and rills have cut across the cultivated fields, and the surface soil has been thinned by erosion to the point where it is only 6 to 8 inches deep in areas between most of the gullies.

This complex is fair for crops and pasture. Suitable crops are more close-growing crops or those that are broadcast. A minimum of row crops should be used. Heavier fertilization and more intensive management are required than on the less sloping units. For more specific suggestions on management refer to management group III-5 in the section, Capability Groups of Soils.

Travis-Axtell soils, eroded, 6 to 12 percent slopes (Tf).—This complex of soils is similar to Travis-Axtell fine sandy loams, 3 to 6 percent slopes, in profile characteristics, but its surface soil is somewhat thinner, between 4 and 6 inches thick on the average. Over half of this unit has been cleared and cultivated at one time but is now in abandoned-field pasture. Most of these old cultivated areas are eroded; they are cut by shallow and, in a few places, by deep gullies. Small areas of Lakeland loamy fine sand are included in this unit.

This complex is unfit for crops and is only fair for pasture. Cleared areas can be improved for pasture by diverting water from gullies to prevent further cutting. The pastures should be fertilized and overseeded with adapted pasture plants, such as bermudagrass, KR bluestem, and burclover. Probably the most practical use of wooded areas is for woodland pasture. Refer to management group VII-1 in the section, Capability Groups of Soils, for additional suggestions on management.

Wilson Series

The Wilson series is made up of moderately productive loamy soils on the upland in the western part of the county. They have developed in alkaline to calcareous clay and sandy clay. The native vegetation consists of prairie grasses, mostly tall bunchgrass, but pastured areas also have buffalograss and gramagrass. Mesquite trees are common, and scattered post oak occurs in some areas.

Wilson clay loam, 0 to 1 percent slopes (Wa).—A typical profile of this soil follows:

- 0 to 8 inches, dark-gray, slightly acid clay loam; friable and granular when moist, hard when dry, and sticky when wet.
- 8 to 24 inches, dark-gray, slightly acid clay; very slowly permeable; compact; very firm when moist, very sticky and plastic when wet, and extremely hard when dry.
- 24 to 34 inches, olive-brown alkaline clay mottled with dark grayish brown; otherwise similar to layer above.
- 34 to 45 inches, olive-brown alkaline clay; same as layer above except that numerous gypsum crystals are present.
- 45 to 60 inches, or more, alkaline light olive-brown clay, the parent material.

This soil is good for crops and pasture. Cotton, sorghums, oats, vetch, and possibly corn are the most suitable crops. Natural fertility is moderate, and yields are limited by droughtiness. Adding mixed fertilizers or plowing under fertilized legumes will increase crop yields. The best use of the soil is for the production of suitable field crops in connection with livestock farming. Refer to management group II-2 in the section, Capability Groups of Soils, for additional suggestions on use and management.

Wilson clay loam, 1 to 3 percent slopes (Wb).—This soil is like Wilson clay loam, 0 to 1 percent slopes, except that it is more sloping and is susceptible to erosion. The profile characteristics are essentially the same. Crop adaptations and fertility needs are similar. If it is used as cropland, care must be taken to prevent erosion. This unit is as well suited to pasture as to crops. Refer to management group III-2 in the section, Capability Groups of Soils, for other suggestions on management.

Yahola Series

The soil of the Yahola series is calcareous and sandy. Generally it occurs on natural levees along the Brazos River or along old stream channels in the Brazos River flood plain. It consists of recent sediments deposited by floodwaters of the river. Although subject to overflow, it is rarely flooded. The native vegetation includes hackberry, elm, oak, pecan, ash, yaupon, and various shrubs and vines.

Yahola fine sandy loam, 0 to 1 percent slopes (Ya).—The following is a typical profile of this soil:

- 0 to 16 inches, light reddish-brown calcareous fine sandy loam; very friable.
- 16 or 60 inches, or more, reddish-brown strongly calcareous light fine sandy loam stratified with fine sand and silt loam; permeable to freely permeable and very friable.

This soil is very good for crops and pasture. Its best use is for crops. Cotton, corn, alfalfa, peas, vegetables, and small fruits are the most suitable. The soil is moderately fertile, and crop yields can be increased by use of mixed fertilizers or by plowing under fertilized legumes. For additional information refer to management group I-2 in the section, Capability Groups of Soils.

Soil Management

In table 2, estimated average acre yields obtained under prevailing management are shown in columns A, and those attainable under good management over a period of years are shown in columns B. The yield estimates in this table were compiled from information furnished by farmers,

from observations and comparisons made by people familiar with the soils, and from results of experiments made by the Texas Agricultural Experiment Station. The prevailing management practices that produce the yields listed in columns A of table 2 and the good management practices needed to obtain the yields in columns B are discussed in this section.

TABLE 2.—Estimated average acre yields of principal crops on soils of Brazos County, Tex.

[A=average yields now obtained under prevailing management; B=approximate average yields attainable under good management]

Soil	Cotton (lint)		Corn		Sorghums (forage)		Sorghums (grain)		Alfalfa		Pasture	
	A	B	A	B	A	B	A	B	A	B	A	B
	Lb.	Lb.	Bu.	Bu.	Tons	Tons	Bu.	Bu.	Tons	Tons	Acres per animal ¹	Acres per animal ¹
Axtell fine sandy loam, 1 to 3 percent slopes	100	200	8	25	1	2.5	8	25			12	5
Bastrop fine sandy loam, 0 to 2 percent slopes	175	350	20	50		2.5					10	3
Bonham fine sandy loam, 0 to 2 percent slopes	175	300	15	40	2	3	15	40	2		9	3
Bonham clay loam, 0 to 2 percent slopes	175	300	15	40	2	3	15	40	2		9	3
Burleson clay, 0 to 1 percent slopes	150	250	12	30	2	3	12	35	2		9	3
Crockett fine sandy loam, 1 to 3 percent slopes	150	250	12	30	1.5	3	12	35	1.5		10	3
Crockett fine sandy loam, eroded, 3 to 6 percent slopes	100		8		1	2	8	25			18	4
Crockett clay loam, 1 to 3 percent slopes	150	250	12	30	1.5	3.5	12	35	1.5		10	3
Crockett clay loam, eroded, 3 to 6 percent slopes	100		8		1	2	8	25			18	4
Crockett soils, severely eroded, 5 to 12 percent slopes											24	² 6
Derby loamy fine sand, 0 to 2 percent slopes	75	200	8	25							14	4
Edge fine sandy loam, 1 to 3 percent slopes	100	200	8	25	1	2.5	8	25			12	5
Edge fine sandy loam, 3 to 8 percent slopes	75										12	² 5
Gowen fine sandy loam, 0 to 1 percent slopes				50		4		40	2.5		6	1.5
Gowen clay loam, 0 to 1 percent slopes	200	350	18	50	3	4	20	40	3		6	1.5
Gravel pits												27
Gullied land												
Houston-Hunt clays, 1 to 3 percent slopes	175	300	15	35	2	3	15	35	2		9	5
Houston-Hunt clays, 3 to 6 percent slopes	125	250	12	30	1.5	2.5	12	30			10	4
Houston-Hunt clays, severely gullied, 3 to 8 percent slopes											12	² 5
Irving-Axtell loams, 0 to 1 percent slopes	125	200	10	25	1	2.5	10	30			9	5
Irving clay loam, 0 to 1 percent slopes	150	250	12	30	1.5	3	12	35	2		10	5
Kaufman clay, 0 to 1 percent slopes	225	350	20	45	3	4	20	40	3		6	2
Lakeland loamy fine sand, 1 to 4 percent slopes	75		8	20		2					24	² 9
Lakeland loamy fine sand, 4 to 12 percent slopes											24	² 9
Lufkin fine sandy loam, 0 to 1 percent slopes	115	180	10	22	1	2.5	10	25			12	5
Lufkin fine sandy loam, 1 to 3 percent slopes	125	200	10	25	1	2.5	10	30			12	5
Lufkin-Edge complex, 1 to 3 percent slopes					1	2					17	² 4
Lufkin-Edge complex, 3 to 8 percent slopes											17	² 7
Miller silt loam, 0 to 1 percent slopes	275	450	30	60	3	4	20	40	3	3.5		1.5
Miller clay, 0 to 1 percent slopes	250	400	25	50	3	4	20	40	2	3	4	2
Miller clay, 3 to 8 percent slopes	125		10		1	2.5			1		6	2
Mixed alluvial land, 0 to 8 percent slopes											9	2
Navasota clay, 0 to 1 percent slopes											12	2
Norwood silt loam, 0 to 1 percent slopes	300	500	30	60	3	4	20	40	3	3.5		1.5
Norwood silt loam, 3 to 8 percent slopes	125		10		1	2			1	2.5	6	2
Norwood silty clay loam, 0 to 1 percent slopes	300	500	30	60	3	4	20	40	3	3.5		1.5
Ochlockonee loamy fine sand, 0 to 2 percent slopes				50		4		40			14	3
Ochlockonee fine sandy loam, 0 to 1 percent slopes											7	1.5
Ochlockonee-Gowen complex, 0 to 2 percent slopes											9	3
Payne clay loam, 0 to 2 percent slopes	150	250	12	30	1.5	3	15	35			9	3
Roebuck clay, 0 to 1/2 percent slopes		300				4		35			6	2
Sawyer loamy fine sand, 1 to 3 percent slopes		250		35		2.5		30			14	4
Tabor loamy fine sand, 1 to 3 percent slopes	100	200	10	35	1	2.5		30			14	4
Tabor fine sandy loam, 1 to 3 percent slopes	125	200	10	25	1	2.5	10	30			12	4
Tabor gravelly loamy sand, 2 to 6 percent slopes											24	² 7
Travis fine sandy loam, 1 to 3 percent slopes	125	300	15	40	1	3	12	35			10	3
Travis-Axtell fine sandy loams, 3 to 6 percent slopes	100		8	30	1	2.5	8	30			12	3
Travis-Axtell soils, eroded, 6 to 12 percent slopes											24	² 7
Wilson clay loam, 0 to 1 percent slopes	150	250	12	30	1.5	3	12	30	2		10	3
Wilson clay loam, 1 to 3 percent slopes	130	250	12	30	1.5	3	12	30	2		10	3
Yahola fine sandy loam, 0 to 1 percent slopes	150	300	20	40			15	35	2.5		7	2

¹ Column A based on grazing period of 8 or 9 months a year; column B based on grazing period of 9 months a year.

² Establishment of improved pastures of the carrying capacity indicated is difficult and expensive and seldom feasible.

Prevailing Management

Experiments at the Texas Agricultural Experiment station and field tests by some of the better farmers have proved that crop yields can be increased by plowing under winter legumes and by using mixed fertilizers. However, few farmers have improved management practices to the point where the highest practical yields are obtained.

Farmers in the early days of agriculture exploited the soil without making any effort to conserve or to replace plant nutrients. Row crops, principally cotton and corn, still occupy about three-fourths of the cultivated acreage. Before 1940, less than 5 percent of the farms were terraced to reduce runoff and erosion. However, improvements were made more rapidly after a Soil Conservation Service District was organized in 1942.

For many years the fertile bottom-land soils of the Brazos River were almost entirely planted to extensive acreages of cotton and small acreages of corn, alfalfa, and sorghum without replenishing plant nutrients. A modified rotation with the minor crops is now practiced to some extent, but, on most of the acreage, cotton is planted on the same soil several years in succession. For the last few years, some of the better farmers have been increasing their yields by planting inoculated winter legumes and plowing them under in time to plant cotton the succeeding spring, and by using nitrogenous fertilizers where legumes are not grown. The winter legumes are nearly always followed by cotton, because they have not made enough spring growth by the time the land must be prepared for corn. On some of the flat areas of heavy soil in the bottom lands, shallow crossable ditches have been constructed to provide better drainage. Most of the depressed areas that remain wet too late in spring for successful cultivation have been drained by ditching and are now successfully cultivated.

Erosion, as well as cropping, has removed plant nutrients and organic matter from the soils of the prairies and from claypan soils of the forested upland. Active erosion is taking place in all cultivated fields that have slopes greater than about 1 percent and are not adequately protected. A few of the farmers have terraced their fields and cultivate on the contour. But some of the terraces are not properly constructed or maintained, and eventually the fields are damaged by gullies that form either because of concentration of water along the terraces or because of poor terrace outlets.

On the uplands the percentage of row crops is about the same as on the bottom lands of the Brazos River, but less cotton and more corn and sorghum are grown. Consequently, a particular row crop is seldom planted on the same field for more than 2 successive years, but crops selected for rotations are not always the best for maintaining soil fertility and controlling erosion. For example, cotton followed by corn is a poor rotation. Cotton or corn followed by a legume or by a close-growing crop such as oats is a better rotation. Such clean-tilled crops as cotton and corn increase erosion and deplete plant nutrients.

In recent years a few of the better farmers of the upland soils have planted winter legumes, mainly vetch and Austrian winter peas, as green-manure crops and have followed them with cotton. They usually apply 200 to 300

pounds of superphosphate per acre when the winter legume is planted. When vetch, Austrian winter peas, or some other legume does not precede cotton or corn, some farmers apply 150 to 200 pounds of 4-12-4 or 5-10-5 fertilizer under the row crop at the time of planting. A few farmers sidedress their corn with 100 to 150 pounds of a nitrogenous fertilizer, generally nitrate of soda. As a rule, farmers do not fertilize sorghums, but nitrogenous fertilizer will increase the yield. All row crops are cultivated as often as necessary to control weeds. They are hoed at least once to thin the crop and destroy weeds. Cotton is sometimes hoed twice.

A large percentage of the claypan soils of the upland has been taken out of cultivation, mostly since about 1935. Most of these soils are of low fertility and are droughty, and crop yields are low under prevailing management. Increases beyond moderate yields are very difficult to obtain because of the poor physical qualities of the claypan soils. Fields, when abandoned, generally are used for pasture, but usually no special pasture improvement is attempted. The abandoned fields are, as a rule, very low in nitrogen and organic matter, and the only plants that can establish themselves are needle-grasses and annual weeds, which grow on soils of low fertility. Better pasture plants, such as bermudagrass and legumes, can increase in quantity only as the fertility of the soil is built up, either by the slow process of nature or by pasture-improvement practices. Only in the past few years has pasture improvement been considered at all. Some farmers now mow for weed control, and apply fertilizers, especially phosphate, to their pastures.

Wooded areas throughout the county are used for grazing livestock. Only a few livestock producers make any effort to increase the carrying capacity of woodland pastures. Improvement of such pastures is difficult and expensive.

Good Management

Nitrogen is the nutrient most deficient in all soils of Brazos County. Phosphorus and potash are deficient, or are unavailable, in all soils except those of the Brazos River bottom lands. Probably phosphorus and potassium are also somewhat deficient in the lighter textured soils of the bottom lands. All of the soils of the upland are low to very low in available plant nutrients. The lime content is low in the forested claypan soils of the upland and in the deep sandy soils. On these soils additional lime is needed for best growth of legumes. All other soils contain enough lime for the legumes commonly grown. None of the soils are known to be deficient in the minor elements required by crop plants.

The kind and quality of fertilizers needed for highest production on the different soils can best be determined by field tests. Soil analyses made by the soil-testing laboratory of the Texas Extension Service will also indicate the approximate fertilizer needs of the different soils for different crops.

Crops generally do not need additional fertilizer if they follow inoculated legumes that have been fertilized with proper amounts of phosphorus and potash at the time of planting and then plowed under. Winter legumes are most beneficial as green manure if they are plowed under after they have made a good growth in the spring. It is

sometimes difficult to get a stand of field crops following winter legumes.

Most of the soils of the Brazos River bottom lands have been farmed for more than 50 years, and some for 75 years or longer. These soils are very fertile and productive. Decrease in crop yields caused by depletion of plant nutrients probably has not been more than about 25 percent since the soils were put into cultivation. Good yields are still being obtained from crops that do not follow alfalfa or some other legume in the rotation. However, crops that follow alfalfa or annual winter legumes show increased yields, and so do crops that receive appropriate amounts and kinds of fertilizers. Such results indicate that it is possible and practical to increase yields on these river-bottom soils as much as 35 to 50 percent under better management.

The soils of the uplands originally were of low to moderate fertility, and crop yields have steadily declined under continuous cropping and indifferent management. However, the soils are very responsive to good management, and the use of winter legumes for green manure or use of proper amounts and kinds of fertilizer will increase average crop yields as much as 50 percent.

Terraces are needed to reduce runoff and erosion on many of the soils of the uplands. Where complete terrace systems are used, contour cultivation, terrace maintenance, proper terrace outlet protection, and the use of proven soil-management practices are necessary for satisfactory results.

Adequate and timely insect control, especially on cotton, must also be practiced to obtain the best yields possible.

Most pastures in Brazos County have a low carrying capacity in their present condition, and most of the plants are of low nutritive value. Many of the pastures are abandoned fields with a thin cover of annual grasses, mostly needlegrass, annual weeds, and some bermudagrass. Fair to good pastures can be developed by adequate fertilization, land preparation, and seeding with desirable and adapted grasses and legumes. Weed-control and controlled grazing are necessary for establishing and maintaining a good cover.

Capability Groups of Soils

The soils of Brazos County are grouped into capability units and capability classes. This grouping is a summary and interpretation of the facts that we know about the soils. The soils are classified according to their relative suitability for cultivation, grassland, or other uses and the limitations or hazards to their maintenance.

Soil characteristics were considered in making this grouping. They give a clue to soil problems and limitations. For example, claypan soils are droughty because water penetrates them slowly and plant roots do not grow in them easily; or some bottom-land soils are frequently flooded. Other soil characteristics give rise to still other limitations and hazards. In addition, the soils were studied with respect to their crop adaptability, need for and response to management, and yields of common crops.

The grouping of soils into capability classes is based on the permanent hazards and limitations to their use and maintenance. Eight classes are used in this system. Soils in class I have few limitations and no hazards to their

use and maintenance. Such soils are productive and need no conservation practices other than good management for fertility maintenance. Each class above class I has more limitations and hazards than the preceding class. When these limitations and hazards are such that it usually is not practical to overcome them under cultivation under present economic conditions, the soil is placed in class V, VI, VII, or VIII.

In determining the capability class, the problems in using each soil and the treatment needed for each problem are considered. Treatments are simple and easy or they are complex and difficult to apply, depending on the problems in use and the crops grown. There usually are several alternative conservation practices that can be used for maintaining or increasing productivity.

After consideration of the hazards and limitations, productivity, crop adaptability, and possible use and management of each soil, the soils were placed in capability units within the classes of the national land-capability classification.

The capability grouping of the soils of Brazos County is a summary and interpretation of the facts we know about the soils now. It is a consensus of many persons who know and work with these soils, arrived at by study of the way the soils respond when they are used. When more is learned about the soils and how to manage them, the new information should be considered to see if changes are needed in the capability groupings.

Soils Suited to Cultivation

Capability class I

Soils of capability class I have few or no permanent limitations and are subject to only slight erosion or other hazards. This capability class includes three soil management groups (I-1, I-2, I-3).

Management group I-1.—Deep, moderately coarse textured, moderately permeable soil of the forested Coastal Plain on nearly level slopes.

Bastrop fine sandy loam, 0 to 2 percent slopes.

A wide range of crops is adapted to this soil. Those best adapted are cotton, corn, peanuts, peas, melons, small fruits, vegetables, vetch, and winter peas. Sweet sorghums can be grown also, but grain sorghums are not well adapted.

The soil is low in organic matter and has moderate to low natural fertility. However, it is drought resistant and produces moderate to high crop yields if it is adequately fertilized and otherwise well managed.

Soil and crop management.—Good yields of field crops can be produced following winter legumes. The legumes should be grown and plowed under for green manure at least every other year. The best results have been obtained if they have been fertilized with 40 to 60 pounds of P_2O_5 and 50 to 70 pounds of K_2O . Crops not preceded by a legume will produce higher yields if fertilized with 200 to 300 pounds of a mixed fertilizer such as 5-10-5. Corn yields can be increased by sidedressing with 20 to 30 pounds of nitrogen. Melons and vegetables need large amounts of mixed fertilizers for good yields.

The soil of this management group is only slightly susceptible to erosion. Good soil-management practices are

usually adequate to control erosion in most places. Areas with surface gradients of more than 1 percent may require terraces for reducing runoff and erosion.

Pasture management on the soil of management group I-1 is similar to that of soils on management group I-2. Pasture mixtures of Dallisgrass, bermudagrass, and bur-clover produce good yields of nutritious forage, especially if fertilized with phosphate.

Management group I-2.—Deep, loamy, moderately permeable soils of the bottom lands on nearly level areas.

Norwood silt loam, 0 to 1 per- cent slopes.	Miller silt loam, 0 to 1 percent slopes.
Norwood silty clay loam, 0 to 1 percent slopes.	Yahola fine sandy loam, 0 to 1 percent slopes.

Cotton, corn, vegetables, small fruits, alfalfa, sorghum, vetch, oats, annual yellow sweetclover (*Melilotus indica*), hubam clover, and Madrid sweetclover are adapted crops.

The soils of this management group, except the Yahola, are fertile, highly productive, easily worked, and drought resistant. They are well drained and are not susceptible to erosion. Nearly all crops adapted to the climate will grow on them. Plant growth is limited mainly by lack of nitrogen, although additional available phosphorus is needed for high yields of some crops. Yahola fine sandy loam, 0 to 1 percent slopes, is more droughty and less productive than the other soils of the group.

Soil and crop management.—A rotation that includes a winter legume to be plowed under every third year, or that includes alfalfa or sweetclover for 2 years, usually will supply enough nitrogen for succeeding crops for the next 2 years. About 40 to 60 pounds of P_2O_5 will increase the growth of the winter legume and will supply sufficient phosphorus for the succeeding two or three crops. Alfalfa yields can be increased by application of about 80 pounds of P_2O_5 at time of planting. Although vegetables are not widely grown, several kinds can be produced commercially with supplementary irrigation.

Forage yields of pasture plants can be almost doubled by establishing desirable pasture plants and practicing good pasture management. Adapted pasture plants for these soils are common and coastal bermudagrasses, Dallisgrass, Texas Rescue 46, lespedeza, burclover, and hubam clover. Sudangrass, oats, and Johnsongrass also make good grazing. Several combinations of these pasture plants can be grown to extend the grazing period each year. The clovers, Texas Rescue 46, and oats are planted in the fall and the others in the spring.

Improved pastures grown in rotation with row crops improve and maintain soil structure.

Management group I-3.—Deep, fine-textured, slowly permeable soils of the bottom lands on nearly level areas.

Miller clay, 0 to 1 percent slopes.	Kaufman clay, 0 to 1 percent slopes.
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Adapted crops are cotton, sorghums, alfalfa, corn, vetch, *Melilotus indica*, winter peas, oats, Madrid sweet-clover, and hubam clover.

The soils of this group are fertile, moderately productive, and responsive to management. However, physical properties and poor moisture relationships lower productivity during extremely wet or extremely dry years. These soils have essentially the same management requirements as those of the loamy bottom-land soils,

but some crops are not as well adapted to these soils as to the sandier soils.

Soil and crop management.—Nitrogen is the least plentiful plant nutrient. It can be supplied either by legumes or by fertilizer. A legume plowed under in the rotation every 3 years will generally supply enough nitrogen for the succeeding two or three crops. Alfalfa planted in the rotation produces a good supply of nitrogen and opens up the heavy clay subsoils by its deep root penetration. Corn can be successfully grown, but poor moisture relations curtail yields. Erosion is not a problem. Drainage is adequate for successful cultivation, but it can be improved in some areas by shallow crossable ditches.

Capability class II

Capability class II consists of soils with moderate permanent limitations or moderate hazards to their maintenance. This capability class includes five soil management groups (II-1, II-2, II-3, II-4, and II-5).

Management group II-1.—Deep, medium-textured, very slowly permeable soils of the Forested Coastal Plain on nearly level areas.

Irving-Axtell loams, 0 to 1 percent slopes.

Early maturing, drought-resistant, and cool-season crops are best adapted. Examples are cotton, sorghum, oats, Sudangrass, vetch, winter peas, and annual sweet-clover.

The poor physical qualities of the soils of this group are due to their thin surface soils and dense clay subsoils. Droughtiness and moderate natural fertility limit crop yields. However, yields can be increased by using soil-management practices that improve fertility and the physical qualities of the soil.

Soil and crop management.—Productivity of this group can be increased by improving the physical condition of the soils and by using fertilizer or manure. Inoculated and fertilized winter legumes grown and plowed under at least every other year (every year if possible) are beneficial. Crops following a legume that made a good growth need no additional fertilizer. Usually, crops grown the second year after a legume will produce higher yields if fertilized with 150 to 250 pounds of a mixed fertilizer such as 5-10-5. Deep-rooted legumes help to increase water intake and should be grown in the rotation as often as possible. Surface crusting can be lessened by keeping some of the crop residues on the surface. Pastures of even moderate carrying capacity are difficult to establish and maintain. Nativegrasses—andropogons, Indiangrass, and switchgrass—will make a better growth and furnish more grazing than any of the other grasses.

Management group II-2.—Deep, moderately fine to fine-textured, slowly to very slowly permeable soils of the Blackland Prairie on nearly level to gently sloping up-land.

Burleson clay, 0 to 1 percent slopes.	Wilson clay loam, 0 to 1 percent slopes.
Irving clay loam, 0 to 1 percent slopes.	Bonham clay loam, 0 to 2 per- cent slopes.
Payne clay loam, 0 to 2 percent slopes.	Houston-Hunt clays, 1 to 3 per- cent slopes.

Cotton, sorghum, oats, corn, vetch, winter peas, Sudan-grass, alfalfa, annual sweetclovers, and burclover are adapted crops.

Poor physical condition restricts the productivity of these soils, especially the Burleson, Irving, Wilson, and Payne. The compact massive subsoils have poor plant-soil moisture relationships, absorb water very slowly, and restrict root growth. A hard crust forms on the surface after rains and inhibits air movement into the soil.

Soil and crop management.—Productivity can be increased by improving the physical condition of the soils and by using fertilizer or manure. Inoculated and fertilized winter legumes grown and plowed under once every 2 or 3 years increase productivity and improve tilth. Legumes, fertilized with 30 to 40 pounds of P_2O_5 and 15 to 20 pounds of K_2O per acre when planted, make satisfactory growth on these soils. The first planting of legumes will probably grow better if some nitrogen is also added. Deep-rooted legumes help to increase water intake and should be used where possible. Some of the crop residues should be kept on the surface to reduce surface crusting. Good yields of crops that do not follow winter legumes can be obtained by applying 200 to 300 pounds per acre of a mixed fertilizer, such as 5-10-5, at the time of the planting. Corn yields can be increased by sidedressing with 25 to 30 pounds of nitrogen when the corn is 18 to 24 inches high.

The Bonham soils have friable and crumbly upper subsoils over very firm lower subsoils. They have better tilth and moisture supplies than the other soils in this group, and their productivity is higher.

Yields can be maintained even though legumes are plowed under less often and 15 to 20 percent less fertilizer is used. Oats, or a combination of oats and vetch, planted in the fall and fertilized with a mixed fertilizer, will make good winter and early spring grazing. If the mixture is not grazed after about the middle of March, it can be cut for hay late in spring when the oats are in the dough stage, or it can be harvested later for grain. The grain crop can be increased if the oats are topdressed early in spring with about 30 pounds of nitrogen.

Corn, although commonly grown on the soils of this management group is somewhat uncertain because of the lack of moisture during the critical period late in June and in July. However, moderate yields of adapted hybrid varieties can be produced during most years if the soils are properly fertilized.

Alfalfa can be grown on these soils and will produce average yields of 1 to 2 tons per acre if properly fertilized. Yields are not high, but the alfalfa produces a nutritious feed for livestock and increases the productivity of the soils for the succeeding one or two crops.

Areas that have slopes of more than 1 percent are susceptible to water erosion. These areas can be protected with terraces in combination with cover crops.

The Burleson and Irving soils occupy nearly level areas and have very slow surface drainage. They stay wet until rather late in spring, and planting is often delayed. Drainage on croplands can be improved with shallow ditches that can be crossed by tillage implements.

Pastures on these soils include buffalograss, mixed bluestem, bermudagrass, and some less important annual grasses. In general, the pastures are fair to poor. They can be improved by applying 200 to 300 pounds of mixed

fertilizer and by overseeding with burclover if none is present. Weed control and controlled grazing will be necessary also. Good pastures on these soils will support a cow for 9 months on about 5 acres.

Management group II-3.—Deep, moderately coarse textured, slowly permeable soil of the Blackland Prairie on smooth upland slopes.

Bonham fine sandy loam, 0 to 2 percent slopes.

Adapted crops are vetch, winter peas, Sudangrass, alfalfa, annual sweetclover, cotton, sorghum, and oats.

The soil of this group produces well if properly managed. Fertility must be kept high by use of fertilizers and green-manure crops.

Soil and crop management.—Deep-rooted legumes help to increase the water-holding capacity and water intake of this soil. Surface crusting is a problem that can be partially overcome by keeping an abundance of crop residues on the surface. Proper management of crop residues and use of green-manure crops will materially affect the production of cash crops. This will also help to prevent erosion, which is a problem on areas having 1 to 2 percent slopes.

Alfalfa can be grown on this soil. It will produce 2 to 2½ tons per acre if properly fertilized. Since alfalfa is a heavy feeder on phosphorus, this fertilizer will have to be applied for best yields.

Management group II-4.—Deep, moderately coarse textured, slowly permeable soil of the Forested Coastal Plain on smooth gently sloping uplands.

Travis fine sandy loam, 1 to 3 percent slopes.

This soil is suited to a wide variety of crops. The best adapted crops are cotton, corn, peanuts, peas, melons, small fruits, vegetables, vetch, and winter peas. Sweet sorghum can be grown also, but grain sorghum is not well adapted.

This soil is low in organic matter and moderate to low in natural fertility. It is, however, very responsive to fertilization and other soil-management practices. The soil is drought resistant and can produce moderate to high yields if it is adequately fertilized and otherwise well managed.

Soil and crop management.—Good yields of field crops can be produced following winter legumes. The legumes should be grown and plowed under for green manure at least every other year. The best results have been obtained when the legumes are fertilized with 40 to 60 pounds of P_2O_5 and 50 to 70 pounds of K_2O . Crops not preceded by a legume will produce higher yields if fertilized with 200 to 300 pounds of a mixed fertilizer such as 5-10-5. Corn yields can be increased by side dressing with 20 to 30 pounds of nitrogen. Melons and vegetables need large amounts of mixed fertilizers for good yields.

This soil is only slightly susceptible to erosion. Good soil-management practices usually are adequate to control erosion in most places. Areas with slopes of more than 1 percent may require terraces for reducing runoff and erosion.

Management group II-5.—Deep, loamy bottom-land soils with nearly level surfaces.

Ochlockonee fine sandy loam, Gowen clay loam, 0 to 1 percent slopes.

Gowen fine sandy loam, 0 to 1 percent slopes.

This management group consists of alluvial soils that have moderate fertility. They are suitable for cultivation. Although they are flooded once or twice a year early in spring, they remain under water only about 24 hours. Many areas are too small, narrow, irregular, and inaccessible for practical use as cropland. All of these soils are suitable for improved pastures. The soils are probably low in phosphorus and nitrogen and moderately well supplied with lime and potash.

Soil and crop management.—Winter legumes or cover crops, adequately fertilized and plowed under every 1 or 2 years, will increase the productivity of the soil. Cotton, corn, or sorghums should be fertilized with about 200 pounds of a complete fertilizer, such as 5-10-5, when they do not follow a fertilized legume. Alfalfa is not grown on these soils but would probably produce moderate yields.

These soils are excellent for improved pastures. Such plants as Dallisgrass, coastal bermudagrass, Texas Rescue 46, and burclover make good growth and grazing.

Capability class III

Capability class III consists of soils that have severe permanent limitations or maintenance hazards. This capability class includes seven soil management groups (III-1, III-2, III-3, III-4, III-5, III-6, and III-7).

In five of the groups, risk of erosion is the chief limitation; in the other two, the soils are so sandy that they do not hold much moisture.

Management group III-1.—Deep, moderately coarse textured, very slowly permeable soils of the forested Coastal Plain on gentle slopes.

Axtell fine sandy loam, 1 to 3 percent slopes.	Tabor fine sandy loam, 1 to 3 percent slopes.
Lufkin-Edge complex, 1 to 3 percent slopes.	Edge fine sandy loam, 1 to 3 percent slopes.
Lufkin fine sandy loam, 1 to 3 percent slopes.	Lufkin fine sandy loam, 0 to 1 percent slopes.

Early maturing, drought-resistant, and cool-season crops are best adapted to the soils of this management group. Examples are cotton, sorghum, oats, Sudangrass, vetch, winter peas, and annual sweetclover.

The tilling of these soils is poor because of their thin surface soils and dense clay subsoils. Much of the rainfall is lost by runoff. Droughtiness and moderate natural fertility limit crop yields. However, productivity can be increased by using soil-management practices that reduce runoff and increase fertility.

Soil and crop management.—These soils occur on gentle slopes and are susceptible to erosion. Terrace systems will reduce erosion and give the water more time to soak into the very slowly permeable subsoils. The effectiveness of terraces for erosion control is increased by maintaining alternate terrace intervals in small grain and legume mixtures.

The fertility and poor physical qualities can be improved by growing and plowing under fertilized winter legumes, such as vetch. These legumes should be grown at least every other year, and every year if possible. Part of the crop residue left on the surface will reduce surface crusting.

Cotton yields were increased about 35 percent following the use of vetch and fertilizer in a 10-year experiment on Lufkin fine sandy loam, 1 to 3 percent slopes (12).² Yields

of corn following the cotton were increased about 40 percent.

Pastures of even moderate carrying capacity are difficult to establish and maintain because of the droughty soils and the long, dry, and hot summers. Currently, the best pasture combination is bermudagrass and burclover; in low areas that receive extra water, some Dallisgrass is included. Grass production can be increased by fertilization, weed control, and grazing that will allow reseeding.

The Edge soil is more crumbly in the upper subsoil and is a little less droughty than the other soils of this group. Some small areas make fair sites for home orchards and gardens.

Management group III-2.—Deep, moderately coarse textured to moderately fine textured, very slowly permeable soils of the Blackland Prairie on gentle slopes.

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

Adapted crops are cotton, sorghum, corn, Sudangrass, vetch, oats, winter peas, alfalfa, and annual sweetclover.

Soil and crop management.—Productivity can be improved by applying fertilizers according to needs indicated by soil tests. Erosion can be controlled by the use of terraces with grassed waterways and a rotation that includes a green-manure crop every 4 years. Crop residues should be returned to the soil and a cover crop grown as often as practicable.

Management group III-3.—Deep, fine-textured, slowly permeable soils of the Blackland Prairie with moderate erosion on moderate slopes.

Houston-Hunt clays, 3 to 6 percent slopes.

Adapted crops are cotton, vetch, Sudangrass, winter peas, annual clovers and sorghum.

These soils are moderately eroded. Water rapidly runs off unprotected areas and very little soaks into the ground during heavy rains.

Soil and crop management.—The productivity of these soils can be restored by heavy fertilization and by growing winter legumes as green-manure crops. It can be maintained by using a cropping system that includes no more than one-third of the land in row crops each year.

Pastures are difficult and expensive to establish on these eroded soils. Probably the quickest way to establish them is to build temporary diversion terraces above eroded areas and gully heads. These areas should then be plowed or disked, heavily fertilized, and planted to winter legumes. The pasture could be overseeded in the spring with KR bluestem. Restricted grazing and other pasture-management practices would be necessary also. A less expensive but slower way is (1) to exclude grazing, (2) divert water from gullies, and (3) fertilize and overseed stabilized spots with burclover in the fall and KR bluestem in the spring. The eroded areas will gradually become sodded as these grasses reseed and spread.

Management group III-4.—Deep, medium to fine-textured soils of the bottom lands on moderate slopes.

Miller clay, 3 to 8 percent slopes.	Norwood silt loam, 3 to 8 percent slopes.
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Alfalfa, oats, sorghum, and cotton are adapted to these soils.

² Italic numbers in parenthesis refer to literature cited, p. 58.

Soil and crop management.—Field tests indicate that fertilizer should be applied before seeding time. Sloping areas in cultivation can be protected from erosion by diverting water from them to sodded channels. Since these areas are usually farmed along with larger areas of more productive soils, some special care and attention should be given them. Barnyard manure and old straw-stacks should be scattered more heavily on these areas to add organic matter and help prevent erosion.

Management group III-5.—Deep, moderately coarse textured, slowly permeable soils of the forested Coastal Plain on moderate slopes.

Travis-Axtell fine sandy loams, 3 to 6 percent slopes.

Adapted crops are cotton, corn, peas, vetch, winter peas, sorghum, hubam clover, and oats.

These soils have many of the same characteristics as the soils of management group II-4. They are more sloping, however, and have heavy slowly permeable subsoils.

Soil and crop management.—Productivity is more difficult to increase and maintain on these soils than on the soil of management group II-4. It will be necessary to control erosion and increase their fertility and organic matter. Erosion can be controlled in cultivated areas by terracing and stripcropping, provided that no more than one-half of the cultivated area is planted to row crops each year. Land not in row crops can be planted to legumes, broadcast crops, or grass. Winter legumes fertilized with phosphorus and plowed under at least every other year, and if possible every year, will increase fertility and production.

Management group III-6.—Deep, coarse-textured, slowly permeable soils of the forested Coastal Plain on gentle slopes.

Sawyer loamy fine sand, 1 to 3 percent slopes. Tabor loamy fine sand, 1 to 3 percent slopes.

Adapted crops are cotton, corn, sorghum, peanuts, melons, peas, small fruits, vegetables, vetch, crotalaria, and winter peas.

These soils are low in fertility and very low in organic matter. Plant nutrients are soon leached from the sandy surface soils. However, these are some of the most drought-resistant soils of the upland in the county. The thick sandy surface soils readily absorb water, but the slowly permeable subsoils retard its downward movement so that adequate moisture is generally available for crops. Erosion is not a problem unless water is concentrated.

Soil and crop management.—Winter legumes or cover crops, adequately fertilized and plowed under every year if possible, will increase the fertility and organic matter of these soils. Fertilizer probably can be better utilized if part of it—200 to 300 pounds of 5-10-5 or its equivalent—is applied to the cover crop and the rest—100 to 200 pounds of 5-10-5—is applied when the succeeding crop is planted. Corn yields can be increased also by side dressing with 20 to 30 pounds of nitrogen. Oats as a rule are not suitable for a grain crop, but a mixture of oats and vetch, heavily fertilized, will produce good winter grazing or a fair yield of hay. Melons, vegetables, and small fruits will produce high yields if heavy applications of fertilizer are used.

Pastures are poor because of the low fertility, low content of organic matter, and poor vegetative cover. Carrying capacities can be raised by fertilizing with 200 to 400 pounds of 5-10-5 fertilizer per acre and overseeding with Texas Rescue 46 and burclover. If a good cover is

to be maintained, it will be necessary to fertilize pastures each year, control weeds, and allow reseeding.

Management group III-7.—Deep, coarse-textured, rapidly permeable soils of the Forested Coastal Plain on gentle slopes.

Derby loamy fine sand, 0 to 2 percent slopes. Lakeland loamy fine sand, 1 to 4 percent slopes.

Peanuts, melons, peas, small fruits, corn, sorghum, nursery plants, summer peas, vetch, and vegetables are adapted crops.

Low fertility and inadequate moisture cause relatively low yields on these deep sandy soils. Fertilizers are leached readily from the soil, and lasting fertility cannot be built up. The soils are droughty because water is not retained in the open porous sand. However, crops respond quickly to fertilizers and good management when there is adequate moisture. These are some of the best soils in the county for melons and small fruits. They are also good for nursery plants and cuttings.

Soil and crop management.—Cover crops of legumes and crop residues plowed deeply into the soil increase organic matter and fertility. Heavy applications of mixed fertilizers are needed to produce fair yields of most crops. Because the fertilizers are leached readily, the most benefit is obtained by applying small amounts several times during the growing season. Fertilized winter legumes, plowed under every year, will increase crop yields. Additional applications of a mixed fertilizer to the crop following the legume, especially if applied as a side dressing, will increase yields also. The kind and quantity of fertilizer depend on the crop. Fruit, melon, and vegetable crops require heavier fertilization than field crops.

Water erosion is not a problem on these soils. Some wind erosion occurs when the fields are left bare after such crops as peanuts. A cover crop of oats, vetch, or winter peas will effectively prevent soil blowing on these areas.

Pastures are poor because of low fertility, low organic matter, and leaching of plant nutrients. Bermudagrass and burclover are the best adapted plants now known but require heavy fertilization to produce much grazing.

Capability class IV

The soils of capability class IV have very severe permanent limitations or hazards. They are suitable for cultivation between long periods of permanent vegetation, or may be used for limited cultivation. This capability class has one soil management group (IV-1).

Management group IV-1.—Deep, loamy, very slowly permeable soils of the Blackland Prairie on moderate slopes with moderate to severe erosion.

Crockett fine sandy loam, eroded, 3 to 6 percent slopes. Crockett clay loam, eroded, 3 to 6 percent slopes.

Adapted crops are sorghum, oats, vetch, Sudangrass, winter peas, and annual sweetclover.

About three-fourths of the area of the soils of this group has been damaged by moderately severe erosion. About half of the surface soil has been lost. Water runs off of unprotected areas rapidly, and very little soaks into the ground during heavy rains.

Soil and crop management.—The eroded Crockett soils, if cultivated, need to be properly terraced to reduce runoff and erosion. The productivity can be restored by heavy fertilization, by growing and plowing under winter legumes for green-manure crops, and by planting close-growing or broadcast crops in the summer for 3 or 4 years in succession. Productivity can be maintained on these eroded soils by proper fertilization and by using rotations that include grain crops, cover crops annually, or grasses in the rotation.

Pastures are difficult and expensive to establish on these eroded soils. They can be most quickly established by building temporary diversion terraces above eroded areas and gully heads. The eroded areas should then be plowed or disked, heavily fertilized, and planted to winter legumes. The area could be overseeded in the spring with KR bluestem. Restricted grazing and other pasture-management practices would be necessary also. A less expensive but slower way is to exclude grazing, divert water from gullies, and fertilize and overseed stabilized spots with burclover in the fall and with KR bluestem in the spring. The eroded areas will gradually become sodded as these grasses reseed and spread.

Soils Not Suited to Cultivation

Capability class V

Soils of capability class V are suitable for permanent vegetation or grazing with few or no permanent limitations or slight hazards. This capability class consists of one management group (V-1).

Management group V-1.—Deep level soils, subject to frequent damaging overflows or moderate wetness.

Navasota clay, 0 to 1 percent slopes.	Mixed alluvial land, 0 to 8 percent slopes.
Ochlockonee-Gowen complex, 0 to 2 percent slopes.	Roebuck clay, 0 to ½ percent slopes.
Ochlockonee loamy fine sand, 0 to 2 percent slopes.	

This management group consists of alluvial soils that have moderate fertility but are not suitable for cultivation in their present condition.

Soils in the Navasota River flood plain, principally Navasota clay and Ochlockonee-Gowen complex, are flooded one to four or more times a year and usually remain under water several weeks at a time, especially late in winter and early in spring. Only a small part of this flood plain is cleared of native trees. The area is used mainly as woodland pasture. The woody cover is not dense in most places, and fair stands of buffalograss and bermudagrass are present in open areas. The grasses will spread naturally on most cleared areas and form a good cover within 1 to 2 years. Phosphorus added to these soils every 2 or 3 years will stimulate grass growth. Some low wet areas remain under water for long periods and have a dense cover of swamp-privet and other water-tolerant shrubs. These areas are practically useless for pasture unless drained.

Ochlockonee loamy fine sand, 0 to 2 percent slopes, occurs on low ridges in the Navasota River flood plain, but is above normal overflow. However, since these low ridges are surrounded by the lower lying periodically

flooded soils, they are inaccessible for farming operations in the spring. Ochlockonee loamy fine sand is moderately fertile. If cleared, fertilized, and planted to adapted pasture plants, about 3 acres will support a cow for 9 months.

Roebuck clay, 0 to ½ percent slopes, occurs in wet depressions in the Brazos River flood plain. In its present condition it is unfit for pasture or crops. Most areas of this soil can be drained. Once drained, they can be farmed or developed into good pasture land. Drained areas have about the same requirement for management for pasture or cropland as the soils of management group I-3.

Mixed alluvial land, 0 to 8 percent slopes, occurs in small irregular areas adjacent to the channel and generally in bends of the Brazos River. This is mixed sandy and clayey material with an uneven to billowy surface. It is occasionally to frequently flooded and is unfit for cultivation. However, the soil materials are fertile and drought resistant, and areas of this land type seeded to adapted grasses and legumes will produce excellent grazing.

Capability class VI

Soils of capability class VI are suitable for permanent vegetation or grazing; they have moderate permanent limitations or moderate hazards. This capability class includes one soil management group (VI-1).

Management group VI-1.—Deep moderately coarse to coarse textured soils of the Forested Coastal Plain on moderate slopes.

Edge fine sandy loam, 3 to 8 percent slopes.	Tabor gravelly loamy sand, 2 to 6 percent slopes.
Lufkin-Edge complex, 3 to 8 percent slopes.	

Good pasture management that includes reseeding, fertilizing, and control of grazing is needed on these soils to prevent further erosion. In some areas diversion terraces above the gullies may keep water out of them and prevent further damage. For further recommendations regarding pasture or tree management, see your local Soil Conservation District technician or your county agent.

Capability class VII

Soils of capability class VII have severe limitations or severe hazards but are suitable for permanent vegetation or grazing. This capability class consists of one management group (VII-1).

Management group VII-1.—Eroded soils on steep slopes.

Lakeland loamy fine sand, 4 to 12 percent slopes.	Travis-Axtell soils, eroded, 6 to 12 percent slopes.
Crockett soils, severely eroded, 5 to 12 percent slopes.	Houston-Hunt clays, severely gullied, 3 to 8 percent slopes.

Erosion and low fertility are common to all of these soils. Those areas that have been cultivated were soon abandoned because of severe erosion and low production. They can be made to grow some grass if properly fertilized and seeded. It has not been found economical to clear wooded areas for pasture. The pasture produced will not pay the cost of expensive clearing operations. For

the best information regarding the use and management of the soils of this group, the local representative of the Soil Conservation Service should be consulted.

Capability class VIII

Capability class VIII contains soils or land types not suited to cultivation or grazing, but which may be suited to wildlife, recreational purposes, or vegetation for watershed protection. This capability class includes one management group (VIII-1).

Management group VIII-1.—Land unsuited to productive vegetation.

Gravel pits.

Gullied land.

Tree plantings for wildlife cover and food may be made on some areas of these land types. Farm ponds may be constructed in some of the larger gullies.

Soil Associations

There are three general kinds of landscapes in Brazos County: (1) flood plains, (2) prairies, and (3) post-oak savannahs. These broad landscapes are divided into soil associations, which are described in this section. As a whole, each soil association area is used for different kinds of agriculture and has somewhat different potentialities for agricultural use. A map of the soil associations of Brazos County is given at the end of this report. The total acreage and the acreage according to degree of suitability for crops are given for each soil association in table 3.

Soil Associations of the Flood Plains

The bottom lands occupy about 26 percent of the county. They consist of three soil associations: (1) the Gowen-Ochlockonee (flood plains of local streams), (2) the Miller-Norwood (flood plains of Brazos River), and (3) the Navasota (flood plains of the Navasota River).

Gowen-Ochlockonee soil association (flood plains of local streams) (GO).—This association covers about 33,000 acres. The soils are moderately well suited to crops and well suited to pasture. When flooded, they remain under water generally less than 24 hours. About 82 percent of the association consists of Gowen soils, and 18 percent, of Ochlockonee soils. Areas are scattered throughout most of the county, but only the areas along the larger tributary streams are shown on the soil association map.

About 41 percent of these bottom lands has been cleared. Although about half of the cleared areas have been cultivated, practically none of them are in cultivation now. Some areas are too small and narrow to be used for fields. However, the soils of this association are naturally fertile and have good plant-soil moisture relationships. Very good pastures can be established on them. In many places along the streams, the worth of the soils for pasture can be greatly increased by clearing, seeding to desirable grasses and legumes, and controlling weeds. Burclover, lespedeza, bermudagrass, and Dallisgrass are desirable pasture plants that will thrive on these bottom lands if fertilized.

Miller-Norwood soil association (flood plains of Brazos River) (MN).—This association consists of about 46,000 acres of reddish calcareous soils, which are fertile, very productive, and rarely inundated. Of this total, about

TABLE 3.—Acreage according to degree of suitability for crops and total acreage for each soil association, Brazos County, Tex.

Landscape and soil association	Suitability for crops						Total
	Excellent	Very Good	Good	Fair	Poor	Unsuitable	
Flood plains:	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Gowen-Ochlockonee (flood plains of local streams)		33,300					33,300
Miller-Norwood (flood plains of Brazos River)	13,600	25,900			3,900	2,900	46,300
Navasota (flood plains of Navasota River)					600	17,100	17,700
Total for bottom lands	13,600	59,200			4,500	20,000	97,300
The Prairies:							
Crockett-Irving soil association (prairie uplands and old stream terraces)		1,400	36,500	2,700	4,100	1,100	45,800
Post-Oak Savannahs:							
Lakeland-Derby (deep sands)				400	7,600	5,400	13,400
Lufkin-Edge (claypan and shallow soils)					12,700	31,500	44,200
Lufkin-Tabor soil association (claypan soils)		1,600	1,800	134,300	6,900	21,800	168,400
Total for forested uplands		1,600	1,800	134,700	27,200	58,700	224,000
Total for soil associations ¹	13,600	62,200	38,300	137,400	35,800	79,800	¹ 367,100

¹ Additional areas not listed are Gravel pits, 200 acres, and Gullied land, 5,820 acres. Total acreage is therefore 373,120.

38,000 acres occur in large, smooth, uniform areas that are well suited to crops; 6,000 acres either occupy slopes or need drainage and are moderately well suited to crops but well suited to pasture; and 1,700 acres of nonarable mixed alluvium that is suitable for pasture.

The Miller-Norwood soil association is composed of the following soils: Kaufman, less than 1 percent; Norwood, 26 percent; Miller, 62 percent; Roebuck, 5 percent; Yahola, 2 percent; and Mixed alluvial land, 4 percent. The soils form a general pattern of distribution. The Mixed alluvial land lies in low areas in bends of the Brazos River. The loamy soils occupy the natural levees along the river, the old stream channels, and other higher lying areas. The clay soils occupy the large flat areas.

The Miller-Norwood soil association area is characterized by large farms of 2 to 500 acres that are operated by owners. However, plantation-type farms of 1,000 to 5,000 acres are operated in some parts of the bottom lands by croppers and hired laborers. A cash-crop type of agriculture is practiced. Cotton is the main crop and produces a higher return per acre than any other crop. Alfalfa is well adapted to soils of the Brazos River bottom lands, and some farmers grow it in crop rotations to increase the yield of cotton or other crops following it. Green-manure crops, such as vetch and Austrian winter peas, are now grown by some of the farmers. High yields of fall-sown oats are obtained. Corn is not grown extensively, but good yields are produced. The main problem of farmers on soils of this association is to plan a system of crop rotations that will eliminate the one-crop system but will still provide a high income from the expensive and highly productive land.

Navasota soil association (flood plains of Navasota River) (NA).—This association consists almost entirely of Navasota clay and small acreages of Gowen and Ochlockonee soils. The soils are moderately fertile. They are flooded two or three times a year and remain so for weeks at a time. As a result they are not suited to crops but are moderately well suited to pasture. Their best use is for livestock farming on a large scale. Most of this bottom land is under a hardwood forest that has an understory of haw bushes and other water-tolerant brush. The association is made up of large holdings, very few of which are resident operated. The acreage is used almost entirely for grazing. The pastures can be improved considerably by clearing the trees and underbrush. The bottom lands of the Navasota River are best suited to livestock farming on a large scale.

Soil Association of the Prairies

The prairies cover about 13 percent of the county and occur for the most part in an irregular strip along the northwestern border. The prairie soils are dark, moderately fertile, and somewhat droughty.

Most of the prairie area can be used for crop production without severe erosion hazard. The northern three-fourths is primarily gently rolling and nearly level. The southern part is mainly nearly level. A few small areas of nearly level prairies, which are too small to be shown on the soil association map, occur on terraces of the Brazos

River in other parts of the county. They are included in one soil association—the Crockett.

Crockett soil association (prairie uplands) (Ci).—This association on the uplands and terraces is composed of the following soils: Bonham, about 2 percent; Crockett, 59 percent; Wilson, 9 percent; Houston-Hunt, 8 percent; Irving, 11 percent; Burleson, 9 percent; and Payne, less than 1 percent. The Irving, Burleson, and Payne soils, which developed from old stream alluvium, occur on terraces of the Brazos River in a rather well-defined topographic pattern. The Wilson soils occupy some nearly level areas, streamhead positions, and shallow valleys within the gently rolling prairies. Crockett soils occupy sloping and gently sloping areas above the Wilson. However, Crockett soils also occur on nearly level areas, in streamhead positions, and in shallow valleys. Houston-Hunt soils occur on gently sloping areas in association with the Crockett soils and on sloping to strongly sloping areas below the Crockett and other areas of Houston-Hunt.

A combination of cash-crop and livestock production is favored by farmers in this soil association area and is apparently its best use. Cotton is the main cash crop, but corn, sorghum, and oats are also grown, either for cash or for feed crops. The prairies, as a whole, are moderately fertile, and moderately productive for adapted crops. Approximately 20 percent of the area is in cultivation, and the rest is in pasture. Farmers generally use the smoother areas for crops, although some are used for pasture along with the sloping and eroded land. All of the sloping areas are highly susceptible to erosion, and usual problems of soil management are erosion control and maintenance of soil productivity. A high percentage of farms are operated by owners in this part of the county. The farmers keep their farms in good repair, and apparently are making a comfortable living. Farms average about 160 acres.

The range of adapted crops is narrow because of the droughtiness of the soils. Most of the soils have compact, clay subsoils that make them unsuitable for orchards and vegetable crops. High summer temperatures and high rates of evaporation, along with uneven rainfall distribution, are other factors that limit the range of adapted crops. However, most of these problems are common throughout the county and present no unusual difficulties in crop selection and soil management.

Soil Associations of the Post-Oak Savannahs

The post-oak savannahs make up about 61 percent of the county. They consist of three soil associations: (1) Lakeland-Derby (deep sands), (2) Lufkin-Edge (claypan and shallow soils), and (3) Lufkin-Tabor (claypan soils).

Lakeland-Derby soil association (deep sands) (LD).—The soils of this association are the least important in Brazos County. They occur in isolated areas, principally along the Brazos and Navasota Rivers. They are poor for crops and very poor for pasture but are moderately productive when used for special crops. The soils, except for small strongly sloping areas, are not susceptible to erosion and have good drainage. They are very low

in fertility but respond to good management when special crops are grown.

Lakeland soils cover about 13,000 acres, or more than 99 percent of the total acreage of this association. The remaining 400 acres are occupied by the Derby soil. Most areas are gently sloping and sloping, but some occur on strong slopes. About half of the total area is in scrub hardwood forest and has a dense underbrush of yaupon. Only about 500 acres of the other half are cropped; the rest is in abandoned-field pastures.

Livestock production is the principal enterprise in this soil-association area. These soils produce about 10 cow-acre-days of grazing a year. Small yaupon trees provide considerable browse for livestock, especially during winter months. The soils are poor for general field crops but have potentialities for growing watermelons, peanuts, peas, and other special crops. They respond to good management, which includes the growing of green-manure crops and heavy fertilization. The area of these sandy soils in the vicinity of Millican is used for growing watermelons and other special crops. The returns from improving pastures on soils of the Lakeland-Derby association probably will not pay for the cost of improvement. Most areas of this association occur on large holdings.

Lufkin-Edge soil association (claypan and shallow soils) (LE).—This association consists of grayish, droughty, claypan and shallow soils that are very low in fertility and productivity. It occurs in the southern part of the county, beginning on a general east-west line about 6 miles southeast of College Station and extending south to the Brazos River flood plain.

The principal soils in this association are Lufkin and Edge, but small areas that are shallow over tuffaceous sandstone are included. The soils are so intermixed that they are mapped together as the Lufkin-Edge complex. The shallow soils comprise less than 3 percent of the total area of the complex. Slopes range from about 1 to 12 percent. The gently sloping soils, those with dominant slopes of less than 3 percent, comprise about 40 percent of the area, and the sloping soils, those with dominant slopes of 3 to 12 percent, occupy the rest of the area. Gully erosion is common on abandoned fields and at streamhead positions is evident even in the forested areas.

The agriculture of this soil association area consists of livestock production on large holdings. About 25 percent of the land has been cleared and farmed. Although a few scattered small fields are used for raising field crops, most of the cleared areas are now used for grazing. Improved pastures of moderate productivity have been developed on a few. The practicability of clearing areas of this association for pasture is questionable, because of their low fertility and the expense of clearing. Grain, hay, and protein supplements must be fed to carry the livestock through the winter. However, when areas of smooth deep soils that occur within the complex are well managed, a large percentage of roughage, such as sorghums and other forage crops, can be raised for winter feeding and for temporary pastures.

A very high percentage of the holdings in this area are owned and operated by nonresidents. During the summer months, the operators or employees make peri-

odic trips to the farms to care for the livestock; and during winter months, they make daily trips to put out feed. Operators of a few of the larger holdings have tenants to care for the livestock and perform other necessary jobs. Probably the best use for this area is for woodland pasture. Some underbrush should be cleared and sites should be selected for temporary pastures and feed crops.

Lufkin-Tabor soil association (claypan soils) (TL).—This is the largest soil association area and occupies the entire central part of the county. It consists of grayish droughty soils that are low in fertility and productivity. They are called claypan soils because they have heavy very compact clay subsoils that are almost impervious to water. About 8,000 acres of soils that do not have claypan subsoils are included in this soil association area, but they occur in tracts too small to be shown separately on the soil association map.

This soil association is composed of claypan soils: Axtell, 4 percent; Edge, 15 percent; Lufkin, 36 percent; and Tabor, about 39 percent; and minor soils, not claypan: Bastrop, less than 1 percent; Sawyer, 1 percent; and Travis, 3 percent. The Axtell, Bastrop, and Travis soils have developed on terraces in old stream alluvium. The Bastrop soil occurs on low terraces adjacent to the flood plain of the Brazos River, whereas Axtell and Travis soils occur on high terraces of the Brazos River. Bastrop and Axtell soils occupy nearly level and gently sloping areas; and the Travis soils occur on gently sloping, sloping, and strongly sloping areas. The Edge, Lufkin, Sawyer, and Tabor occur in close association. The Edge soils generally occupy the stronger slopes but in some areas occur on gentle slopes.

The soils, as a whole, have low natural fertility and are not well suited to cultivation. Because of the dense very compact clay subsoils, they are droughty. The droughtiness causes crop yields to be very low, except when summer rainfall is unusually good. Only about 4 percent of the total area is used for crops. About 60 percent is pastured, and 36 percent is post-oak woodland.

The agriculture is essentially livestock farming, and most of the crops grown are supplementary to livestock production. However, some cotton is grown as a cash crop. The main crops are corn, cotton, and sorghum. Except on the nearly level areas, most of the soils are very susceptible to erosion when cropped. Gully, rill, and sheet erosion have been active on most of the sloping and gently sloping soils that were cropped in past years. Oats and vetch are grown to some extent for winter grazing and for cover crops. Generally 12 to 15 acres of pasture on this soil association are required to support 1 animal unit during the 8-month growing season. There are fewer resident operators in this area than in most areas of the county. A system of management in which large farm units of at least 400 acres are operated, principally for livestock production, is best suited to this soil association area.

The gently sloping tracts of Bastrop, Sawyer, and Travis soils, which comprise about 2 percent of the area, are well suited to crops. These soils are very responsive to good management and are more productive than the other soils of the group. They are suitable for vegetables and other special crops, as well as for the field crops generally grown in the county.

Additional Facts About the County

Climate

Brazos County has a warm-temperate, humid, continental climate that is modified by breezes from the Gulf of Mexico. The summers are long, warm, and dry. The winters, short and mild, are characterized by short periods of clear cold weather that is freezing at times. The cold weather is interspersed with cloudy and rainy days and clear pleasant weather.

Extreme hot or cold temperatures are not common (table 4). The average temperature during the summer months is 83° F., and during the winter months it is 52° F. Extremes in temperature are unusual. Sudden changes in temperature are uncommon in summer and fall, but in winter and early in spring they occur frequently. These sudden changes are brought about by cold waves, or "northers," that blow across the county from the north and northwest. However, cold weather rarely causes the ground to freeze, and when it does, the freeze is of short duration.

The average date for the last killing frost is March 7, and the first in fall is November 22. The latest killing frost ever recorded was on April 13, and the earliest was on October 29. There is an average frost-free season of 260 days. The early frosts in fall are not as damaging to crops as the late frosts in spring. Unusually late spring frosts damage or kill crops that are planted early to lessen

the damage by insects and summer droughts. The late frosts also damage buds on fruit trees. Although fruit growing is not practiced on a commercial scale in the county, many farmers raise fruit for home use.

The long warm summers are suitable for a widely diversified agriculture. Forage and hay crops are harvested once and, occasionally, twice a year. Furthermore, the long growing season is favorable for the development of pastures and production of livestock. Livestock production has been increasing since about 1920.

The annual precipitation, which averages nearly 39 inches, is relatively uniform throughout the county. Droughts of varying duration and severity occur in summer but do not commonly cause complete crop failures. They are mainly the result of a high rate of evaporation, low humidity, and the low water-holding capacity of the soils, especially those of the upland. The highest rainfall is in May, but during January, February, and sometimes December, when the humidity is high and the rate of evaporation low, the ground becomes saturated and remains so for several days. Rain usually falls more slowly in winter than at other times of the year. During the other seasons it often comes with thunderstorms, and at times falls with great intensity. These intense rains cause considerable damage to fields by erosion, packing, and crusting.

The driest part of the year is during the months of July, August, September, and October. Although the rainfall averages more than 2.7 inches per month during

TABLE 4.—Normal monthly, seasonal, and annual temperature and precipitation at College Station, Brazos County, Tex.

[Elevation, 308 feet]

Month	Temperature ¹			Precipitation ²			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1917)	Wettest year (1900)	Average snowfall
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December.....	52.7	89	14	3.88	0.24	1.55	0.2
January.....	51.0	88	0	3.37	1.90	4.55	.3
February.....	53.7	90	5	2.91	2.37	2.88	.2
Winter.....	52.5	90	0	10.16	4.51	8.98	.7
March.....	60.6	94	20	2.86	.58	3.47	0
April.....	68.2	96	31	3.68	2.81	9.13	0
May.....	74.4	101	43	4.83	1.86	12.28	0
Spring.....	67.7	101	20	11.37	5.25	24.88	0
June.....	81.3	108	53	3.16	.05	.23	0
July.....	84.0	110	52	2.62	.81	6.63	0
August.....	84.2	110	41	2.39	2.66	4.61	0
Summer.....	83.2	110	41	8.17	3.52	11.47	0
September.....	79.5	104	44	2.80	2.23	5.82	0
October.....	70.4	100	29	2.96	.22	2.89	0
November.....	59.4	94	20	3.48	.93	6.71	(³)
Fall.....	69.8	104	20	9.24	3.38	15.42	0
Year.....	68.3	110	0	38.94	16.66	60.75	.7

¹ Average temperature based on a 60-year record, through 1953; highest and lowest temperatures on a 38-year record, through 1930.

² Average precipitation and wettest and driest years based on a

63-year record, through 1953; snowfall based on a 33-year record through 1930.

³ Trace.

that time, it may fall in one or two rains and with such intensity that a large part of it runs off before it has time to be absorbed by the soil.

Snowfall in Brazos County is rare, and the snow melts within 3 or 4 days.

The county is small in area; therefore, the climate varies but little in different locations. The only variation is that of summer rainfall caused by local thunderstorms.

Water Supply

In most rural areas water for drinking and other household uses is obtained from wells dug or drilled 40 to 100 feet deep. The water at these depths is generally ample, but in some localities it contains mineral salts. A few of the farm people get their water from cisterns.

Healthful palatable water generally is reached at depths ranging from 150 to 800 feet. There are some flowing wells in the vicinity of Steele's Store in the Brazos River bottom lands. These wells are 200 to 400 feet deep, and reach into the Bocene Reservoir (2). A few weakly flowing wells are in some of the creek bottoms in the northern part of the county. City water supplies are obtained from drilled wells that are 500 to 800 feet deep. The city water is purified by chemical treatment.

Water for stock is furnished mainly by artificial lakes. Cedar Creek, which crosses the north end of the county, is the only creek that flows most, or all, of the year; all other creeks are intermittent. The Navasota and Brazos Rivers flow continuously, and numerous sloughs and natural lakes in the Navasota River bottom never dry up.

Vegetation

Three distinct native plant communities occur in Brazos County—(1) tall-grass prairie, (2) post-oak savannah, and (3) bottom-land hardwoods. The tall-grass prairie and the post-oak savannah make up the native plant communities of the upland. The bottom lands support a hardwood forest where not cleared. The native forest of the Navasota River bottom land was less dense than that of the Brazos and was mostly elm with little under-story of brush.

The tall-grass prairie is confined to the Crockett-Irving soil association, mainly along the northwestern side of the county. Key grasses in the climax are little bluestem, big bluestem, Indiangrass, switchgrass, and side-oats grama.

The post-oak savannah is characterized by an open stand of post and blackjack oaks and a ground cover of tall grasses. The dominant grasses of the true prairie are the important ones in this savannah. In addition, purple-top is found throughout.

The native forests of the Brazos River bottom land consist of dense stands of oak, ash, elm, pecan, willow, sycamore and other trees of lesser importance. Dense stands of trees and heavy growths of shrubs prevent grass from growing well. Little or no grazing is available during summer months. Wildrye and rescuegrass produce some growth in winter after the leaves have fallen. At present, only a few areas remain to give examples of the original plant communities.

Two-fifths of the county still remains in woodland.

The rest of the county was cleared and for the most part cultivated. In recent years many cultivated acres have been abandoned, especially on the upland savannah. In 1950, only about 4 percent of the upland savannah was in cultivation, and about 28 percent of the county was in abandoned fields.

The abandoned fields have a cover of needlegrass and croton weeds, which became established soon after the old fields were retired, and some bermudagrass that infested the fields before abandonment. Andropogons, especially little bluestem, encroached several years later. Soils with loamy fine sand textures soon became covered with partridgepea and other annual weeds and grasses that thrive on deep sandy soils. The nutritive value of all of these plants is low because of the low fertility of the soils.

About 5 percent of the county is still in native pasture. Nearly all of the native pastures are along the northwestern side. Most of the original cover has been destroyed by heavy grazing. It has been replaced principally by bermudagrass, but some buffalograss, grama, and little bluestem are present. Several species of annual plants, mostly crotonweed, broom, and ragweed, have also infested the native pastures. Practically all cultivated fields are infested with grasses and weeds; bermudagrass and Johnsongrass are the most common and persistent.

The management of introduced grasses and legumes for pasture in the post-oak belt of Brazos County has not proven entirely satisfactory. The soils such as the Lufkin, and others having claypans within 10 inches of the surface, are probably best suited as native grassland. These soils will respond to a combination of the following management practices for native grassland. The degree of response will depend on the present condition of the soils.

Grassland management.—The better native grasses can be encouraged and maintained by leaving enough top growth each year to feed the roots and furnish cover—generally half the annual growth. Uniform use can be attained by fencing and planned location of salting and watering places.

Resting a pasture can improve vigor of the better grasses or allow them to reseed. This practice is especially useful for improvement of pastures that have good grasses but are becoming poorer.

Proper grazing and deferred grazing may be all that is needed to maintain or improve native grasslands that are already in fair to good or better condition. However, when overgrazing and brush competition have eliminated almost all of the better native grasses, emergency measures are needed.

The following practices may be needed to improve grassland in poor to fair condition or where brush has increased:

1. When practical, scrub stands of post oak, blackjack oak, and other brush should be brought under control as a first step in improving overgrown areas of grassland savannah.

2. When no seed source of the desirable native grasses remains, as on some abandoned fields, seeding may be needed.

Land Use and Types of Farming

According to the 1950 census, 349,021 acres, or 93.5 percent of the land in the county was in farms. In that

year 1,478 farms were reported. The number of farms has decreased steadily since 1930, when 2,493 farms were reported. In the same period the average size of farms has increased from 108 to 236 acres.

The change in number of farms and in farm population is roughly parallel. As the number of farms has decreased, the farm population has decreased. The greatest decrease in population has been on the soils of the upland. On the upland prairie soils along the northwestern side of the county, however, this trend has not been followed. On the soils of the forested upland many of the smaller farms have been combined into larger units and converted into livestock farms.

Cotton is, and always has been, the leading crop in the county. Cotton acreage has been greatly reduced since government acreage control has been in effect, but cotton still ranks first in acres harvested. Even with the drastic cuts in cotton acreage, there has not been a marked increase in acreage of other crops. Land taken out of cotton usually has been left idle. This idle land is left to revegetate by natural means and is then grazed. A small part of it has been improved for pasture by fertilizing with phosphate, seeding with desirable grasses and legumes, and mowing. The tendency is to use more of these abandoned fields for improved pastures.

At the present time, most of the farming is confined to three main sections: (1) a strip of prairie soils along the Robertson County line on the northwestern side of the county; (2) the western part of the county in the bottom lands along the upper Brazos River; and (3) the southern end of the county in the bottom lands along the lower Brazos River.

Forestry has never been important in Brazos County. Fruit and vegetables have been grown entirely for home use. Except for the smoother sandier soils, which comprise only a small acreage, the soils of the upland are not well suited to forestry, fruits, or vegetables. Truck crops will produce well on the loamy Miller and Norwood soils of the bottom lands, but these crops have not been grown commercially.

Crops

A row-crop type of farming was practiced by the early settlers of Brazos County and it is still the prevailing type. In 1929, according to census reports, about 95 percent of the cropland harvested was planted to cotton and corn. By 1949 the acreage of cotton and corn had decreased to about 76 percent of the total harvested. The acreage of hay crops, especially alfalfa, had increased more than the acreage of any other crop.

Cotton, corn, alfalfa, and sorghum are the principal crops, according to the 1950 census. Minor crops are oats, hay, winter legumes, watermelons, peanuts, potatoes, and sweetpotatoes. The acreage of most of the crops grown in Brazos County from 1929 to 1949, as shown by census reports, is given in table 5.

Cotton.—Land to be planted to cotton is generally bedded the preceding fall or winter. The beds are gone over in the spring to loosen the soil and kill vegetation. Cotton is planted in the beds, beginning about the middle of April. The cotton is hoed once or twice to thin the crop and to clean grass and weeds from the row. It is cultivated

four to six times to kill vegetation. Picking begins about the middle of August and is usually completed by mid-November. Most of the harvesting is done by hand, although a few mechanical pickers are used.

TABLE 5.—Acreage of the principal crops and number of bearing fruit trees in Brazos County, Tex., in stated years

Crops	1929	1939	1949
Corn:	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
All purposes.....	19,902	24,843	7,806
Harvested for grain.....	19,273	24,724	7,656
Oats:			
Cut and fed unthreshed.....	34	356	159
Harvested for grain.....	45	1,129	912
Sorghum:			
Harvested for grain.....	193	658	201
Silage, hay, and forage.....	2,046	3,584	3,063
Sugarcane and sorghum for syrup.....	49	6	16
Cotton (lint).....	64,207	33,111	30,680
Hay crops (except alfalfa).....	638	1,187	2,458
Alfalfa.....	401	1,903	3,813
Peanuts for all purposes.....	277	963	216
Potatoes.....	146	151	¹ 15
Sweetpotatoes.....	141	154	¹ 46
Watermelons.....	33	44	70
	<i>Number</i>	<i>Number</i>	<i>Number</i>
Peach trees.....	6,100	3,614	1,175
Pear trees.....	1,377	908	719
Plum trees.....	2,034	2,244	623
Apple trees.....	92	32	63
Pecan trees.....	3,985	5,102	1,708

¹ Does not include acres for farms with less than 15 bushels harvested.

Corn.—Land to be planted to corn may be bedded in fall or winter and rebudded in spring, or it may be bedded only in spring. Corn is planted on the beds; planting begins about March 10th. Corn is usually hoed once to thin the plants and to clean weeds out of the row, and it is cultivated two to four times. Harvesting begins in September. The ears of corn are pulled by hand and stored in cribs on the farms.

Sorghums.—Land for sorghum is prepared as for corn, if the sorghum is planted in rows. Planting time ranges from April until June, and often the sorghum is planted as a catch crop after some other crop fails. The sorghum may be cut when in the dough stage and put in silos, or it may be cut with a row-binder when mature. Some sorghum is broadcast or drilled on land that is flat-broken (not bedded). The crop is mowed and pressed for hay.

Minor crops.—Land is flat-broken for alfalfa, vetch, oats, and winter peas. These crops are planted in the fall as soon as there is enough rain to germinate the seed.

Livestock and Livestock Products

The number of cattle has greatly increased in the past 10 years (table 6). According to the 1949 census, receipts from the sale of livestock and livestock products, including poultry and dairy products, were \$2,820,060, which is more than four times the receipts for 1939. Nearly all of the livestock industries are located on the uplands and in the smaller creek bottoms. The cost of feed purchased

TABLE 6.—*Livestock on farms in Brazos County, Tex., in stated years*

Livestock	1930	1940	1950
Cattle:	<i>Number</i>	<i>Number</i>	<i>Number</i>
All kinds.....	21, 257	¹ 25, 354	42, 545
Dairy.....	4, 830	5, 183	5, 855
Poultry:			
Chickens.....	¹ 75, 156	² 66, 767	² 70, 302
Turkeys raised.....	16, 947	26, 000	12, 970
Hogs and pigs.....	8, 922	² 8, 215	6, 150
Sheep and lambs.....	2, 038	² 3, 032	1, 344
Goats and kids.....	1, 190	² 3, 805	1, 391

¹ More than 3 months old.

² 4 months old or older.

³ More than 6 months old.

for livestock, including poultry, was \$170,594 in 1939 and \$959,338 in 1949.

Beef cattle.—Production of beef cattle is somewhat evenly distributed throughout all of the county except the Brazos River bottom lands. The heaviest grazing is on the cleared parts of the creek bottoms. The soils of these areas produce more and better forage for a longer period during the year than any of the other soils. Most of the cows used for beef production are crosses of the Jersey, Hereford, and Brahman breeds. There are a few herds of good grade Herefords and Brahmans in the county, and nearly all the cattlemen use registered or good grade bulls to improve their herds.

The cattle get practically all their feed in summer by grazing. Some ranchers creep-feed the calves late in summer and in fall before selling. During winter it is necessary to feed the stock to carry them through to the next growing season. The principal feed is cottonseed meal or cake, along with some Johnsongrass, sorghum, or native hay. The time for starting feeding is determined mainly by the condition of the cattle in the fall. If favorable weather during the summer and early fall keeps the grass growing, supplemental feeding can be delayed longer. The general practice is to sell the unfinished grass-fed calves when they are 9 to 12 months old. Usually they are sold in fall. The small stockmen sell most of the calves at the local auction barn, but stockmen who produce on a larger scale ship their calves to Fort Worth or Houston.

Dairy cattle.—The 1950 census shows 79 farms classed as dairy farms. The total value of dairy products sold was \$826,950. Practically all the dairy cattle are good grade Jersey cows. The Texas Agricultural and Mechanical College has herds of registered Jersey and Holstein cows. Few of the dairymen raise much of the feed they use. Some of them plant small acreages of oats or a mixture of oats and vetch for winter grazing. The milk is marketed through local creameries, where it is pasteurized and sold mostly as whole milk. Some is sold locally, but most of it is shipped to Houston. Many farmers have one or two dairy cows for home use.

Poultry.—Poultry production, as an industry, is increasing but is not of major importance. In 1950, 29 farms were classed as poultry farms. The total value of poultry products sold was \$288,875. The farm flocks are mainly dual-purpose breeds. Most of their feed is picked

up in the farmyard, although this is supplemented by a little grain and mash. The commercial poultry producers buy nearly all the feed they use. Eggs and poultry are sold locally or shipped by truck to nearby cities and towns.

Hogs.—The number of hogs in Brazos County has never been very high. Most of the hogs are raised for home consumption, but usually not more than two or three sows are kept on a farm. On three or four farms large numbers of hogs are raised for sale. Many of the hogs raised in the county are allowed to run in the woods and abandoned fields to find food; acorns are one of the main foods. A short time before the hogs are butchered, they are penned and fed in order to give them additional weight and improve the quality of the meat. Most of the hogs sold are butchered locally.

Minor livestock.—Various miscellaneous small animals and fowls are kept on many of the farms, but they are of little importance. Turkeys are the most important livestock in this group. There are a few flocks of 200 or more and several flocks of 30 or 40. Some farms have a few guineas, ducks, or geese, but these are relatively unimportant.

Farm Power and Mechanical Equipment

Agriculture has always been the main source of income for Brazos County, but most farms have become mechanized only since 1940. Up to that time horses and mules were used for farmwork. After the early 1940's tractors rapidly came into use. In the census of 1940, 53 tractors were reported; the number had increased to 245 in 1945 and to 515 in 1950. All-purpose light- and medium-weight tractors are the principal types used, although heavier ones are becoming more popular, especially on the large farms in the Brazos River bottom.

Motor vehicles, mainly passenger cars, have been used by Brazos County farmers for many years. There were 1,124 motor vehicles on farms in 1934, and 1,590 in 1950.

The farmers on the mechanized farms have listers, planters, cultivators, and mower attachments for their tractors. A few farmers have other equipment such as tandem-disk and gang plows. Several farmers have hay balers (mainly the pickup type), row binders, grain drills, and fertilizer spreaders. Many of these are owned and used by several farmers; others are owned by individuals who do customwork. All of the dairies are equipped with electrically operated milking machines.

Farm Tenure

Up to 1930, the number of owner-operated farms decreased gradually; since then the number has gradually increased. According to the 1950 census, about 55 percent of the farms were operated by the owner, 15 percent by part owners, 5 percent by cash tenants, less than 1 percent by share-cash tenants, more than 12 percent by share tenants, 8 percent by croppers, 3 percent by other and unspecified tenants, and 1 percent by managers.

Sharecropping on a year to year basis is the prevailing system, although some tenants remain on the same place for a number of years. Practically all the tenants are sharecroppers, croppers, or cash tenants. The sharecropper, or share tenant, furnishes the labor, feed, seed,

fuel, and equipment, and the landowner furnishes the land and buildings and receives as rent one-third of the feed crops and one-fourth of the cash crops.

The cropper furnishes only the labor, and the landowner furnishes the land, feed, seed, fuel, equipment, and buildings. In return, the owner receives half of the crops grown. The cost of fertilizer used is divided between the landowner and the tenant according to the proportion of the crops received by each.

The cash tenant pays the landowner cash rent by the acre, or for the entire farm, and retains all the crops produced. Part owners are farmers who own part of the land they farm and rent the rest.

Some sharecroppers and croppers are on the farms in the Brazos River bottom; some large farms in this area are operated almost entirely by tenants. More of the owner operated farms are located on the Prairies, where many smaller farms have been combined into larger units.

Farm Expenditures

The farmers of Brazos County have never raised enough feed for livestock. Those in the Brazos River bottom areas plant most of the high-priced bottom land to cotton, a cash crop, and buy nearly all of their feed. The soils of the upland do not produce high yields of feed crops under present management, and the farmers on these soils must buy it. According to the 1950 census, 1,127 farms in the county reported expenditures for feed, averaging \$850 per farm. This shows a large increase in feed purchasing since 1940, and it is due principally to the large increase in number of livestock, especially beef cattle, in the past few years.

The amount of fertilizers being used in Brazos County has shown a general increase. According to the Texas Agricultural Experiment Station, 1,981 tons of fertilizer was used from July 1, 1948 to June 30, 1949. However, information is not available as to the number of farms this fertilizer was used on.

In 1949, 44 percent of the farms in the county hired labor outside of the operator's own family; the average expenditure for hired labor per farm reporting was \$1,834.

Public Facilities and Farm Improvements

All except seven rural elementary schools have been consolidated with the schools in the towns of Bryan and College Station. Students attending the consolidated schools are transported by school buses. The Texas Agricultural and Mechanical College is at College Station. Allen Military Academy, a private institution in Bryan, has an enrollment of about 400 students.

Churches of various denominations are located in College Station, Bryan, and nearly all of the community centers. However, several rural churches have closed because of migration of population from the communities.

The hospitals of Bryan and College Station serve the needs of the people of Brazos County. The number of rural telephones is very low. According to the 1950 census, only 124 farms reported having telephones. Since the Rural Electrification Association was organized in the county in 1937, all rural sections are served with

electricity. In 1950, 875 farms reported having electricity. Butane gas in the homes is the latest major improvement for the rural population.

The Brazos and Navasota Rivers and lakes in the Navasota River bottom offer good fishing. Deer and small-game hunting is good in the timbered areas; quail and doves are moderately plentiful.

Farm dwellings, as a whole, are not well kept. However, the majority of the owner-occupied homes are kept painted and repaired and have well-kept yards. The tenant-occupied homes, on the other hand, are poorly constructed, as well as in need of paint and repair. Most of the farmsteads have inadequate buildings for farm machinery, or none at all. Fences, as a whole, are in poor repair. However, increased livestock production has caused some of the farmers to repair and improve their fences. Native timber, mainly post oak, is split into posts and allowed to cure before being used. However, the posts do not last many years and are not replaced frequently enough to keep the fences in good repair. Some cedar trees grow in the north end of the county; these make excellent, long-lasting posts.

Some of the farms in the Brazos River bottom are operated as plantations. On such farms the owner's house is centrally located and the tenant houses are grouped nearby.

Transportation and Markets

The railroads and highways in Brazos County serve the needs of the agriculture and industries. United States Highway No. 190 and State Highways Nos. 6 and 21 are important roads in the county. The Texas and New Orleans branch of the Southern Pacific Lines crosses the county in a northwest-southeast direction and connects it with two important markets and shipping points—Dallas and Houston. A branch line of this railroad crosses the western corner of the county. The International-Great Northern Railroad, a branch of the Missouri Pacific Lines, also crosses the county in a northwest-southeast direction and connects Brazos County with Houston and Fort Worth. However, this line closely follows the valley of the Brazos River and more adequately serves the agriculture of this valley. The Gulf, Colorado, and Santa Fe Railway crosses the southern end of the county.

Motortruck and bus lines travel all the main highways and connect Brazos County to all parts of the State. Two commercial airlines with connections to all parts of the world serve College Station.

Some paved farm-to-market roads extend into the outlying parts of the county, and more of this type are under construction. Other all-weather roads are of gravel base. Very few roads in the county ever become impassable, and then only for short periods during extended rainy seasons. The gravel and graded-earth roads are fairly well maintained. The Brazos River bottom, where over 85 percent of the farming is carried on, is well served by railroads, highways, and paved farm-to-market roads.

Eight cotton gins are located at different points in the county; thus, most farmers do not have to take their seed cotton far to be ginned. Most of the cottonseed not saved for planting is marketed and processed in Bryan.

Livestock either is marketed at the local auction barn

or is shipped by truck to Houston or Fort Worth. Most of the milk from the dairies is collected at local stations and shipped to Houston.

Industries

Industries are of minor importance in Brazos County. The largest nonagricultural industries are a furniture company, which employs about 75 workers, and a shoe company. Various other industries also provide some employment. The county has a cooperative planting-seed association that is very beneficial in furnishing good cottonseed to farmers. A clay, high in kaolinite, has been dug from pits 4 miles south of Wellborn and shipped to Houston to be used in the oil industries there.

Forests

The forests of Brazos County, although moderately extensive, have little commercial value. Tree growth is very slow, and the timber is of inferior quality suitable only for firewood, posts, and rough lumber. The climate is not humid enough for commercial forestry. Post and blackjack oaks are the principal forest species on the upland; elm, water oak, post oak, and overcup oak prevail on the wetter bottom land, especially along the Navasota River. Pine may persist when planted but will not thrive, except perhaps on the more sandy soils such as the Lakeland and Sawyer.

Morphology, Genesis, and Classification of Soils

A general account of the morphology and genesis of the soils of the county is given in this section. In addition, the sandy mounds that occur on the forested claypan soils and the mineralogical and chemical properties of Lufkin fine sandy loam, an extensive soil, are discussed.

Soil is the product of the forces of weathering and development acting on the parent soil material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of development have acted on the material. The climate and its influence on soils and plants depends not only on temperature, rainfall, and humidity, but also on the physical characteristics of the soil or soil material and on the relief, which, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

Brazos County lies in the western margin of the forested Gulf Coastal Plain (3) and is within the region of Red-Yellow Podzolic soils. Some dark treeless soils (11) occur along the western edge of the county and near Millican. They are members of the great soil groups of Reddish Prairie soils, Grumusols, and Planosols. Other soils belong to the great soil groups of Planosols (under post-oak savannah), Alluvial soils, and Regosols.

The rocks that constitute the parent materials of most of the soils in Brazos County are unconsolidated materials. The older rocks are composed of sediments laid down in former extensions of what are now the waters of the Gulf of Mexico. They are composed of sand and clay in various proportions and range in reaction from acid to weakly calcareous. These deposits are the principal geologic formations on the Coastal Plain and include the Crockett member of the Cook Mountain formation, and the Yegua, Jackson, and Catahoula formations (15). Deposition began with the submergence at the beginning of the Cretaceous and continued intermittently through the Cretaceous and the Tertiary. As a whole, the plain forming Brazos and nearby counties slopes toward the Gulf of Mexico.

Younger and less extensive areas consist of Pleistocene deposits of Quaternary age on terraces. The Pleistocene deposits consist of clays, silts, and sands. The terraces are, in most places, easily distinguishable from the first bottoms by their superior height and are generally separated from them by long narrow sloping areas. However, in many places the terraces merge with the soils developed from old marine deposits on the upland and are almost indistinguishable from them.

The youngest materials are of recent alluvium that comprise the present flood plains of the streams of the area. This alluvium consists of only slightly altered sandy, silty, and clayey soil materials.

Sandy Mounds

Brazos County is in the extreme southwestern edge of an area where sandy mounds occur. This area lies west of the Mississippi River and includes eastern Texas, eastern Oklahoma, western Louisiana, southern Missouri, and all of Arkansas. Mounds are less numerous in Brazos County than in other parts of the area.

Sandy mounds in Brazos County occur on sandy forested claypan soils, mostly on nearly level areas of erosional upland that have surface gradients of less than 1 percent. The average size of mounds is about 70 feet in diameter and 16 inches in height, although some of the mounds are about 100 feet in diameter and 24 inches in height. The mounds do not form any definite pattern on the ground and cover less than 30 percent of mounded areas.

In Brazos County about 2 percent, or 1,200 acres, of Lufkin fine sandy loam; 5 percent, or 2,000 acres, of Tabor fine sandy loam; and 1 percent, or 300 acres, of Tabor loamy fine sand is mounded. The Tabor soils are sandier and are more susceptible to wind action than the Lufkin soils. Both have developed from the Yegua and Jackson formations, which are marine deposits of Eocene age. These formations consist of stratified clays, sandy clays, and sands, but the clay content is sufficient to give rise to the claypan soils. Occasional mounds occur on Axtell fine sandy loam and Irving clay loam. These two soils have developed in old high-lying stream alluvium of early Pleistocene age.

Tillage operations level the mounds within a few years. The Main Station Farm of the Texas Agricultural Experiment Station, which is within the immediate mounded area, has been cultivated almost 40 years. According to a former superintendent of the farm, productivity and plant growth were smaller on the mound sites than on the

intervening flats after 10 years of continuous cultivation. However, after almost 40 years of continuous cultivation, the mound sites and the intervening flats show no perceptible difference in productivity and plant growth.

A trench on the Experiment Station Farm exposed the soil profile, including the upper subsoil, of two mounds and the intervening flat. A series of borings was made to determine the thickness of the A horizon in the flats for some distance beyond both ends of the trench. The line separating the A and B horizons is extremely wavy (fig. 8). The waviness of the subsoil is very erratic and has no relationship to the presence of sand mounds.

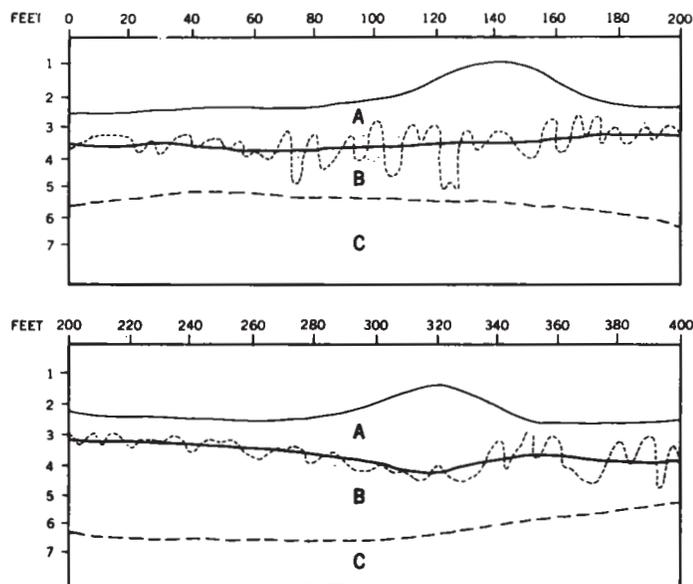


Figure 8.—Cross section of two mounds and intervening flat. The boundary (shown by dotted line) between the A and B horizons is abrupt and very irregular or wavy. The solid line shown between the A and B horizons is the moving-average depth, at 20-foot intervals, to the B horizon. The mounds are formed by a thickening of the A horizon above the B horizon; the surface of the B horizon is at the same average elevation in the mounds as between them. Approximate boundary of the B and C horizons is shown by the dashed line.

Representative profile descriptions from the mound, station 320 (320 feet from point 0), and the flat, station 240 (240 feet from point 0) (fig. 8) are as follows:

Mound:

- A₂₁ 0 to 30 inches, light brownish-gray (10YR 6/2; 4/2, moist) fine sandy loam, slightly mottled with strong-brown specks below 24 inches; slightly hard; very friable; massive; pH 5.5; rounded pebbles in a few places.
- A₂₂ 30 to 33 inches, light-gray (10YR 7/1; 5/1, moist) fine sandy loam with a few spots of brown and yellowish-brown loam to clay loam; pH 5.5; rests abruptly on horizon below.
- B₂ 33 to 48 inches, mottled gray (2.5Y 6/1; 5/1, moist) and brownish-yellow (10YR 6/5; 5/3, moist) extremely compact sandy clay; coarse blocky; pH 5.0 in upper part and 6.0 in lower part.
- B₃ 48 to 57 inches, light-gray (2.5Y 6/1; 5/1, moist) sandy clay with small brownish-yellow spots; extremely compact; pH 6.5.
- C₁ 57 to 90 inches, light-gray (10YR 7/2; 6/2, moist) sandy clay mottled with a few strong-brown spots and an occasional white spot; very compact; pH 8.0.

- C_d 90 to 108 inches +, white stratified clay and sandy clay with brownish-yellow spots.

Where the subsoil is distinctly wavy, the upper 3 inches of it on the crest of the waves is strong coarse columnar. Some of the deep troughs between the waves of the subsoil are a massive loam hardpan.

Flat:

- A₂₁ 0 to 7 inches, light brownish-gray (10YR 6/2; 4/2, moist) fine sandy loam; structureless; pH 5.5.
- A₂₂ 7 to 8 inches, light-gray (10YR 6.5/2; 5/2, moist) fine sandy loam; structureless; pH 5.5; rests abruptly on horizon below.
- B₂₁ 8 to 28 inches, gray (10YR 5/1; 4/1, moist) extremely compact clay; weakly blocky in upper 10 inches but becomes massive below; pH 6.0; passes indistinctly to horizon below.
- B₂₂ 28 to 42 inches, gray (10YR 5/1; 4/1, moist) extremely compact sandy clay; massive; pH 6.5.
- B₃ 42 to 57 inches, grayish-brown (10YR 5/2; 4/2, moist) very compact sandy clay; massive; pH 6.5.
- C₁ 57 to 82 inches, white (10YR 3/2, same moist) sandy clay spotted with brownish yellow; very compact; pH 8.0 but not calcareous.
- C_d 82 to 102 inches +, white (10YR 3/2; same moist) sandy clay weakly stratified with clay; pH 6.0 but not calcareous.

The B horizon grades into the C, and it is difficult to ascertain definitely where the B-C line is. The line shown in figure 8 is only an approximation.

Mechanical analyses of different horizons show no difference in the amounts of sand, silt, and clay in the A₁ and the A₂ horizons of the same profile (table 7). But there are one and a half times as much sand and only half as much clay in the A horizon of the mound as in the A horizon of the flat. These clay determinations made by the hydrometer method are useful for comparison with each other, but they should not be compared with analyses made by the pipette method. The percentage of sand is slightly larger in the B₂ horizon under the mound than in the corresponding B₂₁ horizon of the flat, but the percentage of clay is about the same in the two horizons. In the flat, the B₂₂ horizon has less clay and more sand than the B₂₁ horizon. The B₃ horizons of the two profiles have essentially the same amounts of sand, silt, and clay. The parent material underlying the area examined is stratified and, to some extent, causes the difference in the sand and clay content in the horizons below the A in both profiles.

The A horizons of the mounds and the intervening flat have corresponding distribution of sand-grain sizes. This indicates not only that the A horizons came from a common source of material, but also that the material in the mounds came from nearby. The presence of occasional pebbles in the A horizons is undetermined.

Several hypotheses have been advanced as to the origin of sand mounds, but only two are considered here: (1) that mounds are built by gophers, and (2) that mounds are formed by wind. Gophers build mounds by moving soil material from the A horizon of the surrounding areas to the mound sites. Wind blows and shifts the soil and forms mounds around stationary objects, such as bushes and weed clusters.

Although the theory that the mounds examined were built by gophers is not entirely disregarded, it is difficult to believe that gophers could have moved the soil without having moved almost the same ratio of sand, silt, and clay as was in the A horizon of the flat. However, me-

TABLE 7.—*Mechanical analysis*¹ of profiles on mound and in intervening flat of Lufkin fine sandy loam

ON MOUND (AT STATION 320)

Horizon	Depth	Sand	Silt	Clay	Distribution of sand sizes in millimeters (percentage of total sand)			
					0.5	0.5-0.25	0.25-0.1	0.1-0.05
A ₂₁	<i>Inches</i> 0-30	<i>Percent</i> 65.5	<i>Percent</i> 29.8	<i>Percent</i> 4.7	1	6	48	45
A ₂₂	30-33							
B ₂	33-48	39.9	18.9	41.2	1	4	49	46
B ₃	48-57	49.6	24.3	26.1	1	5	51	43
C ₁	57-90	54.1	23.6	22.3	1	6	52	41
C _d	90-108+	46.5	24.2	29.3	(²)	4	49	47

IN INTERVENING FLAT (AT STATION 240)

Horizon	Depth	Sand	Silt	Clay	Distribution of sand sizes in millimeters (percentage of total sand)			
					0.5	0.5-0.25	0.25-0.1	0.1-0.05
A ₁	<i>Inches</i> 0-7	<i>Percent</i> 44.8	<i>Percent</i> 44.0	<i>Percent</i> 11.2	1	5	50	44
A ₂	7-8	45.0	44.1	10.9	1	5	51	43
B ₂₁	8-28	36.6	27.4	36.0	(²)	7	57	36
B ₂₂	28-42	44.7	26.0	29.3	1	5	50	44
B ₃	42-57	52.5	20.2	27.3	1	6	55	38
C ₁	57-82	55.2	17.5	27.3	1	6	53	40
C _d	82-102+	43.3	22.3	34.4	(²)	3	46	51

¹ Clay fraction by hydrometer; sand fraction by sieving; silt fraction by difference.² Trace

chanical analyses show one and a half times as much sand and only half as much clay in the A horizon of the mounds as in the A horizon of the flat. On the other hand, mounds formed from material blown and shifted by the wind can have more sand and less clay in the A horizon, as the wind carries away part of the clay material. Soil material blown any distance is generally winnowed when deposited in mounds, but the lack of winnowing in the mounds examined indicates that the material came from nearby.

Extensions, or tails, on the leeward side are a common occurrence in mounds formed by wind. Many of the mounds in the immediate area have extensions on the south-southwest side, an indication that the prevailing wind was from the north-northeast when the mounds were formed.

A peculiar characteristic of the claypan soils (Planosols) in the county is the waviness of the subsoil. The depth to subsoil is from 6 to 15 inches greater in the troughs of the waves than on the crests. This waviness is most distinct in the Tabor and Crockett soils and less distinct in the Lufkin and Axtell. The wavy subsoil is not as pronounced in Crockett clay loam as in Crockett fine sandy loam, or in Tabor loamy fine sand as in Tabor fine sandy loam. The wavy subsoil does not occur in all areas of Lufkin and Axtell soils and is not common in the Wilson and Irving soils.

Mineralogical and Chemical Properties of Lufkin Fine Sandy Loam³

Lufkin fine sandy loam is an extreme claypan Planosol developed in moderately clayey sediments in the more western and drier part of the warm-temperate humid zone. The natural vegetation is scrub savannah woodland, mainly post oak, and a thin understory of tall grasses, mainly species of *Andropogon*. Annual temperatures in the extreme southwest occurrence of the series range between 56° F. and 83° F., and they average 70° F. The average annual precipitation is 34 inches. In the extreme northern part, annual temperatures range between 49° F. and 82° F., and they average 64° F. The average annual precipitation is 38 inches. In the approximate eastern range of the series occurrence, average temperatures are 51° F. and 82° F. for winter and summer, respectively. The average annual temperature is 67° F., and the average annual precipitation is 45 inches. The climate is modified continental and tends distinctly toward the Mediterranean type. Evaporation during the summer is high, and summer rainfall is very erratic. Lufkin soils usually are moist from November through May and dry during most of the

³ By George W. Kunze, Soil Mineralogist, Texas Agricultural Experiment Station and Harvey Oakes, Soil Correlator, Soil Conservation Service.

summer and early in fall. During the cool moist season the A horizon often remains saturated for several days or weeks at a time.

Topography, distribution, and extent

Lufkin soils occupy smooth erosional upland. Slopes are dominantly less than 2 percent but range from concave or nearly level to about 6 percent where the soil is a minor part of a soil complex of Lufkin and closely related soils. The landscape of large areas of Lufkin soils is typically nearly level to very gently undulating. Where the Lufkin soil is associated with more rolling normal Red-Yellow Podzolic soils, it occupies flat divides and shallow erosional valleys. Runoff is very slow to slow from areas with modal gradient. Furthermore, in these areas a saturated A horizon and a temporary perched water table over the B horizon are common during extended rainy periods.

The main area of Lufkin soils is coexistent with the post oak strip of east Central Texas. It extends from about Gonzales and Lavaca Counties in the southwest almost to the Red River; but the principal areas are south of Hunt County. Small areas of these soils exist throughout the Forested Coastal Plain of Texas, Arkansas, and Louisiana. The extent of Lufkin and similar soils (Tabor, Edge, and Axtell) in Brazos County is 203,000 acres, or more than half the county. It is estimated that the total extent of these soils is about 3.5 million acres. Similar claypan soils developed from more alkaline parent materials under grass in adjacent areas under like climate probably amount to another 3 million acres. These claypan soils dominate the smooth upland in the post oak strip and occur in areas with convex as well as in those with concave surfaces. Their unfavorable physical characteristics, together with wet winters and dry summers, cause problems in use and management not common to less extremely developed claypans in a similar climate.

Morphology

Lufkin fine sandy loam has a relatively thin A horizon; the erratically developed thin vesicular A₂ horizon rests abruptly on a dense subsoil of clay loam to clay.

In cultivated fields a very hard, light-gray, thin platy crust of very fine sandy loam, 2 to 3 mm. thick, forms on the surface. Under the surface crust, to a depth of about 15 mm., the soil is a loose mass of fine granules; below this depth it is massive and extremely hard when dry. The A₂ horizon of light-gray fine sandy loam ranges in thickness from a thin gray film on the top of the claypan over the microridges to a maximum of 3 inches over the microvalleys.

The subsoil (B₂₁) of extremely compact gray clay loam to clay is weak prismatic and moderate medium to strong coarse blocky in the upper part and massive below. The peds have distinct clayskins (Tonhauchen) about one value darker than the interiors. Vertical partings show distinct organic staining or colloidal coatings also. The lower B horizons are of compact sandy clay or clay; they often contain 6 to 10 percent less clay than the B₂₁. The substratum, below about 50 inches, is light-gray to white sandy clay loam to clay, ranging from strongly acid to alkaline.

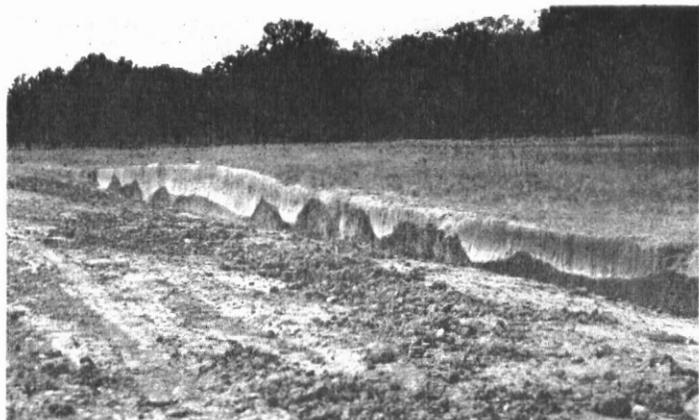


Figure 9.—Side view of a trench across a mound in Lufkin fine sandy loam, showing abrupt wavy boundary between the light-colored A₂ horizon and the darker B horizon.

A unique feature of Lufkin fine sandy loam and the associated similar soils is the valley-and-ridge gilgai microrelief of the subsoil (fig. 9). This wavelike, or undulating, form is most common in nearly level areas but is somewhat common in soils on gentle slopes. Distance between microridges is usually about 6 to 9 feet, but it may be less or as much as 15 feet. Combined thickness of the A₁ and A₂ horizons varies in relation to the ridge-and-valley gilgai microrelief of the B horizon and reaches a maximum of about 25 inches over the microvalleys. On the surface there is no indication of the gilgai microrelief of the subsoil. However, during extremely dry periods cracks that form in the B horizon may extend to the surface upon the crests of the microridges.

Laboratory studies

Two virgin profiles of Lufkin fine sandy loam, representative of the range of the series in Brazos county, were sampled approximately 10 miles apart for laboratory studies. Exchangeable cations were extracted with a neutral, normal solution of ammonium acetate and determined by a flame photometer. Other mineralogical and chemical procedures for these studies have been described elsewhere (9).

Results of the particle-size distribution studies are shown in table 8. Profile No. 1 contains significantly larger amounts of sand in the B horizon and at greater depths than profile No. 2. In contrast, corresponding horizons of profile No. 2 contain significantly larger amounts of clay. This textural range reflects the range in clay content for parent materials of Lufkin soils.

The fine clay (0.2 μ) makes up more than 50 percent of the total clay fraction for all horizons studied; the amounts actually ranged from 53 percent in the C horizon of profile No. 2 to 92 percent in the B₂₁ horizon of profile No. 1. It should be noted also that the greatest concentration of fine clay is found in the B₂₁ horizons. This concentration is indicative of clay movement from the overlying horizons.

Table 9 summarizes the chemical properties for two profiles of Lufkin fine sandy loam, with the exception of ethylene glycol retention, which is given in table 10.

TABLE 8.—Soil separates for two profiles of Lufkin fine sandy loam

Horizon	Profile No. 1					Profile No. 2				
	Depth	Sand	Silt	Clay		Depth	Sand	Silt	Clay	
				<2μ	<0.2μ				<2μ	<0.2μ
	Inches	Percent	Percent	Percent	Percent	Inches	Percent	Percent	Percent	Percent
A ₁ -----	0-8	47.5	39.5	13.0	10	0-5½	49.9	43.3	6.8	5
A ₂ -----						5½-7	50.5	42.8	6.7	
B ₂₁ -----	8-23	32.2	26.9	40.9	38	7-21	22.0	29.7	48.3	41
B ₂₂ -----	23-35	35.7	31.1	33.2		21-35	19.4	33.8	46.8	
B ₃ -----	35-47	39.3	30.7	30.0		35-46	9.1	47.3	43.6	
C ₁ -----	47-64	38.0	32.9	29.1	23	46-70	2.4	43.6	54.0	28
C ₂ -----	64-72	27.6	33.6	38.8						

The pH values for the two profiles show a considerable spread. The reaction for profile No. 1 is neutral in the B₂₂ horizon and slightly alkaline at greater depths, whereas the reaction for corresponding horizons of profile No. 2 is very strongly acid. The alkaline reaction of profile No. 1 may be accounted for by the presence of free calcium carbonate. However, the acid reaction of profile No. 2 is not accounted for so easily. In view of the relatively high amounts of exchangeable sodium, a more alkaline reaction would be expected. However, the soil contains moderate amounts of gypsum, which tends to lower the pH considerably. That soil reaction is difficult to explain is brought out by Richards (13), who found that soils essentially 100 percent sodium saturated varied in pH from 7 to 9.

The organic-matter content does not vary significantly

between the two profiles. For both, the content is relatively low.

The cation-exchange capacities, as a whole, are lower for profile No. 1, primarily because of the lower clay content of this profile. The high cation-exchange capacity of the fine clay (<0.2μ) is of interest. As will be pointed out in more detail later, this fraction is composed primarily of montmorillonite, which accounts for the high values. The exchange capacities for the <0.2μ fraction of the B₂₁ horizons is approximately 10 m. e. less than that of the other horizons investigated. Whether this is a real difference is questionable, since results for two other profiles not reported here did not show the same trend.

The Lufkin soils show a high degree of base saturation. This is characteristic for Planosols as has been shown by Whiteside and Marshall (20).

TABLE 9.—Chemical properties for two profiles of Lufkin fine sandy loam

PROFILE No. 1

Horizon	Depth	pH	CaCO ₃ equivalent	Percent organic matter	Exchangeable cations—percent of the exchange capacity of the soil					Base saturation	Cation exchange capacity (m. e./100 gm.)	
					Ca	Mg	Na	K	H ¹		Soil	<0.2μ ²
A ₁ -----	Inches 0-8	6.3		1.8	52.2	13.9	3.5	0.9	29.5	70.5	12	101
B ₂₁ -----	8-23	5.5		1.0	59.9	18.5	8.2	.7	12.7	87.3	29	93
B ₂₂ -----	23-35	7.0		.7	64.7	19.0	12.3	.7	3.3	96.7	27	
B ₃ -----	35-47	7.8	1.8	.3	(³)	20.7	15.0	.8			25	
C ₁ -----	47-64	8.0	2.7	.1	(³)	21.6	17.2	.9			23	104
C ₂ -----	64-72	7.7	3.4	.1	(³)	20.4	18.0	.7			29	

PROFILE No. 2

A ₁ -----	0-5½	5.8		2.2	53.6	8.7	2.9	5.8	29.0	71.0	7	103
A ₂ -----	5½-7	5.3		.9	37.7	11.5	3.3	3.3	44.0	55.8	6	
B ₂₁ -----	7-21	4.6		1.2	45.5	18.9	9.3	.8	25.5	74.5	35	90
B ₂₂ -----	21-35	4.6		.9	(⁴)	21.3	12.5	.8			38	
B ₃ -----	35-46	4.7		.5	(⁴)	12.9	21.7	1.5			34	
C-----	46-70	4.7		.4	(⁴)	26.7	19.4	1.1			45	104

¹ The value for hydrogen was obtained by difference.

³ Calcareous.

² Organic matter was removed for determinations of cation-exchange capacity.

⁴ Gypsum.

TABLE 10.—Ethylene glycol retention by Lufkin fine sandy loam

Horizon	Profile No. 1			Profile No. 2		
	Depth	Ethylene glycol retained		Depth	Ethylene glycol retained	
		Unheated	Heated (600° C.)		Unheated	Heated (600° C.)
	<i>Inches</i>	<i>mg./gm.</i>	<i>mg./gm.</i>	<i>Inches</i>	<i>mg./gm.</i>	<i>mg./gm.</i>
A ₁ -----	0-8	11	6	0-5½	7	6
B ₂₁ -----	8-23	55	26	7-21	66	19
C ₁ -----	47-64	46	19	46-70	94	28

Studies in connection with exchangeable cations have shown that the Lufkin soils contain relatively large amounts of sodium and magnesium. This was hardly suspected, in view of the climate under which these soils have developed. The relative percentages of exchangeable cations in the lower horizons are indicative of a marine depositional environment. Kelley (7) reported that when he allowed a soil sample to come to equilibrium with fresh sea water, the replaceable bases present (expressed as percentage of the total bases) were as follows: Ca 20, Mg 37, K 7, Na 36. Almost identical values were reported by Zuur (21) for the topsoil of a polder reclaimed from salt water. Westerhof (19) found the following percentages of replaceable bases for a soil that had been inundated with salt water for more than a year: Ca 49, Mg 24, K 6, Na 21. These latter values for replaceable cations are very similar to those found for the lower horizons of the Lufkin profiles.

Kelley (7) observed that soil that had been in contact with sea water became extremely deflocculated and impervious to water after the soluble salts were leached out. Hissink (5) stated that as long as sodium comprises 15 to 20 percent of the exchangeable bases, the risk of deflocculation is very great. According to Richards (13), if the exchangeable sodium percentage is greater than 15 and the conductivity of the saturation extract is less than 4 millimhos/cm. at 25° C., the soil is classified as a nonsaline-alkali soil.

The poor structural properties of Solonetz soils is largely attributed to their relatively large amounts of exchangeable sodium. Riechen and Stalwick (14), Smith (18), and Kelley (7) analyzed for exchangeable cations in soils classed as typical Solonetz soils, and for the most part their results showed that exchangeable sodium was lower than for the Lufkin soils.

Whether the magnesium ion has similar effects upon the structural properties of the soil has not been resolved. Smith, Buchrer, and Wickstrom (17) concluded that the effects of the magnesium ion on structural properties of the soil were more like the effects of the calcium ion than those of the sodium ion. Joffe and Zimmerman (6) concluded that if magnesium is present in high concentration, its effects are harmful and tend in the same direction as sodium. Shavruigin (16) reported that the soil saturated with magnesium did not filter as well as the same soil

saturated with calcium. Furthermore its swelling, maximum hygroscopicity, and moisture capacity were higher than for the soil saturated with calcium but lower than for the soil saturated with sodium. Davidson (1a) found that the swelling pressure produced by samples of the Lufkin clay fraction ($<2\mu$) saturated with magnesium was intermediate between that produced by sodium-saturated samples and calcium-saturated samples. In view of the results of the investigations cited, it appears that the extremely undesirable structural properties of the Lufkin soil can be accounted for in part by the relatively high percentages of exchangeable sodium and magnesium in these soils.

Ethylene glycol retention values are given in table 10. These values are a measure of the specific surface area and accordingly are closely correlated with exchange capacity. They are also, as pointed out by Dyal and Hendricks (4), indicative of the type of clay mineral that dominates in the soil, which, in the Lufkin soils, is montmorillonite, an expanding-lattice type of clay.

Mineralogical composition studies by means of X-ray diffraction were carried out on the following soil separates: Very fine sand (0.1-0.05 mm.), silt (0.05-0.002 mm.), clay ($<2\mu$), coarse clay (2-0.2 μ), and fine clay ($<0.2\mu$). Only the last two fractions were studied for the A₁, B₂₁ and C horizons.

The very fine sand fractions are dominated by quartz. This fraction in profile No. 2 shows trace amounts of feldspar in all horizons.

The silt fraction, like the sand, is dominated by quartz. Feldspar occurs in both profiles at all depths. The feldspar in profile No. 1 varies from trace amounts in the upper two horizons to moderate amounts at the greater depths. Only trace amounts of feldspar occur in profile No. 2. Trace amounts of mica and kaolinite were found in both profiles at the lower levels.

Microscopic examination of the very fine sand and silt fractions of profile No. 2 revealed the presence of glass shards—an indication that volcanic ash is a component of the sediments. Gypsum, which was identified by visual inspection at the time the sample was taken, was removed in the process of fractionating the sample.

The clay fractions ($<2\mu$) for the two profiles, at all levels, are composed of montmorillonite, kaolinite, and quartz. The first is the most abundant in all of the horizons. Kaolinite and quartz occur in only traces to small amounts. For those clay samples that were fractionated with the supercentrifuge, quartz and kaolinite were concentrated in the coarse clay (2-0.2 μ), whereas montmorillonite was concentrated in the fine clay ($<0.2\mu$). X-ray diffraction patterns for the fine clay ($<0.2\mu$) are presented in figure 10. The peaks representing spacings of 17.3 to 18.0 angstrom units are characteristic (001) basal spacings for montmorillonite. The 18.0 angstrom spacing is slightly larger than is generally assigned to montmorillonite. However, spacings of this magnitude are commonly recorded for montmorillonite found in soils, particularly in the upper horizons. The peaks representing spacings of 8.8 angstroms are (002) basal spacings for montmorillonite. The peaks representing spacings of 7.3 and 3.56 angstroms are respectively the (001) and (002) basal spacings for kaolinite or possibly dehydrated halloysite.

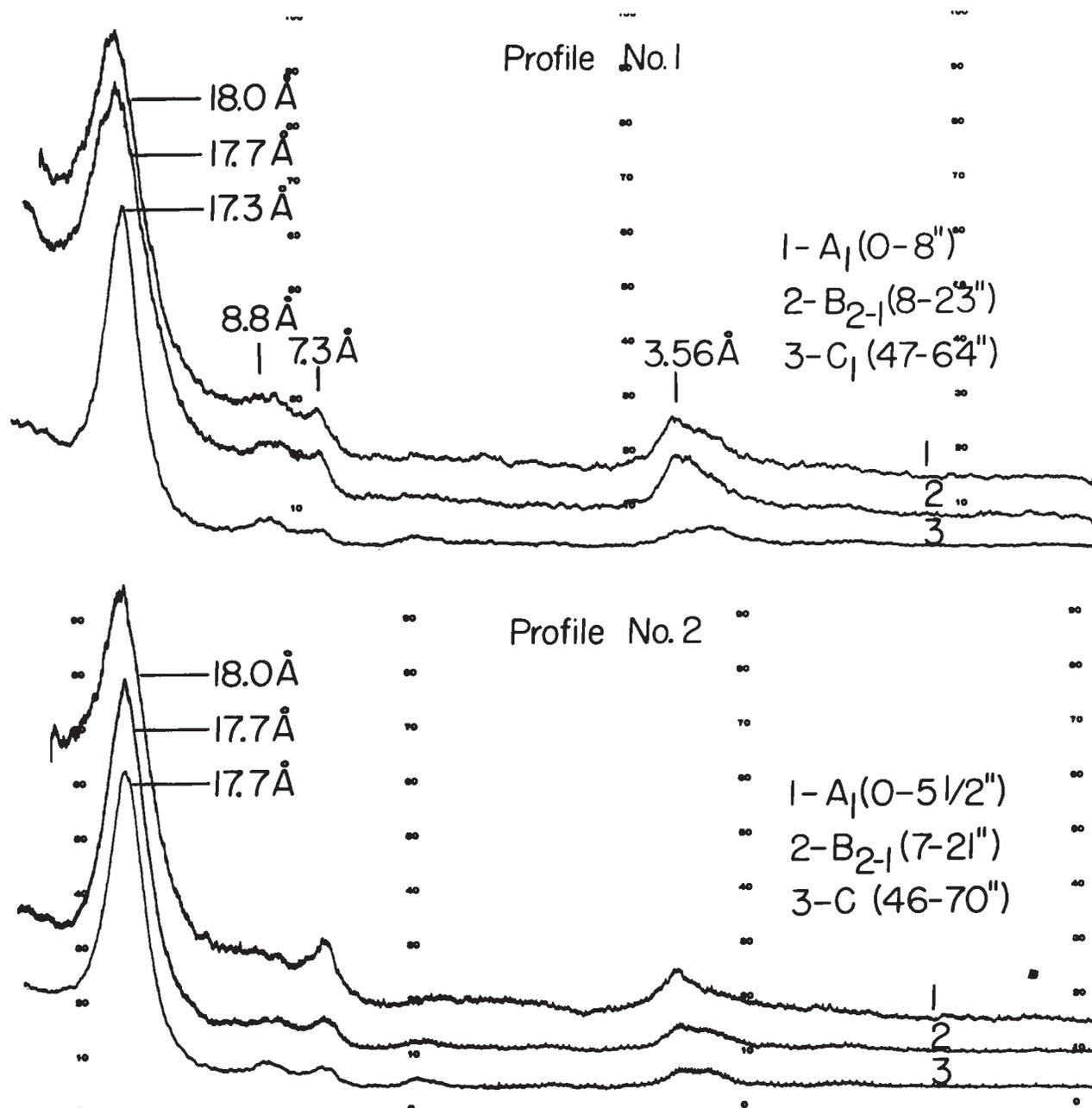


Figure 10.—X-ray diffraction patterns of the <0.2-micron fraction for two profiles of Lufkin fine sandy loam.

A hypothesis for the genesis of the Lufkin soils

Geological studies have shown that the sediments in which the Lufkin soils have developed are of mixed deltaic and marine origin (15). For limited areas, it is believed that volcanic ash materials make up a significant portion of these sediments.

The parent materials in which the Lufkin soils have developed range in texture from sandy clays to clays, and the dominating clay mineral is montmorillonite. The presence or absence of calcium carbonate in some horizons apparently is determined by the calcium content of the original sediments.

Following emergence of these sediments, downward movement of water was not unduly restricted until the soluble salts were leached out. After the removal of the soluble salts, the sediments became deflocculated and water movement was greatly restricted. That water movement was restricted at a rather early stage is indicated by the percentages of exchangeable sodium and magnesium remaining; these percentages approach those of sediments in equilibrium with sea water.

The lighter textured surface horizons overlying the dense claypan are indicative of some downward movement of the clay during the early stages of development. For the two profiles from Brazos County, as well as for two

others not reported herein, the largest percentage of fine clay ($<0.2\mu$) occurred in the B₂₁ horizons. The occurrence of clay in these horizons is further indication of clay movement. The possibility of actual clay formation within the B₂₁ horizons, such as reported by Whiteside and Marshall (20) and Nikiforoff and Drosdoff (10), was not explored but may well be an important factor in the development of the claypan.

Briefly summarizing, both geological and chemical evidence indicate that these sediments were strongly influenced by a marine environment. Following emergence, water movement through the profile was relatively unrestricted until the soluble salts were leached out. After removal of the soluble salts the soil became deflocculated and water movement through the profile was severely restricted. The swelling type of clay mineral (montmorillonite) that dominated the clay fraction also helped restrict water movement. It is believed that the processes of cluviation and clay formation in combination with the swelling type of clay mineral are the cause of the development of the claypan, but which was more important is not known.

Management and morphology

Lufkin soils have distinctive characteristics that cause special problems in management of cultivated crops. Surface crusting interferes with germination and emergence of seedlings and hinders growth by restricting aeration. The relatively high clay content dominated by montmorillonite, an expanding lattice type that swells and shrinks, reduces permeability and aeration. The relatively high sodium, and perhaps magnesium, content adversely affects the inherent unfavorable physical properties of the subsoil. Dispersion, plasticity, swelling, and moisture retention probably are increased because of the exchangeable sodium and magnesium. Crop plants show no toxic effects from sodium; apparently sodium exerts only secondary influence through adverse physical, mainly structural, modifications of the soil. Whether the adverse physical properties are due entirely to interlayer swelling, or to the combination of sodium and magnesium with this type of clay mineral, is not clearly understood.

The improvement of these crusty claypan soils is apparently most critically limited by the low permeability of the subsoil. Leaching the sodium through the profile or replacing it with calcium is impossible or infeasible. The usual practices for preventing crusting, increasing water intake, producing aggregation, and reducing the bulk density of the subsoil by adding organic matter and growing deep-rooted plants are relatively ineffective and of very temporary value because of the inherent properties of the clay.

It is apparent that further research is needed for determining effective and practical measures for improving the physical conditions of the Lufkin soils.

Classification of Soils

The purpose of classification is to place the objects to be classified into suitable categories, the better to study and remember their characteristics and to interpret their

interrelationships (8). According to this statement of the problem, schemes for the classification of natural bodies, such as plants and animals, have been worked out; and on the same basis a classification of soils has been evolving during the last three decades.

In the field mapping of soils, the units described and shown on the map are established on the basis of the characteristics of the soils themselves. On the basis of common characteristics, local soil types and series may be grouped successively into series, great soil groups, and orders.

Brazos County lies at the western edge and in the drier part of the Red-Yellow Podzolic soil zone. However, because parent material is the dominant soil-forming factor, there are very few normally developed Red-Yellow Podzolic soils in the area. The great soil groups that occur in Brazos County are: Alluvial, Reddish Prairie-Planosol, Grumusol-Regosol, and Red-Yellow Podzolic.

The Alluvial soils include the Gowen, Kaufman, Miller, Navasota, Norwood, Ochlockonee, Roebuck, and Yahola series. Two kinds of Alluvial soils occur in this area: Those from reddish calcareous silty and clayey deposits of the Brazos River and those from mostly sandy non-calcareous deposits from local streams. Noncalcareous clayey sediments in the flood plain of the Navasota River are included in the second group. Soil development is lacking or only very weakly expressed in these Alluvial soils.

The Reddish Prairie soils include the Bonham, Payne, Crockett and Bastrop series. The Bonham, Crockett and Payne soils may be considered as medial Reddish Prairie soils in which the alkaline clay parent material is slightly dominant over other factors of soil development. Less clayey and less alkaline more readily weatherable parent materials of comparable age on similar topography normally would give rise to Red-Yellow Podzolic soils in this climatic environment. The Bastrop soils are minimal Reddish Prairie soils. Because of the short time the parent materials have been in place, soil-forming processes have not exerted their full influence in soil development. In time, these soils might be expected to develop characteristics more nearly resembling those of the Red-Yellow Podzolic soils than of the Reddish Prairie soils.

Planosols are the most extensive soils of the area. This great soil group includes the Lufkin, Tabor, Edge, and Axtell series developed under scrubby savannah woodland; and Wilson and Irving developed under grass vegetation. Clayey parent materials are strongly dominant in soil development in these series.

The Grumusols include the Houston, Hunt, and Burleson series. Here again, the kinds of parent materials and their mineralogical content are the main soil-forming factors that produce these weakly developed soils of high clay content.

The only member of the Regosols in the area is in the Derby series. The Derby soil is a deep azonal soil without a textural profile. It is derived from materials that are very high in silica and low in weatherable minerals.

The Red-Yellow Podzolic soils are of very slight extent in the area. The Sawyer, Lakeland and Travis series, although not modal representatives of the group as it exists typically in a more humid climate, are the only members of this great soil group in the county.

Descriptions of representative members of each soil series, as recognized and mapped in Brazos County, are given in the following pages.

Series descriptions

Axtell series.—The Axtell series consists of light-colored crusty claypan soils developed in old alluvial sediments deposited by floodwaters of the Brazos River. This series is in the Planosol great soil group. It occurs on old high terrace remnants, and was developed under a hardwood forest. Associated series are Travis, which has reddish friable sandy clay subsoil; Irving, which has dark-gray compact subsoil; and Bastrop, which has yellowish-red friable light sandy clay subsoil.

The following profile of Axtell fine sandy loam is from an area under native forest that has a surface gradient of $\frac{1}{2}$ percent.

- A₁ 0 to 10 inches, light brownish-gray (10YR 6.5/2; 4/2, moist) fine sandy loam; friable when moist, very hard when dry; very crusty in cultivated fields; structureless; few tree roots; pH 6.0; boundary with horizon below is abrupt.
- B₂₁ 10 to 15 inches, reddish-brown (5YR 5/5; 4/5, moist) clay faintly mottled with pale brown; very firm and compact when moist, very sticky when wet, and very hard when dry; strong fine blocky; tree roots few; pH 5.0; grades gradually to horizon below.
- B₂₂ 15 to 21 inches, strongly mottled pale-brown (10YR 6/3; 5/3, moist) and yellowish-red (5YR 5/6; 4/6, moist) clay; consistence same as above, weak fine blocky; tree roots very few; pH 4.7; grades gradually to horizon below.
- B₂₃ 21 to 33 inches, light-gray (10YR 7/1; 6/1, moist) clay with a few fine distinct reddish-brown spots; consistence same as B₂₁ horizon; massive; occasional tree roots; pH 6.0; grades gradually to horizon below.
- B₃ 33 to 45 inches, light brownish-gray (10YR 6/2; 4.5/2, moist) clay with a few small yellowish-brown spots; consistence same as B₂₁ horizon; massive; a few fine CaCO₃ concretions present; pH 8.0; grades gradually to horizon below.
- C₁ 45 to 56 inches, pale-brown (10YR 6/3; 4/3, moist) clay with a few fine yellowish-red spots; consistence same as above; massive; calcareous; a few small calcium carbonate concretions; grades gradually to horizon below.
- C₂ 56 to 66 inches +, yellowish-red (5YR 5/8; 4/8, moist) light clay; not as firm and hard as above; massive; calcareous.

Range in characteristics.—The surface soil ranges from 4 to 12 inches in thickness and from grayish brown to pale brown in color; some areas have a well-developed lighter colored A₂ horizon. The surface of the subsoil has a characteristic waviness; the crests of the waves are from 6 to 20 inches higher than the troughs. The lower subsoil may or may not contain calcium carbonate concretions.

Topography and erosion.—Surface gradients range from $\frac{1}{2}$ to 4 percent but dominantly are less than 3 percent. Cultivated areas on slopes greater than about 1 percent are susceptible to erosion.

Drainage.—Runoff is slow to medium, and internal drainage is very slow.

Distribution and use.—The Axtell soil occurs on terraces near or adjacent to the Brazos River flood plain. It is used mainly for pasture.

Bastrop series.—The Bastrop series is in the Reddish Prairie great soil group. One member occurs in the county. It is a brownish well-drained loamy soil developed in old alluvial sediments deposited by floodwaters of the Brazos River. It occurs on low river terraces adjacent to the

flood plain of the Brazos River and was developed under tall bunchgrasses. Associated series are the Travis, which has a red less friable sandy clay subsoil; the Irving, which has a dark-gray compact subsoil; the Axtell, which has a mottled compact clay subsoil; and the Derby, which is a deep loamy fine sand.

The following profile of Bastrop fine sandy loam is in an abandoned field with a surface gradient of less than 1 percent. The site is about $7\frac{1}{2}$ miles southwest of Bryan and about $\frac{1}{4}$ mile from the Brazos River.

- A₁ 0 to 15 inches, brown (7.5YR 5/2; 3/2, moist) fine sandy loam; very friable when moist, slightly hard when dry; weakly granular; numerous grass roots; pH 6.5; grades gradually to horizon below.
- A₃ 15 to 18 inches, light reddish-brown transitional layer of fine sandy loam; heavier than A₁ horizon.
- B₂ 18 to 34 inches, yellowish-red (5YR 5/6; 4/6, moist) light sandy clay; friable to firm when moist, hard when dry, slightly sticky when wet; massive; porous; grass roots abundant; pH 6.7; grades gradually to horizon below.
- B₃ 34 to 58 inches, yellowish-red (4YR 5/6; 4/6, moist) sandy clay loam; friable when moist, hard when dry; massive; porous; grass roots few; pH 7.0; grades gradually to horizon below.
- C₁ 58 to 74 inches, yellowish-red (5YR 5/6; 4/6, moist) fine sandy loam; friable when moist, slightly hard when dry; massive; porous; pH 7.0; grades gradually to horizon below.
- C₂ 74 to 96 inches +, yellowish-red (5YR 5/6; 4/6, moist) light fine sandy loam; sand grains are coarse; very friable when moist, soft when dry; massive; porous; pH 7.5.

Range in characteristics.—The surface soil ranges from 12 to 18 inches in thickness, from brown to grayish brown in color, and from fine sandy loam to light fine sandy loam in texture. The subsoil ranges from red to yellowish red in color and from sandy clay loam to a sandy clay in texture. Depth to the C horizon ranges from 3 to 6 feet. Some areas have rounded chert gravel, $\frac{1}{4}$ to $1\frac{1}{2}$ inches in diameter, on the surface and throughout the profile. The gravel never occupies more than 5 percent of the mass.

Topography and erosion.—The Bastrop soil has surface gradients of 0 to 4 percent but dominantly less than 2 percent. It is slightly susceptible to water erosion on slopes of more than $1\frac{1}{2}$ percent gradient.

Drainage.—Runoff is medium to slow; internal drainage is medium to rapid.

Distribution and use.—The Bastrop soil occurs on low terraces adjacent to the Brazos River flood plain but is above overflow. It is mostly in pasture.

Bonham series.—The Bonham series consists of dark friable soils developed in alkaline to weakly calcareous clay and sandy clay. It is in the Reddish Prairie great soil group and was developed under a cover of prairie grasses, mostly tall bunchgrasses. This series occurs in association with the Crockett series, which has a very compact subsoil; the Wilson series, which has a dark-gray compact subsoil, and the Houston-Hunt complex, which consists of clayey soils. Textures of clay loam and fine sandy loam are mapped in this series in Brazos County.

The profile of Bonham clay loam described below is from a cultivated field with a surface gradient of $\frac{1}{2}$ percent. The site is about 7 miles northwest of Bryan along United State Highway No. 190, 300 yards east of the intersection of the highway and the Old San Antonio Road.

- A_{1p} 0 to 4 inches, grayish-brown (10YR 4.5/2; 3.5/2, moist) clay loam; friable when moist, hard when dry, and slightly sticky when wet; weak medium granular; pH 6.2; boundary with horizon below is abrupt.

- A₁ 4 to 10 inches, dark grayish-brown (10YR 4/1.5; 3/1.5, moist) clay loam; friable when moist, hard when dry, moderately sticky and plastic when wet; moderate medium granular; pH 6.2; grades gradually to horizon below.
- B₁ 10 to 16 inches, dark grayish-brown (10YR 4/1.5; 3/1.5, moist) heavy clay loam mottled with about 10 percent dark brown (7.5YR 4/3; 3/3, moist); very crumbly and friable when moist, sticky and plastic when wet, very hard when dry; strong medium granular; pH 6.0; grades gradually to horizon below.
- B₂₁ 16 to 30 inches, mottled olive-yellow (2.5Y 6/6; 5/6, moist), yellowish-red (5YR 5/6; 4/6, moist), and (about 5 percent) light olive-brown (2.5Y 5/4; 4/4, moist) clay; same consistence and structure as B₁ horizon; pH 6.0; grades gradually to horizon below.
- B₂₂ 30 to 44 inches, olive-yellow (2.5Y 6/6; 5/6, moist) clay mottled with about 20 percent of yellowish-red (5YR 5/6; 4/6, moist); very firm when moist, very hard when dry, and very sticky and plastic when wet; weak medium to coarse blocky; pH 6.5; grades gradually to horizon below.
- B₃ 44 to 65 inches, mottled olive-yellow (2.5Y 6/6; 5/6, moist), light yellowish-brown (2.5Y 6/4; 5/4, moist), and (about 5 percent) brownish-yellow (10YR 6/6; 5/6, moist) clay; same consistence as above; massive; pH 6.7; grades gradually to horizon below.
- C 65 to 75 inches +, olive-yellow (2.5Y 6/6; 5/6, moist) clay with lenses or splotches of yellowish-red (5YR 5/6; 4/6, moist); firm and hard; contains about 15 to 20 percent, by volume, of subrounded quartzite and chert gravel and ironstone; a few soft and hard particles of CaCO₃; pH 7.5.

Range in characteristics.—The surface soil ranges from 8 to 6 inches in thickness and from very dark brown to dark grayish brown in color. Fine sandy loam areas have lighter colored A horizons. The B₁ horizon ranges from 5 to 10 inches in thickness; from dark brown to very dark grayish brown, with or without brown mottlings, in color; and from sandy clay loam to light clay in texture. Small subrounded gravel and small shotlike ferromanganese concretions occur throughout the profile in some places.

Topography and erosion.—Surface gradients dominantly range from 0 to 2 percent, but a few small areas have gradients up to 4 percent. Areas with slopes greater than 1 percent are susceptible to slight erosion.

Drainage.—Runoff is slow to medium; internal drainage is slow.

Distribution and use.—The Bonham soils occur in a strip of prairie along the northwestern side of the county. They are mostly in abandoned-field pasture.

Burleson series.—The Burleson series consists of dark, crusty, and clayey soils developed in calcareous old alluvial sediments deposited by floodwaters of the Brazos River. The soils are Grumusols and have developed under a cover of prairie grasses, mostly tall bunchgrasses. The Burleson series is associated with the Irving, which has a textural profile, and the Axtell, which has a light-colored sandy surface soil.

The following profiles of Burleson clay are in a native grass area with a surface gradient of about ½ percent. The surface has a distinct gilgai microrelief. The first profile given occurs in a microdepression; the second is in a microknoll about 9 feet from the profile in the microdepression.

Microdepression:

- A₁₁ 0 to 1 inch, very dark grayish-brown (10YR 3/1.5; 2/1.5, moist) clay; moderately friable when moist, sticky when wet, hard when dry; medium granular; pH 6.0; grass roots moderately numerous; surface is crusty in cultivated fields; grades indistinctly to horizon below.
- A₁₂ 1 to 46 inches, very dark-gray (10YR 3/1; 2/1, moist) clay; extremely firm when moist, extremely sticky and plastic

when wet, extremely hard when dry; weak medium and coarse blocky in upper 18 inches, massive below; pH 7.0 at 12 inches, 7.5 at 24 inches, and 8.0 at 36 inches; grass roots few; grades indistinctly to horizon below.

- AC₁ 46 to 58 inches, dark-gray (10YR 4/1; 3/1, moist) clay with occasional light-red (2.5YR 6/6; 5/6, moist) spots; consistence same as above; massive; calcareous; moderately large number of small hard concretions of CaCO₃; grades gradually to horizon below.
- AC₂ 58 to 72 inches, streaked dark-gray (10YR 4/1; 3/1, moist) and light-red (2.5YR 6/6; 5/6, moist) clay; not as firm, sticky or hard as above; massive; calcareous; grades to horizon below.
- D_u 72 to 90 inches +, red (2.5YR 5/7; 4/7, moist) clay; less firm and less sticky; massive; calcareous; lower part contains numerous soft lumps of CaCO₃.

Microknoll:

- A₁₁ 0 to 6 inches, grayish-brown (10YR 5.5/2; 4.5/2, moist) clay; extremely firm when moist, extremely sticky and plastic when wet, extremely hard when dry; moderate fine blocky; calcareous; numerous CaCO₃ concretions ¼ to ½ inch in diameter; few small ferromanganese concretions; grass roots moderately numerous; grades indistinctly to horizon below.
- A₁₂ 6 to 30 inches, brown (7.5YR 5/2; 4/2, moist) clay with small light reddish-brown (5YR 6/4; 5/4, moist) spots; same consistence as A₁₁ horizon and contains like concretions; moderate fine blocky in upper 10 inches, massive below; calcareous; grass roots few; grades indistinctly to horizon below.
- AC 30 to 58 inches, mottled light-gray (10YR 6/1; 5/1, moist) and light yellowish-brown (10YR 6/4; 5/4, moist) clay with a few reddish-yellow (5YR 6/6; 5/6, moist) spots; consistence same as above; concretions less numerous; massive; calcareous; grades to horizon below.
- D_{u1} 58 to 64 inches, reddish-brown (5YR 5/4; 4/4, moist) clay mottled with light brownish-gray (10YR 6/2; 5/2, moist) and a few yellowish-red (5YR 5/6; 4/6, moist) spots; otherwise same as horizon above.
- D_{u2} 64 to 90 inches +, stratified red (2.5YR 5/6; 4/6, moist) clay and reddish-yellow (5YR 7/7; 6/7, moist) silty clay loam; more friable than above; massive; calcareous.

Range in characteristics.—The color of surface soil ranges from gray in cultivated fields to very dark gray or dark grayish brown in areas under native vegetation. Depth to D_{u2} horizon ranges from 5 to 6 feet.

An area of about 12 acres lying 400 yards southwest of the southwest corner of the Bryan Army Airfield is unlike Burleson clay but is included with it. It consists of 0 to 9 or 15 inches of dark-brown calcareous clay that is granular, friable, and crumbly. This layer rests on pale-brown calcareous loamy sand. This inclusion occurs in a depressional soil area for which there is not an appropriate recognized series. Some areas of Bell clay, not mapped separately in this county, are also included with Burleson clay. Most of these areas are 3 to 5 acres in size; but a few are large, such as the 100-acre area 1 mile northwest of the mouth of Thompsons Creek. The Bell soil differs from Irving in being calcareous throughout the profile and in being more granular in the upper part.

Drainage.—Runoff is very slow and in some places wanting; internal drainage is very slow.

Topography and erosion.—This series occurs on level surfaces free from erosion and erosion hazards.

Distribution and use.—The series is on medium and high terraces in the Brazos River valley. It is mostly in pasture.

Crockett series.—The Crockett series consists of grayish-brown crusty soils with blocky clay subsoils. These soils were developed under prairie grasses in alkaline or weakly calcareous clay and sandy clay. They are members of the great soil group of Reddish Prairie soils. Asso-

ciated series are the Wilson, which is dark gray; the Houston-Hunt complex, which consists of dark-gray or olive-gray clays; and the Bonham, which has a crumbly and friable B₁ horizon. Fine sandy loam and clay loam textures are mapped in the Crockett series in Brazos County.

The profile of Crockett fine sandy loam described below is in a cultivated field with a gradient of about ½ percent.

- A₁₀ 0 to 5 inches, light brownish-gray (10YR 6/2; 4.5/2, moist) fine sandy loam; friable when moist, hard and crusty when dry; structureless; pH 6.3; boundary with horizon below is abrupt.
- A₁ 5 to 9 inches, very dark grayish-brown (10YR 3/1.5; 2/1.5, moist) loam; friable when moist, hard when dry; very weakly granular; pH 6.0; boundary with horizon below is abrupt.
- B₂₁ 9 to 14 inches, light-gray (5Y 7/2; 6/2, moist) clay mottled with reddish-brown (5YR 5/4; 4/4, moist) and a few pale-yellow spots; extremely firm when moist, very hard when dry, extremely sticky and plastic when wet; moderate medium to fine subangular blocky; moderately crumbly; pH 6.2; a few shotlike ferromanganese concretions present; grades gradually to horizon below.
- B₂₂ 14 to 22 inches, mottled light-gray (5Y 7/2; 6/2, moist) and yellow (5Y 7/5; 6/5, moist) clay; consistence same as B₂₁ horizon; weak coarse blocky; very compact; pH 7.0; ferromanganese concretions still present; grades gradually to horizon below.
- B₂₃ 22 to 34 inches, olive (5Y 5/3; 4/3, moist) clay slightly mottled with pale yellow and yellow; consistence same as B₂₁ horizon; ferromanganese concretions and small CaCO₃ concretions are present; pH 8.0; grades gradually to horizon below.
- B₃ 34 to 58 inches, same as horizon above but contains 15 to 25 percent, by volume, of gypsum crystals; pH 8.0 but noncalcareous; grades gradually to horizon below.
- C 58 to 90 inches +, yellow (2.5Y 7/8; 6/8, moist) clay mottled with white (2.5Y 8/2; 7/2, moist) massive and compact; contains about 5 percent, by volume, of gypsum crystals.

Range in characteristics.—The surface soil ranges from 5 to 12 inches in thickness. Crockett clay loam has a darker surface soil and a few small included areas of clay. Crockett fine sandy loam has a wavy contact between the A and B horizons, and the A horizon is as much as 18 inches thick over the micro-depressions in the subsoil. In some areas rounded quartzite and chert gravel, ¼ to 2 inches in diameter, make up 15 to 30 percent of the A horizon. These areas are shown on the map by symbol.

Drainage.—Runoff ranges from slow to medium, the rate depending on the surface gradient.

Topography and erosion.—Surface gradients range from about ½ to 12 percent but are dominantly less than 6 percent. Areas with surface gradients more than about 1 percent are subject to erosion when cultivated. Some of the more sloping areas have been severely eroded.

Distribution and use.—The Crockett soils occur in a strip of prairie along the west side of the county. Only about one-third of their area is now being cultivated.

Derby series.—The Derby series is of the Regosol great soil group. It consists of deep loamy sands developed in sandy alluvial deposits laid down by floodwaters of the Brazos River. However, these deposits were probably shifted and reworked by wind before the present soils were developed. The Derby series was developed under a hardwood forest cover. It is associated with the Bastrop series, which has a yellowish-red light sandy clay subsoil; the Axtell, which has a compact

mottled subsoil; and the Travis, which has a reddish sandy clay subsoil.

The profile of Derby loamy fine sand described below is in a field that was formerly cultivated but is now in pasture. The surface gradient is about ½ percent. The site is 8 miles west-southwest of Bryan, 300 yards east of Texas Highway No. 21, and 300 yards west of the southwest corner of Bryan Army Airfield, south of the county road.

- A₁ 0 to 18 inches, grayish-brown (10YR 5/2.5; 4/2.5, moist) loamy fine sand; very friable when moist, soft when dry; loose, single grain; pH 6.0; grades gradually to horizon below.
- AC 18 to 30 inches, reddish-yellow (7.5YR 5.5/6; 4/4, moist) loamy fine sand; otherwise like horizon A₁; grades gradually to horizon below.
- C 30 to 50 inches +, reddish-yellow (7.5YR 7/6; 6/6, moist) loamy fine sand; otherwise like horizon above.

Range in characteristics.—The darkened surface soil ranges from 12 to 24 inches in thickness and from brown to light brownish gray in color.

Drainage.—Runoff is slow, but the soil rapidly absorbs water; internal drainage is rapid.

Topography and erosion.—The soil occurs in gently undulating areas. It is not susceptible to water erosion, but the surface soil in barren areas is shifted to some extent by wind.

Distribution and use.—The Derby soil occurs on low terraces adjacent to the flood plain of the Brazos River. About one-fourth of their area is now cultivated, and the rest is in abandoned-field pasture.

Edge series.—In the Edge series are forested Planosols developed from acid shaly clay and sandy clay. It occurs under a cover of scrubby hardwood trees. It is associated with the Tabor series, which does not have the reddish coloration in the subsoil; the Lufkin, which has a gray subsoil; and Axtell, which has a more alkaline lower subsoil.

The profile of Edge fine sandy loam described below is in a forested area that has a convex surface gradient of 4 percent. The site is 17½ miles north of Bryan and 3 miles northeast of Edge along a private road.

- A₁ 0 to 4 inches, grayish-brown (10YR 5/2; 4/2, moist) fine sandy loam; friable when moist, hard when dry; crusty surface in cultivated fields; very weakly granular; pH 5.0; grass and tree roots moderately numerous; boundary with horizon below is abrupt.
- A₂ 4 to 8 inches, very pale-brown (10YR 7/4; 5/4, moist) fine sandy loam; very friable when moist, hard when dry; massive, porous; pH 6.0; grass and tree roots moderately numerous; boundary with horizon below is abrupt.
- B₂₁ 8 to 16 inches, yellowish-red (5YR 4/6; 3/6, moist) clay slightly mottled with brown, brownish yellow, and gray; very firm when moist, very hard when dry, and very sticky and plastic when wet; moderate fine and medium blocky; pH 4.8; tree roots few; grades gradually to horizon below.
- B₂₂ 16 to 44 inches, yellowish-red (5YR 5/6; 4/6, moist) clay mottled with light brownish-gray (10YR 6/2; 5/2, moist); consistence same as B₂₁ horizon; weak coarse blocky to massive; pH 4.8 at 24 inches and 5.0 at 36 inches; grades to next horizon.
- B₃ 44 to 52 inches, pale-brown (10YR 5.5/3; 4.5/3, moist) clay, yellowish red (5YR 5/6; 4/6, moist) mottles common; a few gypsum crystals; pH 5.0; grades gradually to horizon below.
- C 52 to 72 inches +, light brownish-gray (10YR 6/2; 5/2, moist) shaly clay with laminae of pale yellow (2.5YR 8/4; 7/4, moist) and brownish-yellow (10YR 6/6; 5/6, moist) material that appears to be limonite; pH 5.5 at 60 inches and at 72 inches.

Range in characteristics.—Surface soil ranges from 4 to 12 inches in thickness, from brown to light grayish brown in color, and from fine sandy loam to light fine sandy loam in texture. Low sand mounds occur on some of the nearly level areas. The B₂₁ horizon ranges from nearly solid red to strongly mottled yellowish red, gray, and brownish yellow.

Drainage.—Surface drainage is slow to rapid, the rate depending upon surface gradient. Internal drainage is very slow.

Topography and erosion.—Surface gradients range from less than 1 percent to 12. Dominant slopes are less than 8 percent. Areas on slopes greater than about 1 percent are susceptible to erosion when cultivated, and some of the more sloping cultivated areas are severely eroded.

Distribution and use.—This series is extensive and occurs on eroded upland throughout the county. Nearly all the soil is in pasture, either abandoned-field pasture or woodland pasture.

Gowen series.—In the Gowen series are grayish Alluvial soils that occur in flood plains of the small local streams. These soils consist of sediments washed from the local prairie uplands and forested uplands. The vegetation is a thick growth of trees and underbrush. Textures of fine sandy loam and clay loam are mapped in this series in Brazos County. Associated series are the Kaufman, which is darker and less acid; the Ochlockonee, which is brownish and sandier; and the Navasota, which is strongly acid, poorly drained, and under water for long periods.

The following profile of Gowen clay loam is in a nearly level abandoned field. The site is in the area where the flood plains of Bowman Creek and those of the Navasota River merge.

- A₁ 0 to 24 inches, gray (10YR 5/1; 3.5/1, moist) clay loam; moderately friable when moist, very hard when dry, very sticky when wet, massive but weakly porous; pH 6.0 at 12 inches and 7.0 at 24 inches; grass roots few to moderately numerous; grades very gradually to layer below.
- A₂ 24 to 54 inches, gray (10YR 6/1; 4/1, moist) heavy clay loam weakly stratified with sandy clay loam; moderately friable when moist, sticky when wet, hard when dry; massive; pH 8.0 at 36 inches and 48 inches but noncalcareous; grass roots few.

Range in characteristics.—The surface soil ranges from dark gray to grayish brown. A few areas have mottlings of yellowish brown and strong brown in the subsurface layer. Small areas of Kaufman clay, usually lying a little lower, are included.

Drainage.—Very slow from the surface, and slow internally.

Topography and erosion.—The soil occurs on level and nearly level flood plains. It is free from erosion hazard. It overflows one or two times annually but is usually under water less than 24 hours.

Distribution and use.—This series is confined to flood plains of small local streams throughout the county. Nearly all of the series is currently used for pasture.

Houston-Hunt clays.—These mapping units consist of soils of the Houston and Hunt series. Both of these series are Grumusols (11). They have developed in calcareous clay under prairie grasses, mostly coarse bunchgrasses. They are distinguished from the associated Crockett, Wilson, and Bonham soils in being more granular and in lacking a textural profile. Each soil occurs in such small areas that it is not feasible to separate them. The areas

have distinct microrelief; the Hunt occurs in the micro-depressions, and the Houston on the microknolls.

Profiles of Houston and Hunt clays from an area under native grass and having a gradient of 2 percent are described below.

Houston clay:

- A₁ 0 to 5 inches, light olive-brown (2.5Y 5/4; 4/4, moist) clay; strong medium granular; crumbly; friable to firm when moist, very sticky when wet, very hard when dry; strongly calcareous; contains numerous small concretions of calcium carbonate; grades gradually to horizon below.
- AC 5 to 30 inches, light yellowish-brown (2.5Y 6/4; 5/4, moist) clay; moderate medium blocky in upper part to weak coarse blocky in lower part; very firm when moist, very stiff and sticky when wet, very hard when dry; strongly calcareous; contains numerous small hard concretions of calcium carbonate; grades gradually to horizon below.
- C 30 to 44 inches +, mottled olive-yellow (2.6Y 6/8; 5/8, moist) and pale-yellow (2.5Y 7/4; 6/4, moist) clay; massive; very firm; very sticky; strongly calcareous.

Hunt clay:

- A₁₁ 6 to 8 inches, very dark-gray (5Y 3/1; 2/1, moist) clay; crumbly and friable when moist, very stiff and sticky when wet, very hard when dry; strong medium granular; very slightly acid; grades gradually to horizon below.
- A₁₂ 8 to 18 inches, olive-gray (5Y 4/2; 3/3, moist) clay; crumbly; weak granular to weak medium blocky; very firm when moist, very stiff and sticky when wet, very hard when dry; grades gradually to horizon below.
- AC 18 to 40 inches, olive-gray (5Y 4/2; 3/3 moist) clay; massive; very firm; very stiff and sticky when wet, very hard when dry; mildly alkaline; grades gradually to horizon below.
- C 40 to 48 inches +, pale-olive (5Y 7/3; 6/3, moist) clay; massive; weakly calcareous; contains a few small concretions of calcium carbonate.

Range in characteristics.—The color of surface soil of the Houston clay ranges from light olive brown to yellowish brown and the thickness from 5 to 10 inches; thickness of the solum ranges from 30 to 45 inches. The thickness of the surface soil of the Hunt clay ranges from 8 to 14 inches, and that of the solum ranges from 36 to 48 inches. The A₁ horizon is thinner in both of these soils where the surface gradient is more than 4 or 5 percent. Small tracts of Crockett or Wilson clay, or both, that are too small to delineate are included in some areas.

Topography and erosion.—These soils occur on convex slopes ranging from 1 to 15 percent. Areas with gradients of more than 1 percent are susceptible to erosion. The susceptibility to erosion increases with gradient, especially in cultivated fields. Some of the more sloping areas are severely eroded.

Drainage.—Runoff ranges from slow to moderately rapid.

Distribution and use.—This complex occurs mainly in the western part of the county. Less than one-third of it was cultivated in 1950. Nearly all of the more sloping areas are in pasture; the greater part was cultivated at one time and is now eroded.

Irving series.—The Irving series comprises dark-colored Planosols developed in old calcareous alluvial sediments under a cover of coarse prairie grasses. The sediments were deposited by floodwaters of the Brazos River. The Irving series occurs in association with the Axtell series, which has mottled subsoil; the Burleson, which does not have a textural profile; the Travis, which has a reddish sandy clay subsoil; and the Bastrop, which has a yellowish-red light sandy clay subsoil

The following profile of Irving clay loam is in a nearly level abandoned field. The site is 18 miles southeast of Bryan and 2½ miles north-northwest of Allen Farm, along the south side of the track of the Missouri Pacific.

- A_{1p} 0 to 4 inches, gray (10YR 5/1; 3.5/1, moist) clay loam; massive; friable when moist, hard when dry, sticky when wet; pH 6.0; boundary with horizon below is abrupt.
- A₁ 4 to 10 inches, dark-gray (10YR 4/1; 3/1, moist) clay loam; weak medium blocky; moderately friable when moist, hard when dry, sticky when wet; pH 6.0; boundary with horizon below is abrupt.
- B₂₁ 10 to 36 inches, dark-gray 10YR 4.5/1; 3/1, moist) clay; moderate coarse blocky; extremely firm when moist, extremely sticky when wet, extremely hard when dry; pH 6.3; changes gradually to horizon below.
- B₂₂ 36 to 45 inches, gray (10YR 6/1.5; 5/1.5, moist) clay; massive; same consistence as B₂₁ horizon; pH 8.0, but non-calcareous; this is a transition layer; grades gradually to horizon below.
- B₃ 45 to 82 inches, pale-yellow (2.5Y 7.5/4; 6/4, moist) clay; massive; firm when moist, moderately sticky when wet; pH 8.0 but noncalcareous; small lumps of pink unweathered alluvium in the lower part of the profile; grades gradually to horizon below.
- C_{oa} 82 to 94 inches, pink (7.5YR 7/4; 6/4 when moist) weakly mottled with reddish yellow (5YR 6/6; 5/6 when moist) clay; friable when moist; calcareous; contains numerous soft and hard calcium carbonate concretions.
- C₁ 94 to 120 inches +, parent material of reddish-yellow (5YR 6/6; 5/6, moist) silty clay containing a few soft and hard calcium carbonate concretions.

A few small iron oxide concretions are present throughout the profile but are more numerous in horizon B₃.

Range in characteristics.—The surface soil varies in thickness from 8 to 14 inches, in color from gray to dark gray, and in texture from sandy clay loam in some cultivated fields to clay loam. In places the subsoil has some coarse sand in the upper part. After rains, a hard light-gray crust forms on the surface in cultivated fields.

Drainage.—Runoff is very slow but adequate for general field crops. Internal drainage is very slow.

Topography and erosion.—The Irving soils occur in level or nearly level areas with surface gradients of dominantly less than ½ percent. They are free from erosion hazards.

Distribution and use.—This series occurs on low to high terraces in the valley of the Brazos River. At the time of the survey only about one-fourth of their total area was being cultivated. Most of the rest had been cultivated in the past.

Kaufman series.—The Kaufman series comprises Alluvial soils, which are sediments washed mostly from the local upland prairies. The native vegetation is a rather thick cover of deciduous forest and underbrush. This series is associated with the Gowen series, which is less dark and generally more acid; the Ochlockonee, which is brownish, sandy, and more acid; and the Miller, which is calcareous and reddish.

The profile of Kaufman clay described below is in a level cultivated field. The site is on the edge of the Little Brazos River flood plain, 8 miles west-northwest of Bryan and 1 mile south of the intersection of the Old San Antonio Road with the Mumford Road.

- A_{1p} 0 to 4 inches, dark-gray (10YR 4/1; 3/1, moist) clay; some sand grains noticeable; very firm when moist, very hard when dry, very sticky and plastic when wet; weak medium granular; pH 7.0; boundary with horizon below is abrupt.
- A₁₂ 4 to 18 inches, very dark-gray (10YR 3/1; 4/1, moist) clay; consistence same as layer above; massive; pH 7.0; grades gradually to horizon below.

AC 18 to 38 inches, dark-gray (10YR 4/1; 3/1) alkaline clay; more compact and sticky than layer above.

C 38 to 54 inches +, weakly stratified dark-gray (10YR 4/1; 3/1, moist) clay and grayish-brown (10YR 5/2; 4/2, moist) clay loam; less firm and hard than layer above; massive; pH 8.0, but horizon is noncalcareous.

Range in characteristics.—Some areas have 2 to 4 inches of sandy clay overwash. The surface soil ranges from dark gray to very dark gray in color and from heavy clay loam in some cultivated fields to heavy clay. Some areas are not stratified in the lower part. Reaction varies from slightly acid to alkaline, but the soil is noncalcareous.

Drainage.—Runoff and internal drainage are very slow but are adequate for successful growth of all field crops common to the area.

Topography and erosion.—This series occurs on level to nearly level flood plains. It is not susceptible to erosion but may be flooded once every 3 or 4 years.

Distribution and use.—This series occurs in the west end of the county along the Little Brazos River. Less than one-fourth was in cultivation in 1950.

Lakeland series.—The Lakeland series comprises maximal Red-Yellow Podzolic soils. It consists of deep light-colored loamy sands over clayey materials and was developed in acid sandy clay loam under a scrubby hardwood forest on the upland. It is associated with the Tabor series, which has compact clay subsoils within 30 inches of the surface; the Travis, which has red heavy sandy clay subsoils within 15 inches of the surface; and Sawyer, which has friable sandy clay loam subsoils over clay lower subsoils.

The profile of Lakeland loamy fine sand described below is in a wooded area with a convex surface of 1 percent gradient. The site is 5¼ miles north of Tabor and along the south side of a county road, ¼ mile east of Bee Creek.

- A₁ 0 to 7 inches, light brownish-gray (10YR 6/2; 5/2, moist) loamy fine sand; very friable when moist and loose when dry; single grain; pH 6.0; small tree roots abundant; boundary with horizon below is abrupt.
- A₂ 7 to 37 inches, very pale brown (10YR 8/3.5; 7/3.5, moist) loamy fine sand; very friable when moist and loose when dry; single grain; pH 6.0; tree roots abundant in upper part; grades gradually to horizon below.
- A₃ 37 to 46 inches, very pale brown (10YR 8/3; 7/3, moist) loamy fine sand mottled with yellow and reddish yellow; very friable, loose; pH 6.0; grades gradually to horizon below.
- AC 46 to 53 inches, very pale brown (10YR 8/3; 7/3, moist) fine sandy loam mottled with yellow, white, and distinct yellowish red; the yellowish red is centered around ferruginous concretions; friable; massive; pH 5.5; boundary with horizon below is abrupt.
- B₂₁ 53 to 73 inches, white (10YR 8/2; 7/2, moist) sandy clay coarsely mottled with red (10YR 4/6; same when moist); very firm when moist, very hard when dry, and very sticky when wet; weak medium blocky; few tree roots; pH 5.0; grades gradually to horizon below.
- B₂₂ 73 to 97 inches, white (10YR 8/2; 7/2, moist) sandy clay loam mottled with red (2.5YR 4/8; same when moist); consistence same as B₂ horizon; pH 5.0; grades gradually to horizon below.
- C 97 to 120 inches, white (10YR 8/2; 7/2, moist) light sandy clay loam mottled with light red (2.5YR 5/8; same when moist); friable when moist and hard when dry; pH 5.5 (Temporary or perched water table on the B horizon after heavy rains.)

Range in characteristics.—The A₁ horizon ranges from 6 to 20 inches in thickness and from grayish brown to light brownish gray in color. Color of A₂₁ horizon ranges from light yellowish brown to very pale brown. Depth to B₂₁

horizon ranges from 30 to 72 inches. Texture of B₂₁ horizon ranges from sandy clay loam to clay.

Drainage.—Runoff is slow to medium. The loose loamy fine sand surface soil rapidly absorbs water. Internal drainage is rapid.

Topography and erosion.—This series occurs on gently sloping to strongly sloping eroded upland. Gully erosion occurs on sloping cleared areas where water concentrates above the slope and flows over it. Some shifting of the surface soil by the wind occurs in barren areas.

Distribution and use.—The Lakeland series occurs adjacent to the flood plain of the Navasota River and intermixed with other soils on high terraces along the Brazos River. Only a small acreage was cultivated in 1950. Some of the series is in abandoned-field pasture, and the rest is in woodland pasture.

Lufkin series.—The Lufkin series consists of grayish forested Planosols developed in alkaline clay and sandy clay. It is associated with the Tabor series, which has a yellowish subsoil; the Edge and Axtell, which have strongly mottled subsoils; and the Lakeland, which is a deep loamy sand.

The profile of Lufkin fine sandy loam described below is in a cleared pasture (slope about $\frac{3}{4}$ percent) that has never been cultivated. The site is in a pasture of the Texas Agricultural and Mechanical College, 1 mile west-northwest of the depot at College Station,

- A₁ 0 to 7 inches, gray (10YR 6/1.5; 4/1.5, moist) fine sandy loam; friable when moist and very hard when dry; massive; fine porous; pH 6.0; boundary with horizon below is abrupt.
- A₂ 7 to 8 inches, light-gray (10YR 7/1.5; 5/1.5, moist) fine sandy loam; friable when moist and very hard when dry; massive; porous; pH 5.8; boundary with horizon below is abrupt.
- B₂₁ 8 to 28 inches, gray (10YR 5/1; 3.5/1, moist) clay; very compact; extremely firm when moist, extremely hard when dry, and extremely sticky and plastic when wet; sand grains noticeable; weak coarse blocky; pH 6.3; grades gradually to horizon below.
- B₂₂ 28 to 42 inches, gray to light-gray (10YR 6.5/1; 5/1, moist) clay of same consistence as above; massive; pH 6.3; grades gradually to horizon below.
- B₃ 42 to 57 inches, grayish-brown to light brownish-gray (10YR 5.5/1; 4.5/1, moist) sandy clay with a few yellowish-brown spots; not as compact, firm, and hard as above; massive; pH 6.5; grades gradually to horizon below.
- C₁ 57 to 74 inches, light-gray (10YR 7/1; 6/1, moist) sandy clay with very pale-brown and light yellowish-brown spots; moderately firm and hard; pH 6.5.
- C₂ 74 to 108 inches +, white (10YR 8/2; 7/2, moist) sandy clay mottled with light yellowish brown and brown; pH 6.8 to 7.0.

Range in characteristics.—The A₁ horizon ranges in thickness from 5 to 10 inches, in color from a gray to light brownish gray, and in texture from a loam to a light fine sandy loam. The A₂ horizon, a gray layer, is not always present. It varies from a light gray to almost white and has a maximum thickness of 2 inches in some areas. The subsoil ranges in color from a dark gray to light brownish gray. In a few areas it has brownish-yellow mottlings, and in a few others, reddish-brown or yellowish-red mottlings in the upper 6 to 8 inches. Depths to alkaline material in this series vary from 24 to 44 inches. Most areas become calcareous at 36 to 48 inches and have a few to many calcium carbonate concretions in the lower part of the subsoil. Depths to the underlying substratum range from 38 to 60 inches.

Drainage.—Runoff ranges from very slow to moderately rapid, the rate depending on the surface gradient. Internal drainage is very slow.

Topography and erosion.—Slopes range from 0 to 8 percent but are dominantly less than 3 percent. Cultivated areas of this series with slopes of more than 1 percent are susceptible to erosion; some of the more sloping areas are severely eroded.

Distribution and use.—This is the most extensive series in the county and occurs in small and large tracts. Only about 5 percent was in cultivation in 1950, and about 60 percent was in abandoned-field pasture; the rest was in native woodland pasture.

Miller series.—The Miller series consists of reddish clayey Alluvial soils that are composed of recent sediments deposited by floodwaters of the Brazos River. Most of these sediments have been washed from the Reddish Chestnut soils of western Texas. Textures of clay and silt loam are mapped in the Miller series in Brazos County. Associated series are the Norwood, which has a loamy or silty subsoil; the Yahola, which has a sandy subsoil; and the Roebuck, which is in depressions and is poorly drained.

The profile of Miller clay described below is from a nearly level cultivated field. The site is 23 miles southeast of Bryan, near the channel of the Brazos River.

- A 0 to 18 inches, dark reddish-brown (5YR 4/3; 3/3, moist) clay; very firm when moist, very hard when dry, and very sticky and plastic when wet; strong medium granular when dry and exposed; strongly calcareous; grades gradually to horizon below.
- AC 18 to 50 inches +, reddish-brown (5YR 5/4; 4/4, moist) clay; consistence same as horizon above; massive in place, but granular when exposed and dried out; strongly calcareous; in nearby cut, this clay extended to depth of about 10 feet.

Range in characteristics.—The darkened upper layer ranges from 12 to 24 inches in thickness and from dark brown to reddish brown in color. Small tracts totalling less than 2 percent of the area and mapped as Miller clay are stratified with lighter textured material below a depth of 18 inches. The lighter textured strata are not thick enough to affect materially the drainage and productivity of the soil. In some areas along the lower Navasota River the topmost 10 or 15 inches is dark gray to dark grayish brown. These areas are on bottom land just above the junction of the Navasota River with the Brazos River. Some areas have a surface layer consisting of 6 to 24 inches of light-brown silt loam; these are mapped as Miller silt loam.

Drainage.—Runoff and internal drainage are very slow. Drainage, however, is adequate for successful growing of the common field crops of the area.

Topography and erosion.—This series occupies level flood plains along the Brazos River. Normally there is no erosion hazard. Some erosion has occurred on slopes leading down to drains that cross the large areas of Miller clay. The Miller series is subject to overflow, but at the time of the survey no flooding had occurred for 10 years.

Distribution and use.—The series occurs in the flood plain along the Brazos River. About four-fifths of its total area is in cultivation.

Navasota series.—The Navasota series comprises grayish clayey Alluvial soils that are strongly acid, poorly drained, and inundated for extended periods. The sediments are washed from the Blackland Prairie and local

forested upland. Associated series are the Gowen, which is less acid; the Ochlockonee, which is brownish, sandy, and less acid; and the Miller, which is reddish and calcareous.

The profile described below is in a level area of open forest with an undercover of grass. The site is 12 miles east-southeast of Bryan, on the south side of the county road and about 200 yards from the Navasota River.

- A 0 to 8 inches, dark-gray (10YR 4.5/1; 3.5/1, moist) clay; weak coarse granular to massive; very firm when moist very hard when dry, and very stiff and sticky when wet; pH 6.0; tree roots numerous; boundary with horizon below is abrupt.
- AC 8 to 12 inches, gray (10YR 6.5/1; 5/1, moist) silty clay loam weakly mottled with yellowish brown; firm when moist, sticky when wet, and hard when dry; massive; pH 4.8; few tree roots; boundary with horizon below is abrupt.
- C 12 to 54 inches +, gray (10YR 5/2; 3/1, moist) clay; firm when moist and sticky and stiff when wet; massive; pH 4.5 to 5.0.

Range in characteristics.—The darkened surface soil ranges from 6 to 12 inches in thickness and from very dark gray to dark grayish brown in color. The AC horizon is not always present. Where present, it ranges from 4 to 6 inches in thickness, from clay to silt loam in texture, and from gray to light brownish gray in color. Mottles are common. They occur in from 5 to 15 percent of the soil. The mottles range from yellowish brown to dark brown. Near the junction of the bottom lands of the Navasota and Brazos Rivers, the lower subsoil becomes alkaline at a depth of about 4 feet. Included with the Navasota clay are small areas that have clay loam or fine sandy loam surface soils over the clay. These areas are adjacent to the hillside where small drains carry sandy sediments onto the bottom land.

Drainage.—Runoff and internal drainage are very slow. The flood plain on which this series occurs is flooded about twice each year to depths of 6 to 8 feet, and remains so for several days or weeks. Water remains in the sloughs and depressions for several weeks after it has drained from surrounding areas on the bottom land.

Topography and erosion.—This series is level but has occasional sloughs and shallow depressions. It is not subject to erosion.

Distribution and use.—The Navasota series occurs entirely in the Navasota River flood plain. It is used almost entirely as woodland pasture.

Norwood series.—The Norwood series comprises reddish well-drained Alluvial soils. Floodwaters of the Brazos River have carried in sediments from the Reddish Prairies of west Texas and from the sandy forested soils and the Blackland Prairies of central Texas. Textures mapped in this series are silt loam and silty clay loam. An associated series is the Miller, which has clay subsoils; and the Yahola, which has sandy subsoils.

The profile of Norwood silt loam described below is in a nearly level cultivated field.

- A₁ 0 to 15 inches, light-brown (7.5YR 6/4; 5/4, moist) silt loam; very friable when moist and hard when dry; calcareous; grades indistinctly to horizon below.
- AC 15 to 40 inches +, light reddish-brown (5YR 6/4; 5/4, moist) silt loam weakly stratified with thin layers of clay loam to very fine sandy loam; very friable when moist and slightly hard when dry; permeable; calcareous.

Range in characteristics.—The slightly darkened upper layer ranges from 1 to 2 feet in thickness, from brown to light reddish brown in color, and from silt loam to loam

in texture. Small fragments of snail shells are common in the surface soil. Areas mapped as Norwood silty clay loam have a darker surface soil.

Drainage.—Runoff is very slow, but internal drainage is medium. Depth to water table exceeds 10 feet and is generally 20 to 30. During the infrequent major floods of the Brazos River, which occur at intervals of about 10 to 15 years, the areas are inundated 1 to 5 days. Crop injury from these floods generally is moderate.

Topography and erosion.—This series occurs mainly on almost level natural levees that are free from erosion and erosion hazards. Some sloping areas occur adjacent to streams and are mostly eroded.

Distribution and use.—The Norwood soils occur in the flood plain of the Brazos River. Nearly all areas have been cleared, and nearly 90 percent is in cultivation.

Ochlockonee series.—The Ochlockonee series consists of brownish sandy Alluvial soils in small local stream bottoms. The sediments have been washed from the local sandy uplands. Fine sandy loam and loamy fine sand textures are mapped in this series in Brazos County. Associated series are the Gowen, which is grayish and generally less acid; and the Navasota, which is grayish, clayey, and strongly acid.

The following is the description of a profile of Ochlockonee fine sandy loam in a small stream bottom under a hardwood forest. The site is beside a county road 8 miles north of Bryan and 1¼ miles southwest of Tabor.

- A₁ 0 to 8 inches, brown (10YR 5/3; 4/3, moist) fine sandy loam with a few small mottlings or spots of dark yellowish brown; friable when moist; massive; pH 5.0; grades gradually to horizon below.
- AC 8 to 25 inches, light yellowish-brown (10YR 6/4; 5/3, moist) light fine sandy loam with a few small yellowish-brown spots; stratified in places with clay loam and loamy fine sand; very friable when moist; massive; pH 6.0; grades to horizon below.
- C 25 to 52 inches +, yellow (10YR 8/6; 7/6, moist) loamy fine sand stratified with clay loam and fine sandy loam; very friable; massive; pH 6.5.

Range in characteristics.—The darker upper layer ranges from 6 to 15 inches in thickness, from loam to loamy fine sand in texture, and from light brown to a brown or grayish brown in color. In some places there is little difference in color between the two upper layers.

Drainage.—This series has good drainage. It is slow from the surface but is free internally. The soils are subject to overflow two or more times each year but are generally flooded less than 24 hours.

Topography and erosion.—The Ochlockonee soils occur on nearly level flood plains of local streams. They are free from erosion or erosion hazard but receive some deposits of stream sediments in places.

Distribution and use.—The soils of this series occur in small narrow areas throughout the county. In 1950, a very small part was cultivated land, two-fifths was cleared pasture, and the rest was in woodland pasture.

Payne series.—This series is in the Reddish Prairie great soil group. It consists of brownish heavy soil developed under prairie grass, mostly tall bunchgrass, from old calcareous stream sediments. The sediments were deposited by floodwaters of the Brazos River, but the soil is now above overflow. Associated series are the Irving, which is more grayish and more compact; the Burleson, which is grayish and does not have a textural

profile; the Houston, which is strongly calcareous and brownish; and the Axtell, which is sandy and has a strongly mottled subsoil.

The profile of Payne clay loam described below is in an abandoned-field pasture on a slope of 2½ percent. The site is 7½ miles west of Bryan, along the east side of the Old San Antonio Road, 200 yards south of the Missouri Pacific Railroad crossing.

- A₁₀ 0 to 8 inches, dark grayish-brown (10YR 4/2; 2.5/2, moist) clay loam; massive; friable when moist and very hard when dry; pH 6.7; boundary with horizon below is abrupt.
- B₂₁ 8 to 22 inches, dark-brown (7.5YR 4/2; 2.5/2, moist) clay; massive; very firm when moist, very sticky when wet, and very hard when dry; pH 7.0; slowly permeable; boundary with horizon below is abrupt.
- B₃ 22 to 36 inches, reddish-brown (5YR 5/4; 4/4, moist) clay; more friable and permeable than layer above; massive; pH 7.5; grades gradually to horizon below.
- C 36 to 54 inches +, yellowish-red (5YR 4/6; same moist) clay or sandy clay with a few concretions of calcium carbonate; massive; alkaline.

Horizons B₃ and C contain a few small concretions of ferromanganese.

Range in characteristics.—The A horizon ranges from 6 to 12 inches in thickness, from grayish brown to dark grayish brown, and from heavy fine sandy loam in some cultivated fields to clay loam. Depths to the reddish material range from 3 to 5 feet. The subsoil of some areas is mottled olive, yellowish red, and brownish yellow; these areas are grading to the Axtell soils.

Drainage.—Runoff is slow and internal drainage is slow to very slow.

Topography and erosion.—This series occurs on nearly level to gently sloping old river terraces. Slight erosion has occurred in some fields. Unprotected fields are subject to slight or moderate erosion.

Distribution and use.—The Payne series is confined to terraces along the Brazos River along the western side of the county. It is now used for pasture, although most of it has been cultivated.

Roebuck series.—This series comprises poorly drained depressional Alluvial soils developed in relatively recent sediments deposited by floodwaters of the Brazos River. Uncleared areas are under a cover of deciduous forest of oak, elm, ash, pecan, and hackberry trees. Associated series are the Miller, which is better drained and has unmottled subsoils; and the Norwood and Yahola, which are more permeable.

The profile of Roebuck clay described below is in a depression that has been cleared of its native forest, drained, and put in pasture. The site is 3½ miles south of Millican and 530 yards south of the Missouri Pacific Railroad track.

- A₁ 0 to 12 inches, dark-brown (7.5Y 4/2; 2/2, moist) clay; very firm when moist, very sticky when wet, and very hard when dry; strong fine blocky; calcareous; changes gradually to horizon below.
- AC 12 to 20 inches, reddish-brown (5YR 4/3; 3/3, moist) clay; consistence same as layer above; weak fine blocky; calcareous; changes gradually to horizon below.
- C 20 to 54 inches +, mottled light reddish-brown (5YR 6/4; 5/4, moist), brown (7.5YR 5/3; 4/3, moist), and gray (10YR 6/1; 5/1, moist) clay; consistence same as layer above; weak fine subangular blocky; calcareous.

Range in characteristics.—The brown surface soil ranges from 10 to 24 inches in thickness and from brown

to dark grayish brown in color. Depth to the mottling ranges from 10 to 24 inches.

Drainage.—Runoff is very slow to wanting, and internal drainage is very slow. Water remains on the surface 3 or 4 months during the cool wet season. Natural drainage is too poor for successful cultivation, but the soil is productive where adequately drained.

Topography and erosion.—This series occurs in depressed areas and in old sloughs. There is no erosion hazard. Overflow from the Brazos River occurs about once in 10 or 12 years.

Distribution and use.—The Roebuck soil occurs on the flood plain of the Brazos River. It is used mostly for pasture.

Sawyer series.—This series is in the Red-Yellow Podzolic great soil group, and it consists of light-colored sandy soil developed in alkaline sandy clay, with some strata of sandy clay loam, under a cover of small hardwoods. Associated series are the Tabor, which has a yellow claypan subsoil; the Edge, which is strongly mottled and has a heavy clay subsoil; and the Lufkin, which has a gray claypan subsoil.

The profile of Sawyer loamy fine sand described below is in an abandoned field with a slope of 2 percent. The site is on the south side of a county road 2 miles southeast of Edge.

- A₁₀ and A₁ 0 to 12 inches, pale-brown (10YR 6.5/3; 4/3, moist) loamy fine sand; very friable when moist and soft when dry; structureless; porous; pH 6.3; boundary with horizon below is abrupt.
- A₂ 12 to 18 inches, very pale brown (10YR 7/4; 6/4, moist) loamy fine sand; very friable when moist and soft when dry; structureless; porous; pH 6.3; grades gradually to horizon below.
- A₃ 18 to 23 inches, yellow (10YR 7/6; 6/6, moist) heavy fine sandy loam weakly mottled with very pale brown (10YR 7/4; 6/4, moist); friable when moist and hard when dry; massive, porous; pH 6.2; grades gradually to horizon below.
- B₁ 23 to 32 inches, mottled very pale brown (10YR 7/4; 6/4, moist) and brownish-yellow (10YR 6/6; 5/6, moist) clay loam; permeable; crumbly and friable when moist and hard when dry; pH 5.3; numerous ferromanganese concretions in lower 1 or 2 inches; grades gradually to horizon below.
- B₂₁ 32 to 40 inches, mottled light-gray (10YR 7/2; 6/2, moist) and yellowish-brown (7.5YR 6/8; 5/8, moist) clay with a few red (2.5YR 5/6; 4/6, moist) streaks; firm when moist, very hard when dry, and sticky when wet; massive; pH 5.5; grades gradually to horizon below.
- B₃ 40 to 68 inches, mottled red (2.5YR 5/6; 4/6, moist) and light-gray (10YR 7/2; 6/2, moist) clay; yellow (10YR 7/6; 6/6, moist) mottles make up about 5 percent of the exposed surface; very firm when moist, very hard when dry, and very stiff and sticky when wet; massive; pH 6.0; grades gradually to horizon below.
- C₁ 68 to 82 inches, mottled light-gray (10YR 7/2; 6/2, moist) and yellowish-brown (10YR 6/6; 5/6, moist) sandy clay; red (2.5YR 5/6; 4/6, moist) streaks make up about 5 percent of the exposed surface; firm when moist, hard when dry, and sticky when wet; massive; pH 8.0; grades gradually to horizon below.
- C₂ 82 to 88 inches +, pale-brown (10YR 7/3; 6/3, moist) sandy clay loam mottled with brownish-yellow (10YR 6/6; 5/6, moist); friable; massive; pH 8.0.

Range in characteristics.—The darker surface soil ranges from 8 to 15 inches in thickness, from a loamy fine sand to light fine sandy loam in texture, and from a grayish brown to a pale brown in color. The friable upper subsoil layer ranges from 6 to 15 inches in thickness.

Small, intermingled areas of Bowie loamy fine sand are included with Sawyer loamy fine sand. These small areas occupy less than 15 percent of the total area mapped as Sawyer loamy fine sand and have the same crop adaptations, management requirements, and fertilizer needs. Also included with Sawyer loamy fine sand are a few small areas of Travis loamy fine sand. The included soil consists of a pale-brown, massive, slightly acid loamy fine sand, ranging from 18 to 36 inches in thickness. This material grades into a red, massive, acid friable to firm clay subsoil. Adapted crops and soil productivity are about equal to those of Sawyer loamy fine sand.

Drainage.—Runoff and internal drainage are slow.

Topography and erosion.—This series occurs on undulating to gently sloping areas on erosional upland. Surface gradients are dominantly 1 to 3 percent, but some small areas with gradients up to 4 percent are included. The soil is not subject to erosion except in areas where the surface gradients are more than 2 percent. Most areas are uneroded.

Distribution and use.—All of this series is in the north end of the county in the vicinity of Edge. All areas were in pasture in 1950.

Tabor series.—This series consists of light-colored crusty claypan soils. It is in the Planosol great soil group and occurs on erosional upland that developed in alkaline to slightly acid sandy clay. Textures of loamy fine sand, fine sandy loam, and gravelly loamy sand are mapped in this series in Brazos County. The native vegetation consists of a scrubby growth of hardwood trees. Associated series are the Lufkin, which is gray; the Sawyer, which has a friable upper subsoil; and the Edge, which is strongly mottled.

The profile of Tabor fine sandy loam described below is in an area covered with native woods that has a convex surface gradient of 1½ percent. The site is 4½ miles southeast of Kurten, and northwest of a county road, 220 yards northeast of the L turn to the northwest.

- A₁ 0 to 7 inches, pale-brown (10YR 6/3; 4/3, moist) fine sandy loam; friable when moist and hard when dry; massive; pH 6.0; grades gradually to horizon below.
- A₂ 7 to 10 inches, very pale brown (10YR 7/3; 5/3, moist) fine sandy loam; very friable when moist; massive; pH 6.0; rests on horizon below.
- B₂₁ 10 to 25 inches, light yellowish-brown (10YR 6/4; 5/4, moist) clay mottled with yellow (10YR 7/6; 6/6, moist); contains a few yellowish-red (5YR 5/6; same when moist) spots that make up less than 2 percent of the mass; very firm when moist, very stiff and sticky when wet, and very hard when dry; weak coarse blocky; pH 5.3; grades gradually to horizon below.
- B₂₂ 25 to 38 inches, mottled light-gray (10YR 7/2; 6/2, moist) and brownish-yellow (10YR 6.5/6; 6/4, moist) clay with an occasional strong-brown (7.5YR 5/8; same when moist) spot; massive; same consistence as above; pH 5.5; grades gradually to horizon below.
- B₃ 38 to 46 inches, mottled very pale brown (10YR 7/3; 6/3, moist) and light yellowish-brown (10YR 6/4; 6/4, moist) and light-gray (10YR 7/1; 6/1, moist) clay with small spots of red (2.5YR 5/6; same when moist); massive; pH 7.5; grades gradually to horizon below.
- C 46 to 54 inches +, white (10YR 8/2; 7/2, moist) sandy clay mottled with very pale brown (10YR 8/3; 7/3, moist) and spotted with strong brown (7.5YR 5/8; same moist); massive; pH 8.0.

Range in characteristics.—The darkened surface layer ranges from 4 to 10 inches in thickness, from grayish brown to very pale brown in color, and from a heavy fine sandy loam to a light fine sandy loam in texture. The

total thickness of the A horizon ranges from 4 to 14 inches. The amount of red mottling in the subsoil varies from place to place; it may be totally absent or make up as much as 15 percent of the soil mass. Some areas of Tabor fine sandy loam include small tracts, up to 5 acres, of Lufkin fine sandy loam. The top of the subsoil in nearly all areas has a characteristic microrelief of alternating microknolls and microdepressions. The average difference in depth of the surface soil over the microknoll and over the microdepressions is about 12 inches; extreme differences are as much as 30 inches.

Drainage.—Runoff is slow; internal drainage is very slow to wanting. Tabor gravelly loamy sand has medium runoff.

Topography and erosion.—This series occurs on gently sloping eroded upland. Slopes are dominantly from ½ to 3 percent, but small areas with slopes up to 4 percent are included. Tabor gravelly loamy sand is on slopes dominantly from 2 to 6 percent. Nearly all cultivated areas have some erosion and all are subject to erosion.

Distribution and use.—The soils of the Tabor series occur in small and large areas throughout all parts of the county except the large areas of bottom land. In 1950, less than 6 percent of the Tabor soils was cultivated and about 68 percent was in abandoned-field pasture. The rest was in woodland pasture.

Travis series. The Travis series is a normal Red member of the Red-Yellow Podzolic great soil group. It was developed in old alluvial sediments under a hardwood forest. The alluvial sediments were washed from prairies and plains of western Texas and were deposited by floodwaters of the Brazos River. Associated series are the Bastrop, which is more permeable; the Axtell, which has a mottled claypan subsoil; and the Irving, which has a gray claypan subsoil.

The profile of Travis fine sandy loam described below is in a wooded area with a convex gradient of 2 percent.

- A₁ 0 to 7 inches, pale-brown (10YR 6/3; 4/3, moist) light fine sandy loam; very friable when moist and slightly hard when dry; massive; pH 6.5; boundary with horizon below is abrupt.
- A₂ 7 to 12 inches, pink (7.5YR 7/4; 6/4, moist) light fine sandy loam; very friable when moist and soft when dry; massive; pH 6.3; boundary with horizon below is abrupt.
- B₂₁ 12 to 30 inches, red (2.5YR 4/6; same when moist) heavy sandy clay; firm when moist, hard when dry, and stiff and sticky when wet; massive to weak blocky; pH 5.5; grades gradually to horizon below.
- B₂₂ 30 to 46 inches, mottled red (2.5YR 4/6; same when moist) and yellowish-red (5YR 5/6; same when moist) heavy sandy clay; consistence same as horizon above; massive; pH 5.0; grades gradually to horizon below.
- B₃ 46 to 54 inches, red (2.5YR 4/6; same when moist) light sandy clay or clay loam; friable to firm but becoming more friable with depth; pH 5.0.

Range in characteristics.—The darkened layer of the A horizon ranges from 6 to 12 inches in thickness, from very pale brown to brown in color, and from a loamy fine sand to a fine sandy loam in texture. The total thickness of the A horizon ranges from 8 to 16 inches. The subsoil ranges from a clay to a sandy clay, and coarse sand grains are noticeable throughout the subsoil in all areas.

Drainage.—Runoff is slow to medium, depending on slope. Internal drainage is slow.

Topography and erosion.—Surface gradients range from ½ to 15 percent. Areas with gradients of less than about 1½ percent are not susceptible to erosion. Those with

surface gradients of more than 1½ percent are susceptible to erosion when cultivated and require erosion control measures.

Distribution and use.—This series occurs on high terraces in the valley of the Brazos River. One-fourth of this series was cropped in 1950. The rest was in abandoned-field pasture and woodland pasture.

Wilson series.—This series consists of dark Planosols developed in alkaline to calcareous clay and sandy clay under a native cover of tall bunchgrasses and scattered trees. Associated with the Wilson is the Crockett series, which has a mottled subsoil; the Bonham series, which has mottled subsoils that are friable in the upper part; and Houston-Hunt clays, which are granular in the upper part and do not have a textural profile.

The profile of Wilson clay loam described below is in an area never cultivated that has a concave surface of ¼ percent. The site is 11 miles north of Bryan, 150 feet east of the Old San Antonio Road and 6¾ miles northeast of the intersection with United States Highway No. 190.

- A₁ 0 to 8 inches, dark-gray (10YR 4/1; 3/1, moist) clay loam; friable; hard when dry and moderately sticky when wet; moderate medium granular and fine blocky; contains a few small ferromanganese concretions; pH 6.3; boundary with horizon below is abrupt.
- B₂₁ 8 to 24 inches, dark-gray (10YR 4/1; 3/1, moist) clay; very firm when moist and very hard when dry; compact; very sticky when wet; moderate medium blocky; contains a few small chert fragments; pH 6.3; grades gradually to horizon below.
- B₂₂ 24 to 38 inches, olive-brown (2.5Y 4/4; same when moist) clay mottled with dark grayish brown (2.5YR 4/2; same when moist); consistence same as above; contains a few chert fragments and gypsum crystals; pH 8.0; grades gradually to horizon below.
- C 38 to 54 inches +, olive-brown (2.5Y 4/4; same when moist) clay same as layer above; 10 percent of mass is gypsum crystals; alkaline.

Range in characteristics.—The surface soil ranges from 5 to 12 inches in thickness, from gray to very dark grayish brown, and from a loam in some cultivated fields to a clay loam. Some small areas of Crockett clay loam are included. A few small areas, 3 to 30 acres in size, in nearly level shallow valleys have a dark-gray to grayish-brown crumbly clay surface layer that grades to compact clay subsoil at 6 to 10 inches. These areas are small inclusions of Wilson clay that total about 100 acres. They have the same productivity, crop adaptations, and management requirements as the clay loam. Depth to alkaline material ranges from 30 to 42 inches. Gypsum crystals are not always present in the lower subsoil.

Drainage.—Runoff is slow to very slow, and internal drainage is very slow.

Topography and erosion.—This series occurs on nearly level to gently sloping areas, mainly in shallow valleys, and has surface gradients of ½ to 3 percent. These areas are susceptible to erosion, especially that caused by excess water from higher areas.

Distribution and use.—Soils of this series occur almost entirely in the western part of the county in a prairie area. In 1950 only about 37 percent of their total area was cultivated.

Yahola series.—This series is in the Alluvial soils great soil group and has permeable to freely permeable subsoils. It consists of recent sediments deposited by floodwaters of the Brazos River. Associated series are the Norwood, which has less sandy subsoil; and the Miller and Roebuck, which have clay subsoils.

The profile described below is from a pasture with a convex surface of ½ percent gradient. The site is west of Texas Highway No. 90, ¾ mile north of the bridge across the Brazos River.

- A₁ 0 to 16 inches, light reddish-brown (5YR 6/4; 4.5/4, moist) light fine sandy loam; very friable when moist and soft when dry; structureless; calcareous; grades gradually to horizon below.
- C₂ 16 to 60 inches +, reddish-brown (5YR 5/4; 4/4, moist) light fine sandy loam; very friable when moist and soft when dry; structureless; calcareous.

Range in characteristics.—The surface layer ranges from 12 to 24 inches in thickness, from light reddish brown to reddish brown in color, and from a fine sandy loam to a loamy fine sand in texture. Stratification with sand is variable from place to place.

Drainage.—Runoff is medium; internal drainage is free to rapid.

Topography and erosion.—This series consists of gently undulating soils free from hazards of water erosion. However, some shifting of the surface soil by wind occurs in barren areas.

Distribution and use.—The Yahola soil occurs on natural levees along the Brazos River and along old sloughs and stream channels in the Brazos River flood plain. Less than half of the total area was cultivated in 1950.

Engineering Applications⁴

This soil survey report for Brazos County, Tex., contains information that can be used by engineers 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 drainage structures and planning dams and other structures for water and soil conservation.
- (3) Make reconnaissance surveys of soil and ground conditions that will aid in selecting highway and airport locations and in planning detailed soil surveys for the intended locations.
- (4) Locate sand and gravel for use in structures.
- (5) Correlate pavement performance with types of soil and thus develop information that will be useful in designing and maintaining the pavements.
- (6) Determine the suitability of soil units for cross-country movements of vehicles and construction equipment.

⁴ This section was prepared by the Physical Research Branch, Bureau of Public Roads. Test data in table 11 were obtained in the Soils Laboratory, Bureau of Public Roads.

- (7) Supplement information obtained from other published maps and reports and aerial photographs, for the purpose of making soil maps and reports that can be readily used by engineers.

The mapping and the descriptive report are somewhat generalized, however, and should be used only in planning more detailed field surveys to determine the in-place condition of the soil at the site of the proposed engineering construction.

Soil Science Terminology

Some of the terms used by the agricultural soil scientist may be unfamiliar to the engineer, and some words—for example, soil, clay, silt, sand, aggregate, and granular structure—may have special meanings in soil science. These terms are defined as follows:

Soil: The natural medium for the growth of land plants on the surface of the earth; composed of organic and mineral materials.

Clay: A soil separate or size group of mineral particles less than 0.002 mm. in diameter. Clay as a textural class includes soil material containing 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Silt: A soil separate having diameters ranging from 0.05 mm. to 0.002 mm. As a textural class silt includes soil material that contains 80 percent or more silt and less than 12 percent clay.

Sand: A soil separate ranging in diameter from 2.0 mm. to 0.05 mm. As a textural class sand includes soil material that contains 85 percent or more sand, and the percentage of silt plus $1\frac{1}{2}$ times the percentage of clay shall not exceed 15.

Aggregate: A cluster of primary soil particles held together by internal forces to form a clod or fragment.

Granular structure: Individual grains grouped into spherical aggregates with indistinct sides. Highly porous granules are commonly called crumbs.

Soil Test Data and Engineering Soil Classifications

To be able to make the best use of the soil maps and the soil survey reports, the engineer should know the physical properties of the soil materials and the in-place condition of the soil. After testing soil materials and observing the behavior of soils when used in engineering structures and foundations, the engineer can develop design recommendations for the soil units delineated on the maps.

Soil test data

Samples from the principal soil type of three extensive soil series were tested in accordance with standard procedures (1) to help evaluate the soils for engineering purposes. The test data are given in table 11. Although two of the soils were sampled in three different localities and the third soil in two localities, the test data probably do not show the maximum range in physical test characteristics of the B and C horizons of each soil series.

The engineering soil classifications in table 11 are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. Mechanical analyses were made by combined sieve and hydrometer methods. Percentage of clay obtained by the hydrometer

method should not be used in naming soil texture classes.

The liquid-limit and plastic-limit tests measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a solid to semi-solid or plastic state. As the moisture content is further increased, the material changes from the plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a solid to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

Table 11 also gives compaction (moisture-density) data for the tested soils. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material will increase until the "optimum moisture content" is reached. After that the density decreases with increase in moisture content. The highest dry density obtained in the compaction test is termed "maximum dry density." Moisture-density data are important in earthwork, for as a rule optimum stability is obtained if the soil is compacted to about the maximum dry density, when it is at approximately the optimum moisture content.

Engineering classifications systems

Most highway engineers classify soil materials in accordance with 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, consisting of gravelly soils of high bearing capacity, to A-7, consisting of clay soils having low strength when wet. Within each group, the relative engineering value of the material is indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest. The group index number is shown in parentheses, following the soil group symbol, in the next to last column of table 11. The principal characteristics according to which soils are classified in this system are shown in table 12.

Some engineers prefer to use the Unified soil classification system (18a). In this system, soil materials are identified as coarse grained (8 classes), fine grained (6 classes), or highly organic. An approximate classification can be made in the field. For exact classification, mechanical analyses are used for GW, GP, SW and SP soils; and mechanical analyses, liquid limit and plasticity index data are used for GM, GC, SM and SC soils and for the fine-grained soils. A plasticity chart, on which the liquid limit and the plasticity index may be plotted, is required for classification of the fine-grained soils and for identification of the secondary component of the silty and clayey sands and gravels. The principal characteristics of the 15 classes of soil are given in table 13. The classification of the tested soils according to the Unified system is given in the last column of table 11.

TABLE 11.—Engineering test data¹ for soil

Soil name and location	Parent material	Bureau of Public Roads report number	Depth	Horizon	Mechanical analysis ²				
					Percentage passing sieve				
					1 in.	¾ in.	⅜ in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
Crockett fine sandy loam: 17 miles N. of Bryan; 300 yards E. of Old San Antonio Road on S. side of county road to Edge.	Alkaline clay, sandy clay, and shale.	91368 91369 91370	<i>Inches</i> 0-7 9-27 54-80	A _P -----	-----	100	99	98	94
				B ₂₁ and B ₂₂ -----	-----	-----	100	98	92
				C-----	-----	-----	-----	100	98
9.5 miles N. of Bryan; 1.5 miles NE. of Tabor along county road.	Same-----	91371 91372 91373	0-6 6-30 56-80	A _{1P} -----	-----	-----	-----	100	99
				B ₂₁ and B ₂₂ -----	-----	-----	-----	-----	100
				C-----	-----	-----	-----	-----	100
4.5 miles N. of circle at Bryan; 100 yards SW. from turn in Farm Road 974.	Same-----	91374 91375 91376	0-5 5-42 60-84	A _P -----	-----	-----	100	99	97
				B ₂₁ , B ₂₂ and B ₂₃ -----	-----	-----	-----	100	99
				C-----	-----	-----	-----	-----	100
Lufkin fine sandy loam: 9 miles N. of circle at Bryan; 1.9 miles WNW. of Kurten along county road.	Alkaline to weakly calcareous clay and sandy clay.	91377 91378 91379	0-6 6-34 46-60	A _P -----	-----	-----	-----	-----	-----
				B ₂₁ and B ₂₂ -----	-----	-----	-----	-----	-----
				C-----	100	94	81	70	59
3.2 miles NE. of intersection of State Highways 6 and 21; along county road 0.9 mile SE. of State Highway 21.	Same-----	91380 91381 91382	0-5 5-34 42-72	A _{1P} -----	-----	-----	-----	-----	-----
				B ₂₁ and B ₂₂ -----	-----	-----	-----	-----	-----
				C-----	100	98	89	78	69
9.8 miles SE. of circle at Bryan; ¼ mile E. of Rock Prairie Church; 100 feet E. of T road intersection.	Same-----	91383 91384 91385	0-7 7-34 42-72	A _{1P} -----	-----	-----	-----	-----	100
				B ₂₁ and B ₂₂ -----	-----	-----	-----	-----	100
				C-----	-----	-----	-----	-----	100
Miller clay: 9 miles W. of Bryan; 0.4 mile E. of Varisco gin; 1.1 miles NE. of Farm Road 50.	Slowly permeable reddish brown clay; calcareous; stream alluvium.	91366	0-36	A-----	-----	-----	-----	-----	-----
10 miles SW. of Bryan; 1.5 miles NNE. of cotton gin in Mudville.	Same-----	91367	0-36	A-----	-----	-----	-----	-----	-----

¹ Tests performed by Bureau of Public Roads in accordance with standard procedures of the American Association of State Highway Officials (A.A.S.H.O.).

² Mechanical analyses according to the A.A.S.H.O. Designation: T 88-54. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey pro-

cedure of the Soil Conservation Service (SCS). In the A.A.S.H.O. procedure, the fine material is determined by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 mm. in diameter. In the SCS soil survey procedure, the fine material is determined by the pipette method and the material coarser than

samples from eight profiles, Brazos County, Tex.

Mechanical analysis ²							Liquid limit	Plasticity index	Moisture-density		Engineering soil classification	
Percentage passing sieve			Percentage smaller than						Maximum dry density	Optimum moisture content	A.A.S.H.O. ³	Unified ⁴
No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.						
								<i>Lb. per cu. ft.</i>	<i>Percent</i>			
89	87	54	43	27	17	13	22	124	11	A-4(4)-----	CL-ML	
88	87	68	62	52	43	40	56	102	21	A-7-6(17)----	CH	
94	93	72	66	54	42	36	50	112	17	A-7-6(17)----	CL-CH	
97	95	67	50	28	13	11	20	118	12	A-4(6)-----	ML	
99	98	87	80	67	49	45	53	104	19	A-7-6(17)----	CH	
97	96	94	87	65	36	31	50	114	15	A-7-6(18)----	CL-CH	
94	93	68	53	33	17	15	20	120	12	A-4(7)-----	CL-ML	
97	96	84	79	64	46	40	54	105	19	A-7-6(19)----	CH	
99	98	94	90	79	62	54	70	100	23	A-7-6(20)----	CH	
100	98	45	33	20	12	10	20	113	14	A-4(2)-----	SM	
100	99	75	66	54	45	41	64	102	20	A-7-6(20)----	CH	
59	59	57	56	51	37	31	86	90	29	A-7-5(15)----	CH	
100	98	44	31	17	11	9	20	110	13	A-4(2)-----	SM	
100	99	76	67	55	44	41	53	101	20	A-7-6(19)----	CH	
69	68	44	38	30	25	21	56	96	24	A-7-6(8)-----	SC	
99	96	60	45	24	12	9	21	115	13	A-4(5)-----	CL-ML	
99	97	82	71	61	44	39	54	104	19	A-7-6(19)----	CH	
97	94	70	63	52	43	38	61	98	23	A-7-6(18)----	CH	
-----	-----	100	99	98	85	69	72	95	25	A-7-5(20)----	CH	
-----	-----	100	99	97	82	67	69	97	24	A-7-5(20)----	CH	

² 2 mm. in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

³ Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (pt. 1, 7th ed.): The Classification

of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, A.A.S.H.O. Designation: M 145-49.

⁴ Based on the Unified Soil Classification System, Technical Memorandum No. 8-357, v. I, Waterways Experiment Station, Corps of Engineers, March 1953.

Soil Engineering Data and Recommendations

Some of the engineering information can be obtained from the soil map and the soil association map. It will often be necessary, however, to refer to the text of the report, particularly the section, Soils of Brazos County, and, the section, Morphology, Genesis, and Classification of Soils.

The soil test data in table 11, together with information given in the remainder of the report and experience with the same soils in other counties, were used to prepare the soil engineering data and recommendations given in table 14. The ratings given the soils as sources of topsoil⁵ for slopes and selected material for subgrades are for the soils of this county. For example, selected material for the subgrade should preferably have a higher content of gravel and less clay than the soils that have been given a rating of "good."

Some of the material removed from shallow gravel pits in Tabor gravelly loamy sand about 6 miles west-northwest of Bryan has been used in base courses for county roads. Material from other pits not shown on the soil map, but developed in the Tabor soils, has been used in construction of low-traffic roads. Sand from other sources has been mixed with the local soil material to produce a satisfactory base-course material. However, the Tabor soil is usually too high in clay content to be used in base courses for roads that are to be subjected to heavy wheel loads.

The soil map shows quarries in the Lufkin-Edge complex, $\frac{1}{2}$ to $1\frac{1}{4}$ miles north of Big Creek, in the southern part of the county. These quarries are in the Dunlap Quarry member of the Catahoula formation, and crushed sandstone from them may be suitable for use in base courses of roads.

The roads in the bottom lands should be constructed so the pavement will be above normal flood level. The Navasota and associated depressional Roebuck soils should be avoided in road location wherever possible because they are usually under water for several weeks each year. It will usually not be economically feasible to maintain the moisture content of the material from the Navasota, Roebuck, and Miller soils within the limits required for adequate compaction. Therefore when roads are constructed on the Navasota, Roebuck, and Miller soils, the material for use in the embankments should be obtained from adjacent coarser grained soils. The Ochlockonee and Yahola soils will usually contain better construction materials than the other soils of the bottom lands. However, they may contain lenses of fine-grained material. Furthermore, some areas of both soils may be inaccessible

⁵ Topsoil, as used here, refers to soil material containing organic matter and suitable as a surfacing for shoulders and slopes.

to construction equipment for relatively long periods each year because of flooding of the adjacent soils.

The Houston-Hunt and Wilson (and to a lesser extent the Crockett and Bonham) soils shrink greatly on drying and swell on wetting. If these soils in subgrades are too wet when the pavement is laid, subsequent drying will cause shrinkage of the soil under the edges of the pavement, and longitudinal cracking of the pavement may occur. If they are too dry, absorption of moisture by the soil under the outer edge causes enough swelling to warp the pavement. To control detrimental shrinkage and swelling in embankments, these highly plastic soils should be compacted to at least the maximum density, at or slightly above the optimum moisture content, as determined in the standard American Association of State Highway Officials compaction test.

The warping of pavements caused by wetting or drying of the plastic soil will be minimized if a blanket course of soil having low volume change is used beneath the pavement.

Deep-rooted vegetation reduces the percentage of moisture content of these highly plastic prairie soils several points below that of nonvegetated soils or of soils with light vegetation. Where dry bulbs of soil exist in the soil profile at the time a pavement is constructed, the soil swells when made wet and a wavy pavement surface results. Proper earthwork construction procedures should be used to obtain a uniform moisture content of the subgrade soil and thereby prevent waves in the pavement surface.

In the forested upland, there should be no unusual soil problems in construction involving the Lakeland, Derby and Bastrop soils, as these soils are sandy and the terrace surface is nearly level. Other soils developed on terraces, such as the Axtell and Travis-Axtell, are clayey and will provide poor support for engineering structures. The texture varies considerably in the Tabor and Travis soils; the coarser grained soil materials should be selected for use in the subgrades for pavements. In the steeper areas of Edge and Lufkin-Edge soils, highway construction may involve considerable earthwork, and the shale or sandstone parent material may be reached. This bedrock will normally be soft weathered material and, except in some deep cuts, can be excavated with the necessary equipment.

On many construction sites, major soil variations occur within the depth of proposed excavation and several soil units are within short distances. The soil map and profile descriptions, as well as the engineering data and recommendations given in this section, should be used in planning the detailed soil survey to be made at the construction site. The use of such information will enable the soils engineer to concentrate his efforts on some soil units and obtain a minimum of soil samples for testing in the laboratory. He can thus make an adequate soil investigation at minimum cost.

TABLE 12.—Classification of soils by American Association of State Highway Officials ¹

General classification	Granular materials (35 percent or less passing No. 200 sieve)							Silt-clay materials (More than 35 percent passing No. 200 sieve)				
	A-1		A-3	A-2				A-4	A-5	A-6	A-7	
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5	A-7-6
Sieve analysis: Percent passing— No. 10.....	50 maximum.											
No. 40.....	30 maximum.	50 maximum.	51 minimum.									
No. 200.....	15 maximum.	25 maximum.	10 maximum.	35 maximum.	35 maximum.	35 maximum.	35 maximum.	36 minimum.	36 minimum.	36 minimum.	36 minimum.	36 minimum.
Characteristics of fraction passing No. 40. Liquid limit.....			NP ²	40 maximum. 10 maximum.	41 minimum. 10 maximum.	40 maximum. 11 minimum.	41 minimum. 11 minimum.	40 maximum. 10 maximum.	41 minimum. 10 maximum.	40 maximum. 11 minimum.	41 minimum. 11 minimum. ³	41 minimum. 11 minimum. ³
Plasticity index.....	6 maximum.	6 maximum.	NP ²									
Group index.....	0.....	0.....	0.....	0.....	0.....	4 maximum.	4 maximum.	8 maximum.	12 maximum.	16 maximum.	20 maximum.	20 maximum.
Usual types of significant constituent materials.	Stone fragments, gravel, and sand.	Stone fragments, gravel, and sand.	Fine sand.	Silty gravel and sand.	Silty gravel and sand.	Clayey gravel and sand.	Clayey gravel and sand.	Nonplastic to moderately plastic silty soils.	Highly elastic silts.	Medium plastic clays.	Highly plastic clays.	Highly plastic clays.
General rating as subgrade.	Excellent to good.						Fair to poor.					

¹ Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (pt. 1): The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, A. A. S. H. O. Designation: M 145-49.

² NP—nonplastic.

³ Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30.

TABLE 13.—*Characteristics of soil groups*

Major divisions	Group symbol	Soil description	Value as foundation material ²	Value as base course directly under bituminous pavement	Value for embankments
Coarse-grained soils (<i>less than 50 percent passing No. 200 sieve</i>):	GW	Well-graded gravels and gravel-sand mixtures; little or no fines.	Excellent.....	Good.....	Very stable; use in pervious shells of dikes and dams.
	GP	Poorly graded gravels and gravel-sand mixtures; little or no fines.	Good to excellent.	Poor to fair...	Reasonably stable; use in pervious shells of dikes and dams.
Gravels and gravelly soils (<i>more than half of coarse fraction retained on No. 4 sieve</i>).	GM	Silty gravels and gravel-sand-silt mixtures.	Good.....	Poor to good..	Reasonably stable; not particularly suited to shells, but may be used for impervious cores or blankets.
	GC	Clayey gravels and gravel-sand-clay mixtures.	Good.....	Poor.....	Fairly stable; may be used for impervious core.
	SW	Well-graded sands and gravelly sands; little or no fines.	Good.....	Poor.....	Very stable; may be used in pervious sections; slope protection required.
Sands and sandy soils (<i>more than half of coarse fraction passing No. 4 sieve</i>).	SP	Poorly graded sands and gravelly sands; little or no fines.	Fair to good..	Poor to not suitable.	Reasonably stable; may be used in dike section having flat slopes.
	SM	Silty sands and sand-silt mixtures.	Fair to good..	Same.....	Fairly stable; not particularly suited to shells, but may be used for impervious cores or dikes.
	SC	Clayey sands and sand-clay mixtures.	Fair to good..	Not suitable..	Fairly stable; use as impervious core for flood-control structures.
Fine-grained soils (<i>more than 50 percent passing No. 200 sieve</i>):	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, and clayey silts of slight plasticity.	Fair to Poor..	Not suitable..	Poor stability; may be used for embankments if properly controlled.
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, and lean clays.	Fair to poor..	Not suitable..	Stable; use in impervious cores and blankets.
Silts and clays (<i>liquid limit of 50 or less</i>).	OL	Organic silts and organic clays having low plasticity.	Poor.....	Not suitable..	Not suitable for embankments.
	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, and elastic silts.	Poor.....	Not suitable..	Poor stability; use in core of hydraulic fill dam; not desirable in rolled fill construction.
	CH	Inorganic clays having high plasticity and fat clays.	Poor to very poor.	Not suitable..	Fair stability on flat slopes; use in thin cores, blankets, and dike sections of dams.
Silts and clays (<i>liquid limit greater than 50</i>).	OH	Organic clays having medium to high plasticity and organic silts.	Same.....	Not suitable..	Not suitable for embankments.
	Pt	Peat and other highly organic soils.	Not suitable..	Not suitable..	Not used

¹ Based on information in The Unified Soil Classification System, Technical Memorandum No. 3-357, Volumes 1, 2, and 3, Waterways Experiment Station, Corps of Engineers, 1953. Ratings and

ranges in test values are for guidance only. Design should be based on field survey and test of samples from construction site.

² Ratings are for subgrade and subbases for flexible pavement.

in Unified soil classification system ¹

Compaction: Characteristics and recommended equipment	Approximate range in A. A. S. H. O. maximum dry density ³	Field (in-place) CBR	Subgrade modulus, k	Drainage characteristics	Comparable groups in A. A. S. H. O. classification
	<i>Lb./cu. ft.</i>		<i>Lb./sq. in./in.</i>		
Good; use crawler-type tractor, pneumatic-tire roller, or steel-wheel roller.	125-135	60-80	300+	Excellent.....	A-1.
Same.....	115-125	25-60	300+	Excellent.....	A-1.
Good, but needs close control of moisture; use pneumatic-tire or sheepsfoot roller.	120-135	20-80	200-300+	Fair to practically impervious.	A-1 or A-2.
Fair, use pneumatic-tire or sheepsfoot roller.	115-130	20-40	200-300	Poor to practically impervious.	A-2.
Good; use crawler-type tractor or pneumatic-tire roller.	110-130	20-40	200-300	Excellent.....	A-1.
Same.....	100-120	10-25	200-300	Excellent.....	A-1 or A-3.
Good, but needs close control of moisture; use pneumatic-tire or sheepsfoot roller.	110-125	10-40	200-300	Fair to practically impervious.	A-1, A-2, or A-4.
Fair; use pneumatic-tire roller or sheepsfoot roller.	105-125	10-20	200-300	Poor to practically impervious.	A-2, A-4, or A-6.
Good to poor; close control of moisture is essential; use pneumatic-tire or sheepsfoot roller.	95-120	5-15	100-200	Fair to poor.....	A-4, A-5, or A-6.
Fair to good; use pneumatic-tire or sheepsfoot roller.	95-120	5-15	100-200	Practically impervious.....	A-4, A-6, or A-7.
Fair to poor; use sheepsfoot roller. ⁴	80-100	4- 8	100-200	Poor.....	A-4, A-5, A-6, or A-7.
Poor to very poor; use sheepsfoot roller. ⁴	70-95	4- 8	100-200	Fair to poor.....	A-5 or A-7.
Fair to poor; use sheepsfoot roller. ⁴	75-105	3- 5	50-100	Practically impervious.....	A-7.
Poor to very poor; use sheepsfoot roller. ⁴	65-100	3- 5	50-100	Practically impervious.....	A-5 or A-7.
in embankments, dams, or subgrades for pavements				Fair to poor.....	None.

³ Determined in accordance with Designation: T 99-49, A. A. S. H. O.

⁴ Pneumatic-tire rollers may be advisable, particularly when moisture content is higher than optimum.

TABLE 14.—Highway soil engineering

BOTTOM

Soil series and land type	Brief description of soil profile and ground condition	Dominant slope	Parent material
		<i>Percent</i>	
Gowen.....	Poorly drained ³ clay loam to sandy loam.....	0- 1	Alluvium.....
Kaufman.....	Poorly drained clay.....	0- 1	Alluvium.....
Miller.....	Poorly drained clay.....	0- 1	Calcareous clayey alluvium.....
Mixed alluvial land.....	Imperfectly drained ³ loamy sand with strata of silt loam and silty clay loam.	0- 8	Calcareous sandy and clayey alluvium.
Navasota.....	Poorly drained clay.....	0- 1	Acid clayey alluvium.....
Norwood.....	Well drained silt loam.....	0- 1	Calcareous sandy alluvium.....
Ochlockonee.....	Imperfectly drained ³ loamy sand to sandy loam.....	0- 2	Acid sandy alluvium.....
Ochlockonee-Gowen.....	Imperfectly drained ³ sandy loam or clay loam.....	0- 2	Alluvium.....
Roebuck.....	Poorly drained clay.....	0- ½	Calcareous clayey alluvium.....
Yahola.....	Well drained sandy loam.....	0- 1	Calcareous sandy alluvium.....

PRAIRIES

Bonham.....	Moderately well drained clay.....	0- 2	Alkaline clay.....
Burleson.....	Poorly drained clay.....	0- 1	Calcareous clayey old alluvium.....
Crockett.....	Imperfectly drained clay.....	1- 6	Alkaline clay and sandy clay.....
Houston-Hunt.....	Imperfectly drained clay.....	1- 6	Calcareous clay.....
Irving.....	10 to 12 inches imperfectly drained clay loam over clay.	0- 1	Calcareous sandy and clayey alluvium.
Irving-Axtell.....	10 to 12 inches imperfectly drained loam over clay.....	0- 1	Same.....
Payne.....	Poorly drained clay.....	0- 2	Alkaline sandy and clayey old alluvium.
Wilson.....	Poorly or imperfectly drained clay.....	0- 3	Alkaline clay.....

FORESTED UPLANDS

Axtell.....	Imperfectly drained clay.....	1- 3	Calcareous clay and sandy clay; old alluvium.
Bastrop.....	Well drained sandy clay loam or sandy clay.....	0- 2	Calcareous sandy alluvium.....
Derby.....	Well drained loamy sand.....	0- 2	Sandy alluvium.....
Edge.....	Imperfectly drained clay.....	1- 8	Acid clay, shale, and sandy shale.....
Lakeland.....	4 feet well drained loamy sand over sandy loam or sandy clay loam.	1-12	Acid sand.....
Lufkin.....	3 to 3½ feet imperfectly drained clay over sandy clay.....	0- 3	Alkaline to weakly calcareous clay and sandy clay.
Lufkin-Edge.....	Imperfectly drained clay.....	1- 8	Slightly acid clay and sandy clay.....
Sawyer.....	1½ feet moderately well drained loamy sand over clay, sandy clay, or clay loam.	1- 3	Acid sandy clay and clay.....
Tabor.....	Poorly drained clay.....	1- 3	Acid clay and sandy clay.....
Travis.....	Well drained sandy clay.....	1- 3	Alkaline sandy and clayey old alluvium.
Travis-Axtell.....	Imperfectly drained sandy clay.....	3-12	Same.....

¹ As used here, topsoil refers to soil material containing organic matter and suitable as a surfacing for shoulders and slopes.

² Field survey required to determine suitable source within mapped unit.

data and recommendations

LANDS

Estimated soil classification		Normal depth to water table	Adaptability to earthwork during rainy periods	Suitability as source of—	
A. A. S. H. O.	Unified			Topsoil ¹	Selected material for subgrade ²
		<i>Feet</i>			
A-4 or A-6.....	SC or CL.....	5-6.....	Limited.....	Good.....	Fair.
A-7.....	CH.....	10+.....	Not adapted.....	Poor.....	Not suitable.
A-7.....	CH.....	Deep.....	Not adapted.....	Poor.....	Not suitable.
A-2 with A-4 and A-6.....	SM with ML or CL.....	Variable.....	Limited.....	Fair.....	Fair.
A-7.....	CH.....	4-5.....	Not adapted.....	No.....	Not suitable.
A-4 or A-6.....	ML or CL.....	Deep.....	Not adapted.....	Fair.....	Fair.
A-2 or A-4.....	SM or SC.....	3-4.....	Limited.....	Good.....	Good.
A-2, A-4 or A-6.....	SM, SC or CL.....	5.....	Limited.....	Good.....	Fair to good.
A-7.....	CH.....	Shallow.....	Not adapted.....	No.....	Not suitable.
A-2 or A-4.....	SM or SC.....	Deep.....	Limited.....	Good.....	Good.

PRAIRIES

A-7.....	CH or MH.....	Deep.....	Not adapted.....	Fair.....	Not suitable.
A-7.....	CH.....	Deep.....	Not adapted.....	No.....	Not suitable.
A-7.....	CH.....	Deep.....	Not adapted.....	Poor.....	Not suitable.
A-7.....	CH.....	Deep.....	Not adapted.....	No.....	Not suitable.
A-6 over A-7.....	CL over CH.....	Deep.....	Not adapted.....	No.....	Not suitable.
A-4 or A-6 over A-7.....	CL over CH or MH.....	Deep.....	Not adapted.....	No.....	Not suitable.
A-7.....	CH or MH.....	Deep.....	Not adapted.....	No.....	Not suitable.
A-7.....	CH.....	Deep.....	Not adapted.....	No.....	Not suitable.

FORESTED UPLANDS

A-7.....	CH.....	Deep.....	Not adapted.....	No.....	Not suitable.
A-2, A-4 or A-6.....	SC or CL.....	Deep.....	Limited.....	Good.....	Good.
A-2.....	SM.....	Deep.....	Good.....	Good.....	Good.
A-7.....	CH.....	Deep.....	Not adapted.....	No.....	Not suitable.
A-2 or A-3 over A-4 or A-6.....	SM or SP over SC or CL.....	Deep.....	Limited.....	Good.....	Good.
A-7.....	CH over SC or MH.....	Deep.....	Not adapted.....	No.....	Not suitable.
A-7.....	CH or MH.....	Deep.....	Not adapted.....	No.....	Not suitable.
A-2 over A-4 or A-6.....	SM over SC or CL.....	Deep.....	Limited.....	Good.....	Fair.
A-7.....	CH or MH.....	Deep.....	Not adapted.....	No.....	Not suitable. ⁴
A-6 or A-7.....	CL, CH, or MH.....	Deep.....	Not adapted.....	Good.....	Poor.
A-6 or A-7.....	CL, CH, or MH.....	Deep.....	Not adapted.....	Poor.....	Poor.

³ Soil has good internal drainage but is subject to occasional or frequent overflow.

⁴ Exception: Tabor gravelly loamy sand to depth of about 20 inches is good.

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SUPPLEMENT TO SOIL MAP OF BRAZOS COUNTY, TEX.,

Map symbol	Soil	Profile		
		Surface soil	Subsoil	Parent materials
Aa	Axtell fine sandy loam, 1 to 3 percent slopes.	Very pale brown fine sandy loam; slightly acid; about 7 inches thick.	Very slowly permeable; highly mottled claypan; acid.	Calcareous clay and sandy clay; old stream alluvium.
Ba	Bastrop fine sandy loam, 0 to 2 percent slopes.	Light-brown fine sandy loam; slightly acid; about 15 inches thick.	Yellowish-red permeable light sandy clay; slightly acid.	Calcareous sandy old stream alluvium.
Bc	Bonham fine sandy loam, 0 to 2 percent slopes.	Grayish-brown fine sandy loam; slightly acid; about 10 inches thick.	Permeable clay over slowly permeable mottled clay; acid.	Alkaline to weakly calcareous clay and sandy clay.
Bb	Bonham clay loam, 0 to 2 percent slopes.	Dark grayish-brown friable clay loam; slightly acid; about 10 inches thick.	Same.....	Same.....
Bd	Burleson clay, 0 to 1 percent slopes.	Dark-gray clay; slightly acid....	Very slowly permeable, very dark gray dense clay; alkaline.	Calcareous; clayey; old....
Cc	Crockett fine sandy loam, 1 to 3 percent slopes.	Grayish-brown crusty fine sandy loam; slightly acid; about 6 inches thick.	Very slowly permeable, mottled claypan; slightly acid.	Alkaline to weakly calcareous clay and sandy clay.
Cd	Crockett fine sandy loam, eroded, 3 to 6 percent slopes.	Grayish-brown crusty fine sandy loam; slightly acid; about 4 inches thick.	Same.....	Same.....
Ca	Crockett clay loam, 1 to 3 percent slopes.	Dark grayish-brown crusty clay loam; slightly acid; about 6 inches thick.	Same.....	Same.....
Cb	Crockett clay loam, eroded, 3 to 6 percent slopes.	Dark grayish-brown crusty clay loam; slightly acid; about 4 inches thick.	Same.....	Same.....
Ce	Crockett soils, severely eroded, 5 to 12 percent slopes.	Brownish crusty fine sandy loam to clay loam; slightly acid; thickness variable.	Same.....	Same.....
Da	Derby loamy fine sand, 0 to 2 percent slopes.	Grayish-brown loose loamy fine sand; slightly acid; 18 inches thick.	No profile development.....	Unconsolidated loamy sands.
Ea	Edge fine sandy loam, 1 to 3 percent slopes.	Light brownish-gray fine sandy loam; acid; about 7 inches thick.	Very slowly permeable; highly mottled claypan.	Acid shaly clay and sandy clay.
Eb	Edge fine sandy loam, 3 to 8 percent slopes.	Light brownish-gray fine sandy loam; acid; about 5 inches thick.	Same.....	Same.....
Gb	Gowen fine sandy loam, 0 to 1 percent slopes.	Grayish-brown friable fine sandy loam; slightly acid.	Fine sandy loam alluvium; weakly stratified.	Alluvium.....
Ga	Gowen clay loam, 0 to 1 percent slopes.	Gray friable clay loam; slightly acid.	Clay loam alluvium; weakly stratified.	Alluvium.....
Gc	Gravel pits.....
Gd	Gullied land.....

SUPPLEMENT TO SOIL MAP OF BRAZOS COUNTY, TEX.,

Map symbol	Soil	Profile		
		Surface soil	Subsoil	Parent materials
Ha	Houston-Hunt clays, 1 to 3 percent slopes.	Light olive-brown and very dark gray crumbly clay; calcareous and alkaline.	Slowly permeable yellowish-brown and olive-gray dense clay; calcareous and neutral.	Calcareous clay-----
Hb	Houston-Hunt clays, 3 to 6 percent slopes.	Same-----	Same-----	Same-----
Hc	Houston-Hunt clays, severely gullied, 3 to 8 percent slopes.	Brownish-yellow crumbly calcareous clay with very dark gray alkaline spots.	Same-----	Same-----
lb	Irving-Axtell loams, 0 to 1 percent slopes.	Gray crusty loam; strongly acid; about 7 inches thick.	Very slowly permeable dark-gray claypan; alkaline.	Calcareous sandy and clayey alluvium.
la	Irving clay loam, 0 to 1 percent slopes.	Gray moderately friable clay loam; slightly acid; about 8 inches thick.	Same-----	Same-----
Ka	Kaufman clay, 0 to 1 percent slopes.	Very dark gray firm clay; neutral.	Very slowly permeable, very dark gray clay; alkaline.	Alluvium-----
La	Lakeland loamy fine sand, 1 to 4 percent slopes.	Light brownish-gray loose loamy fine sand; slightly acid; A horizon about 48 inches thick.	Slowly permeable mottled sandy clay loam; strongly acid.	Acid sandy clay loam-----
Lb	Lakeland loamy fine sand, 4 to 12 percent slopes.	Same-----	Same-----	Acid sand-----
Lc	Lufkin fine sandy loam, 0 to 1 percent slopes.	Gray crusty fine sandy loam; acid; about 8 inches thick.	Very slowly permeable gray claypan; acid.	Alkaline to weakly calcareous clay and sandy clay.
Ld	Lufkin fine sandy loam, 1 to 3 percent slopes.	Gray crusty fine sandy loam; slightly acid; about 6 inches thick.	Very slowly permeable gray claypan; slightly acid.	Same-----
Lf	Lufkin-Edge complex, 3 to 8 percent slopes.	Same as for individual soil types; slightly acid.	Same as for individual soil types; slightly acid to acid.	Slightly acid clay and sandy clay.
Le	Lufkin-Edge complex, 1 to 3 percent slopes.	Same-----	Same-----	Same-----
Md	Miller silt loam, 0 to 1 percent slopes.	Light brown friable silt loam; calcareous; about 15 inches thick.	Slowly permeable reddish-brown clayey alluvium.	Calcareous clayey alluvium.
Mb	Miller clay, 0 to 1 percent slopes.	Dark reddish-brown crumbly clay; calcareous; about 18 inches thick.	Slowly permeable reddish-brown clay; calcareous; stream alluvium.	Calcareous clayey alluvium.
Mc	Miller clay, 3 to 8 percent slopes.	Dark reddish-brown crumbly clay; calcareous; about 12 inches thick.	Same-----	Calcareous clayey alluvium.
Ma	Mixed alluvial land, 0 to 8 percent slopes.	Reddish sandy and clayey sediments; calcareous.	Stratified alluvial sediments; calcareous.	Calcareous sandy and clayey alluvium.
Na	Navasota clay, 0 to 1 percent slopes.	Dark-gray firm clay; slightly acid.	Very slowly permeable gray clay; strongly acid.	Acid clayey alluvium-----
Nb	Norwood silt loam, 0 to 1 percent slopes.	Light-brown friable silt loam; calcareous; about 18 inches thick.	Permeable reddish-brown silt loam; calcareous.	Calcareous sandy alluvium..
Nc	Norwood silt loam, 3 to 8 percent slopes.	Light-brown friable silt loam; calcareous; about 15 inches thick.	Permeable reddish-brown silt loam; calcareous.	Calcareous sandy alluvium..

SHOWING IMPORTANT CHARACTERISTICS OF SOILS—Continued

Topography	Native vegetation	Susceptibility to erosion	Drainage	Moisture relations	Natural fertility	Response to management	Suitability for	
							Crops	Pasture
Gently sloping upland.	Prairie.....	Slight to moderate.	Good.....	Good.....	Moderate to high.	Fair.....	Good.....	Good.
Sloping upland.....	Prairie.....	High.....	Good.....	Good.....	Moderate to high.	Fair.....	Poor.....	Fair.
Strongly sloping upland.	Prairie.....	High.....	Good.....	Poor.....	Moderate...	Poor.....	Unsuited...	Fair.
Nearly level terrace..	Prairie.....	None.....	Imperfect to poor.	Poor.....	Moderate...	Poor.....	Fair.....	Fair.
Level terrace.....	Prairie.....	None.....	Imperfect to poor.	Poor.....	Moderate...	Poor.....	Moderately good.	Moderately good.
Level flood plain.....	Forest.....	None.....	Imperfect; occasional overflow.	Poor.....	Moderate...	Poor.....	Very good..	Very good.
Gently sloping upland.	Scrub forest	Slight.....	Excessive...	Good.....	Very low...	Very good..	Poor.....	Poor.
Sloping upland.....	Scrub forest..	Moderate...	Excessive...	Good.....	Very low...	Very good..	Unsuited...	Poor.
Level upland.....	Gladly scrub forest.	None.....	Poor to imperfect.	Poor.....	Moderate...	Poor.....	Fair.....	Fair.
Gently sloping upland.	Scrub forest	Slight to moderate.	Poor.....	Poor.....	Moderate...	Poor.....	Fair.....	Fair.
Sloping upland.....	Scrub forest	High.....	Good.....	Poor.....	Moderate to low.	Poor.....	Unsuited...	Fair to poor.
Gently sloping upland.	Scrub forest	Moderate...	Poor.....	Poor.....	Moderate to low.	Poor.....	Poor.....	Fair to poor.
Nearly level flood plain.	Forest.....	None.....	Good; seldom flooded.	Excellent...	High.....	Very good..	Excellent...	Excellent.
Level flood plain.....	Forest.....	None.....	Imperfect..	Good.....	High.....	Fair.....	Very good..	Excellent.
Sloping flood plain...	Forest.....	Moderate...	Good.....	Good.....	High.....	Fair.....	Unsuited...	Good.
Level to sloping flood plain.	Forest.....	None.....	Good but frequently flooded.	Good.....	High.....	Good.....	Unsuited...	Moderately good.
Level flood plain.....	Forest.....	None.....	Poor; frequent overflow.	Poor.....	Moderate...	Poor.....	Unsuited...	Moderate to good.
Nearly level flood plain.	Forest.....	None.....	Good.....	Excellent...	High.....	Very good..	Excellent...	Excellent.
Sloping flood plain...	Forest.....	Moderate...	Good.....	Excellent...	Moderate...	Very good..	Poor.....	Very good.

SUPPLEMENT TO SOIL MAP OF BRAZOS COUNTY, TEX.,

Map symbol	Soil	Profile		
		Surface soil	Subsoil	Parent materials
Nd	Norwood silty clay loam, 0 to 1 percent slopes.	Brown crumbly silty clay loam; calcareous; about 20 inches thick.	Permeable reddish stratified silt loam and silty clay loam alluvium; calcareous.	Calcareous sandy and clayey alluvium.
Ob	Ochlockonee loamy fine sand, 0 to 2 percent slopes.	Grayish-brown loamy fine sand; slightly acid.	Freely permeable loamy fine sand stream alluvium; acid.	Acid sandy alluvium.....
Oa	Ochlockonee fine sandy loam, 0 to 1 percent slopes.	Brown fine sandy loam; medium acid.	Permeable sandy stream alluvium; slightly acid.	Acid sandy alluvium.....
Oc	Ochlockonee-Gowen complex, 0 to 2 percent slopes.	Gray moderately friable clay loam and grayish brown loamy fine sand; slightly acid.	Slowly permeable gray clay loam and brown freely permeable loamy fine sand; acid.	Alluvium.....
Pa	Payne clay loam, 0 to 2 percent slopes.	Dark grayish-brown friable clay loam, slightly acid; about 8 inches thick.	Very slowly permeable dark-brown compact clay; neutral.	Alkaline sandy and clayey old alluvium.
Ra	Roebuck clay, 0 to ½ percent slopes.	Brown crumbly clay; calcareous.	Very slowly permeable reddish-brown clay; stream alluvium; calcareous.	Calcareous clayey alluvium.....
Sa	Sawyer loamy fine sand, 1 to 3 percent slopes.	Pale-brown loamy fine sand; slightly acid; about 14 inches thick.	Permeable mottled clay loam over slowly permeable mottled clay; acid.	Alkaline to slightly acid sandy clay.
Tc	Tabor loamy fine sand, 1 to 3 percent slopes.	Pale-brown loamy fine sand; slightly acid; about 24 inches thick.	Very slowly permeable mottled claypan; acid.	Same.....
Ta	Tabor fine sandy loam, 1 to 3 percent slopes.	Pale-brown fine sandy loam; slightly acid; about 8 inches thick.	Same.....	Same.....
Tb	Tabor gravelly loamy sand, 2 to 6 percent slopes.	Light brownish-gray gravelly loamy sand; slightly acid; about 24 inches thick.	Slowly permeable strongly mottled sandy clay; acid.	Same.....
Td	Travis fine sandy loam, 1 to 3 percent slopes.	Pale-brown fine sandy loam; slightly acid; about 10 inches thick.	Slowly permeable red heavy sandy clay; acid.	Alkaline sandy and clayey old alluvium.
Te	Travis-Axtell fine sandy loams, 3 to 6 percent slopes.	Pale-brown fine sandy loam; slightly acid; about 8 inches thick.	Same.....	Same.....
Tf	Travis-Axtell soils, eroded, 6 to 12 percent slopes.	Pale-brown fine sandy loam; slightly acid; about 5 inches thick.	Same.....	Same.....
Wa	Wilson clay loam, 0 to 1 percent slopes.	Dark-gray crumbly clay loam; slightly acid; about 7 inches thick.	Very slowly permeable dark-gray claypan; alkaline.	Alkaline clay and shale.....
Wb	Wilson clay loam, 1 to 3 percent slopes.	Same.....	Same.....	Same.....
Ya	Yahola fine sandy loam, 0 to 1 percent slopes.	Light reddish-brown fine sandy loam; calcareous, several feet thick.	Calcareous sandy alluvium.....	Calcareous sandy alluvium.....

SHOWING IMPORTANT CHARACTERISTICS OF SOILS—Continued

Topography	Native vegetation	Susceptibility to erosion	Drainage	Moisture relations	Natural fertility	Response to management	Suitability for	
							Crops	Pasture
Nearly level flood plain.	Forest.....	None.....	Good.....	Excellent...	Moderate...	Very good..	Excellent...	Excellent.
Nearly level flood plain.	Forest.....	None.....	Excessive; isolated by flood-water.	Good.....	Moderate...	Very good..	Poor.....	Moderate to good.
Nearly level flood plain.	Forest.....	None; occasional overflow.	Good; occasional overflow.	Good.....	Moderate...	Very good..	Very good..	Excellent.
Gently undulating flood plain.	Forest.....	None.....	Frequent overflow.	Poor and good.	Moderate...	Fair.....	Unsuited...	Good.
Gently sloping terrace.	Prairie.....	Slight.....	Good.....	Poor.....	Moderate...	Fair.....	Good.....	Good.
Level flood plain.....	Forest.....	None.....	Poor to lacking.	Poor.....	High.....	Fair.....	Unfit; good when drained.	Poor; good when drained.
Gently sloping upland.	Scrub forest..	Slight.....	Good.....	Good.....	Low.....	Very good..	Moderate to good.	Moderate.
Gently sloping upland.	Scrub forest..	Slight.....	Imperfect..	Very good..	Moderate to low.	Good.....	Fair.....	Fair.
Gently sloping upland.	Scrub forest..	Slight to moderate.	Imperfect..	Poor.....	Low.....	Poor.....	Fair.....	Fair.
Sloping upland.....	Scrub forest..	Moderate to high.	Good.....	Good.....	Very low...	Good.....	Unsuited...	Poor to fair.
Gently sloping terrace.	Scrub forest..	Slight to moderate.	Good.....	Good.....	Moderate...	Very good..	Very good..	Good.
Sloping terrace.....	Scrub forest..	Moderate to high.	Good.....	Good.....	Moderate to low.	Very good..	Fair.....	Fair.
Strongly sloping terrace.	Forest.....	High.....	Good.....	Good.....	Moderate to low.	Good.....	Unsuited...	Fair.
Nearly level upland.	Prairie.....	Slight.....	Good.....	Poor.....	Moderate...	Fair.....	Good.....	Good.
Gently sloping upland.	Prairie.....	Moderate...	Good.....	Poor.....	Moderate...	Fair.....	Good.....	Good.
Nearly level flood plain.	Forest.....	None.....	Excessive...	Good.....	Moderate...	Very good..	Very good..	Very good.

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