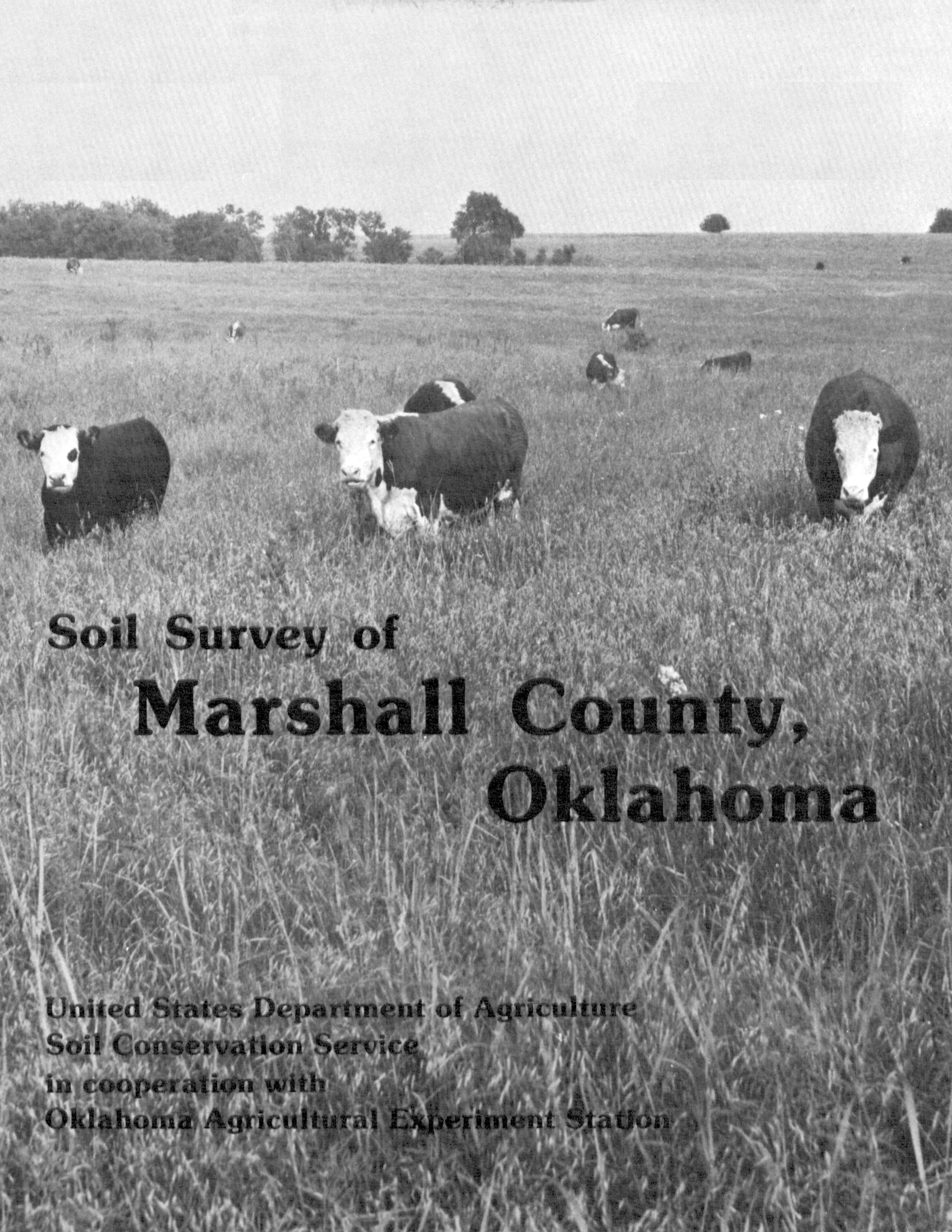
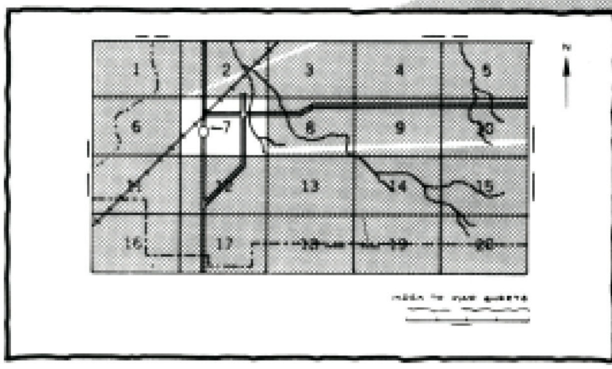


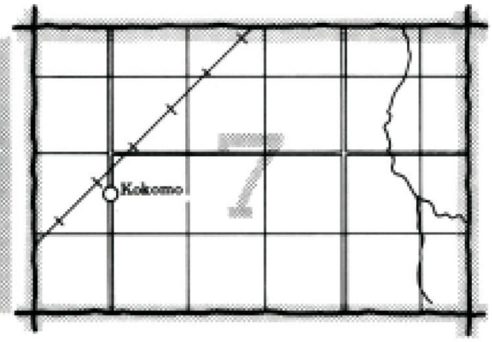
Soil Survey of Marshall County, Oklahoma

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Oklahoma Agricultural Experiment Station

HOW TO USE

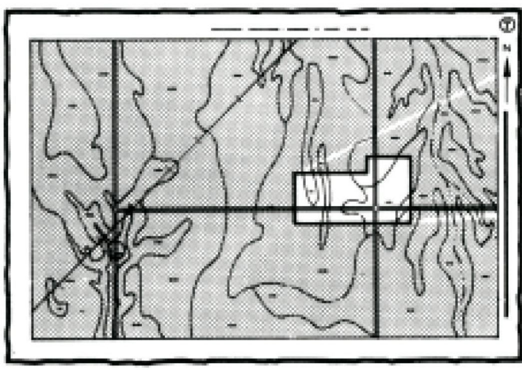
1. Locate your area of interest on the "Index to Map Sheets"

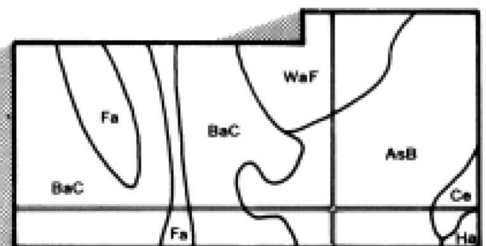




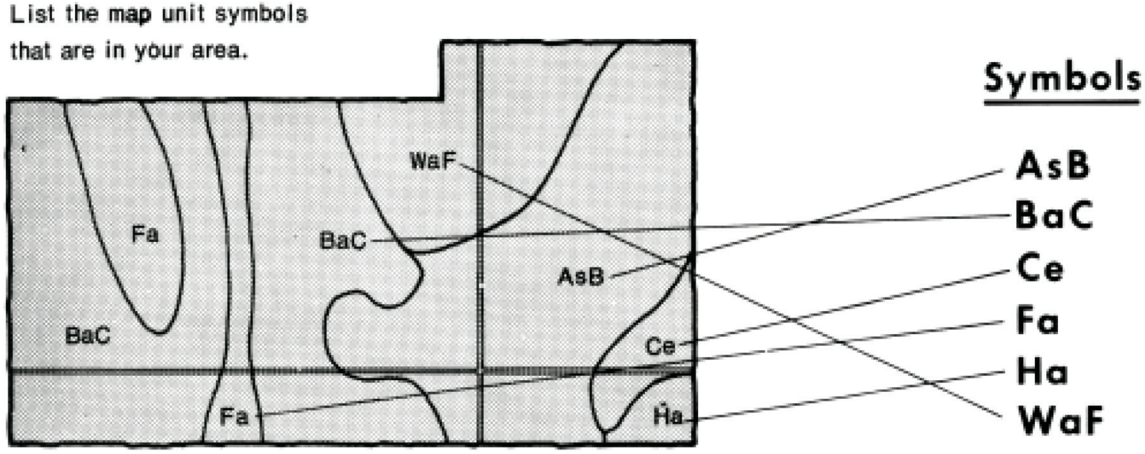
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



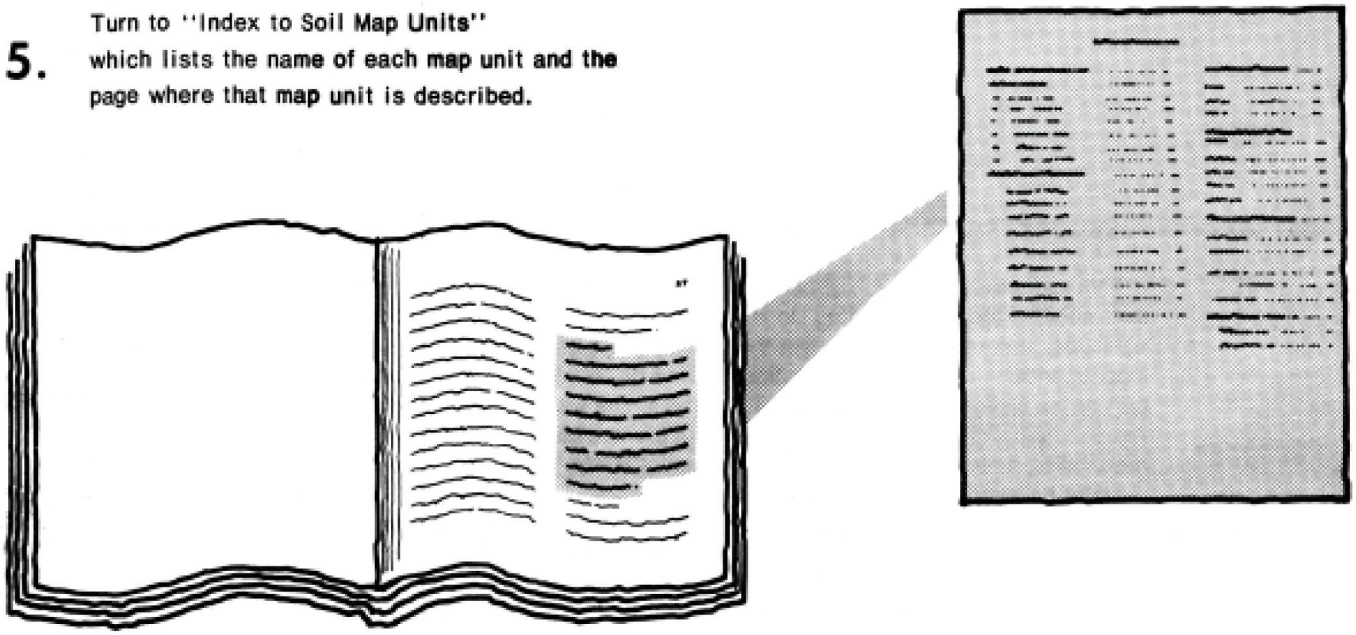


4. List the map unit symbols that are in your area.

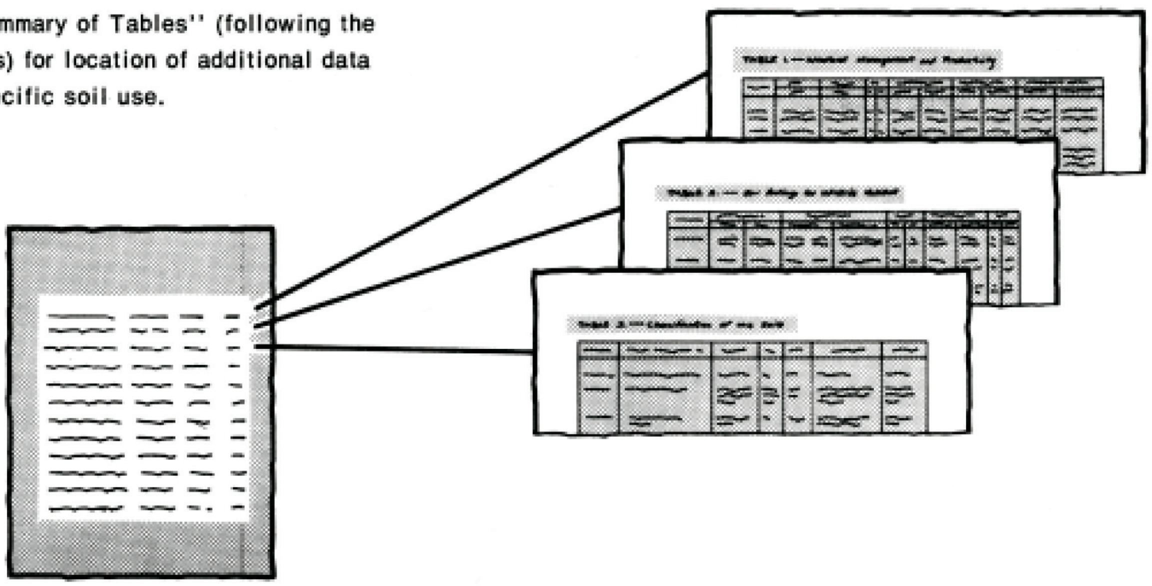


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1973-78. Soil names and descriptions were approved in 1978. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1978. This survey was made cooperatively by the Soil Conservation Service and the Oklahoma Agricultural Experiment Station. It is part of the technical assistance furnished to the Marshall County Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Cattle grazing native grass on Durant loam, 1 to 3 percent slopes. This soil is in the Loamy Prairie range site.

Contents

Issued April 1980

Index to map units

Summary of tables

Foreword

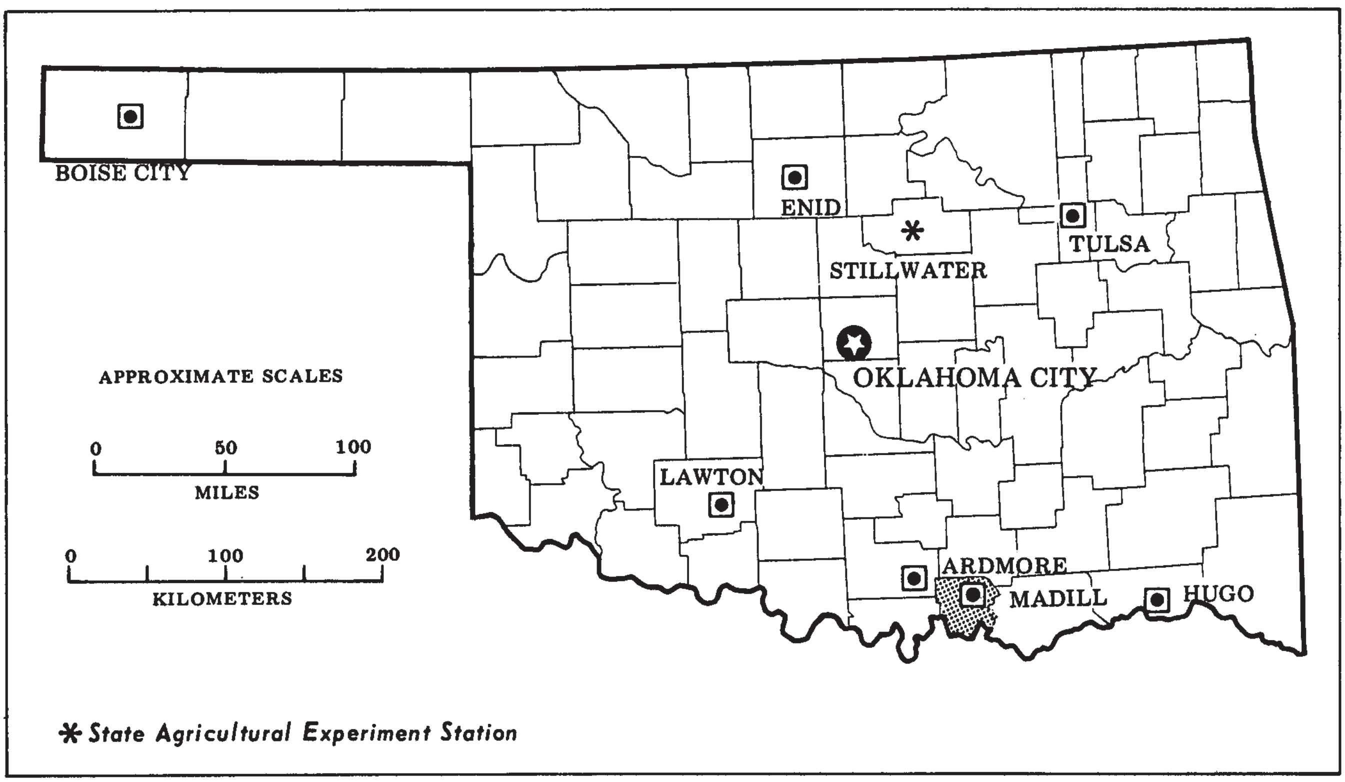
This soil survey contains information that can be used in land-planning programs in Marshall County, Oklahoma. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Roland R. Willis
State Conservationist
Soil Conservation Service



Location of Marshall County in Oklahoma.

Soil Survey of Marshall County, Oklahoma

By Dent L. Burgess, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service
in cooperation with the Oklahoma Agricultural Experiment Station

MARSHALL COUNTY, in south-central Oklahoma, has an area of 269,440 acres, or 421 square miles. This includes 40,910 acres of water, which is mainly in Lake Texoma. Madill, the county seat, is in the central part of the county. The county is bordered on the west by Love and Carter Counties, on the north by Johnson County, and on the east and south by Lake Texoma. Across the lake are Bryan County, Oklahoma, to the east, and Grayson County, Texas, to the south.

General nature of the county

This section gives general information about the county concerning relief and drainage, settlement and development, natural resources, transportation and industry, and climate.

Relief and drainage

Marshall County is predominantly nearly level to gently sloping except for the strongly sloping to moderately steep areas along drainageways. The general slope is from the northwest to the southwest. The Red River and Washita River systems primarily drain the county. Brier, Caney, Glasses, Little Glasses, and Hauani Creeks are the secondary streams, and they drain into Lake Texoma. The lake impounds water in both the Red River and the Washita River.

The county's soils developed in timbered uplands, blackland prairies, and flood plains. The areas between the drainageways are nearly level to gently sloping and are 1/2 mile to 3 miles in width, but slopes that extend into the drainageways are strongly sloping to moderately steep. The drainageways range from about 200 feet in width along the smaller streams to about 2 miles in width along the rivers. The areas along these drainageways are nearly level flood plains and nearly level to gently sloping stream terraces.

Settlement and development

Marshall County is a part of the Chickasaw Nation of Indian Territory, which was established in southern Oklahoma by a treaty in 1855. Burney Institute, a Chickasaw girls' school, was located about 1 mile east of Lebanon. This institute, which is now abandoned, was established before the Civil War. The first post office to be established in Marshall County was started at Burney Institute on July 3, 1860.

The county is in an area originally designated Pickens County and named for Edmond Pickens, who came from Mississippi in 1852 and settled at Pettyjohn Springs. The Pickens County courthouse was 3 miles from Lebanon. Later, Marshall County was created from the southeastern part of old Pickens County. The town of Madill was established in 1900, and the Marshall County courthouse was erected there in 1915.

Early settlers established small subsistence farms in the late 1800's. Cotton was the major cash crop, and only enough other crops were grown to provide feed for livestock.

The Denison Dam, on the Red River, was completed in 1944 to help form Lake Texoma. This lake is among the largest manmade lakes in the country. Recreational facilities in the vicinity of Lake Texoma are important to the economy of the area.

Natural resources

The natural resources of the county are mainly soil, water, timber, limestone, wild game and fish, gravel, and scenic beauty.

The soil is the most important natural resource in the county. It produces grass for livestock, timber, crops, and mineral resources that are a dominant part of the economy in the county.

The water supply for towns is mainly from wells and reservoirs. Flood control reservoirs furnish recreation and irrigation water. Farm ponds supply water for livestock needs.

Timber production has been declining. Most of the timber has been cut over, and the trees that were left to propagate the stands are of poor quality. Some areas are being planted to trees. The timber is used mainly for lumber and firewood.

Limestone is the most common surface mineral in the area. In some areas this mineral is of excellent quality for agricultural lime. Gravel is mined in the northern part of the county for roads and for commercial and agricultural purposes.

Wildlife and game are abundant in the survey area. Habitat is provided for deer, quail, dove, rabbit, and duck. Ducks are furnished a refuge along the Washita River and in areas of Lake Texoma.

Clear running streams, small ponds, and lakes with recreation facilities attract thousands of visitors each year, especially to the Lake Texoma area during the spring and summer.

Transportation and industry

Marshall County is served by a network of State and Federal highways and one railroad. State Highway 99 and Federal Highway 70 cross the county in a north-south direction. State Highway 32 and State Highway 199 cross the county in an east-west direction. In farm areas, dirt, gravel, and paved roads provide access to State and Federal highways. A railroad transits the county east and west.

Beef cattle raising is the major agricultural enterprise in Marshall County. Small grains, peanuts, cotton, and livestock are marketed locally or in adjacent counties. Limestone and gravel for commercial and agricultural purposes are mined in the northern or central part of the county. Industry is the small commercial type, but it is increasing in the area. Madill is one of the major trailer manufacturing centers in the state.

Marshall County's first oil well was drilled in 1909. The oil industry is active, and large quantities of oil and gas are produced in the county.

Climate

Prepared by the National Climatic Center, Asheville, N.C.

Marshall County is hot in summer but cool in winter when an occasional surge of cold air causes a sharp drop in otherwise mild temperatures. Rainfall is fairly uniformly distributed throughout the year. Snowfalls are infrequent. Annual total precipitation is normally adequate for peanuts, feed grains, and small grains.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at Tishomingo, Okla., for the period 1951 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 44 degrees F, and the average daily minimum is 31 degrees. The lowest temperature on record, -8 degrees, occurred at Tishomingo on February 2, 1951. In summer the average temperature is 81 degrees, and the average daily maximum is 94 degrees. The highest temperature, 111 degrees, was recorded on August 16, 1956.

Growing degree days, shown in table 1, are equivalent to "heat units." Beginning in spring, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 23 inches, or 59 percent, usually falls during the period April through September, which includes the growing season for most crops. Two years in 10, the April-September rainfall is less than 17 inches. The heaviest 1-day rainfall during the period of record was 6.42 inches at Tishomingo on September 22, 1957. Thunderstorms number about 50 each year, 18 of which occur in summer.

Average seasonal snowfall is 3 inches. The greatest snow depth at any one time during the period of record was 7 inches. On the average, 1 day has at least 1 inch of snow on the ground, but the number of such days varies from year to year.

The average relative humidity in midafternoon is less than 55 percent. Humidity is higher at night in all seasons, and the average at dawn is about 80 percent. The percentage of possible sunshine is 75 percent in summer and 55 percent in winter. The prevailing direction of the wind is from the south. Average windspeed is highest, 13 miles per hour, in March.

Tornadoes and severe thunderstorms occur occasionally. These storms are local and of short duration, and the pattern of damage is variable and spotty.

How this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

General soil map for broad land use planning

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each association on the general soil map is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in others but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Each association generally is rated for *cultivated crops, pastures, woodland,* and *urban uses.* Cultivated crops are those grown extensively in the survey area. Pastures support native or tame plants adapted to the area. Woodland refers to areas of native or introduced trees. Urban uses include residential, commercial and industrial developments.

Descriptions of the associations shown on the general soil map follow.

1. Bastrop-Konawa association

Deep, nearly level to sloping, well drained soils with a loamy surface layer and a loamy subsoil; on terraces

This association consists of nearly level to sloping soils on terraces along the Red River, the Washita River, and some major streams within the county. Slopes range from 0 to 6 percent.

This association makes up about 10 percent of the county. It is about 26 percent Bastrop soils, 25 percent Konawa soils, and 49 percent minor areas of Counts, Dougherty, Konsil, Teller, and other soils.

Bastrop soils are on high terraces. These deep soils are nearly level to very gently sloping and well drained. Typically, they have a brownish loamy surface layer and a brownish and reddish loamy subsoil.

Konawa soils are on lower terraces than Bastrop soils. These deep soils are very gently sloping to sloping and well drained. Typically, they have a brownish loamy surface layer, a brownish and reddish loamy subsoil, and yellowish loamy underlying material.

Minor soils in this association include the somewhat poorly drained Counts soils in slightly concave drainageways, the well drained Dougherty and Teller soils on terraces at lower elevations, and the well drained Konsil soils on the sides of drainageways.

The soils in this association have high potential for small grains and row crops. Crops that produce large amounts of residue help protect these soils from erosion. Cover crops and terraces also help control erosion on very gently sloping to sloping areas.

The soils in this association have high potential for tame pastures and native grasses. The quality of these grasses can be improved by proper stocking, controlling grazing, and preventing fires.

The soils in this association have low potential for woodland. Under natural conditions trees do not grow to any significant height.

These soils have high potential for most urban uses. There are no major limitations for most sanitary facilities or building site development.

2. Dougherty-Konawa association

Deep, nearly level to sloping, well drained soils with a sandy and loamy surface layer and a loamy subsoil; on terraces

This association consists of nearly level to sloping soils on terraces along the Red River and some major streams within the county. Slopes range from 0 to 6 percent.

This association makes up about 8 percent of the county. It is about 36 percent Dougherty soils, 22 percent Konawa soils, and 42 percent minor areas of Bastrop, Counts, Eufaula, and other soils.

Dougherty soils are on terraces. These deep soils are nearly level to gently sloping and well drained. Typically, they have a brownish sandy surface layer, a brownish and yellowish loamy subsoil, and yellowish sandy underlying material.

Konawa soils are on terraces slightly lower than Dougherty soils. These deep soils are very gently sloping to sloping and well drained. Typically, they have a brownish loamy surface layer, a brownish and reddish loamy subsoil, and yellowish loamy underlying materal.

Minor soils in this association include the well drained Bastrop soils on terraces at higher positions, the somewhat excessively drained Eufaula soils in slightly higher positions, and the somewhat poorly drained Counts soils in slightly concave drainageways.

The soils in this association have medium potential for crops. Soil blowing is a problem if these soils do not have vegetation or surface mulch during spring. Cover crops, minimum tillage, and residue management help control erosion.

These soils have medium potential for native grass and tame pasture. Proper stocking, controlling grazing, and preventing fires help improve the quality of native and tame pasture grasses.

These soils have low potential for woodland. Under natural conditions trees do not grow to any significant height.

These soils have high potential for most urban uses. There are no major limitations for building site development or sanitary facilities.

3. Durant-Collinsville association

Deep and shallow, very gently sloping to strongly sloping, moderately well drained and somewhat excessively drained soils with a loamy surface layer and a loamy and clayey subsoil; on uplands

This association consists of hills and ridges that are drained by small streams. The hills are smooth and slightly convex with slopes of 200 to 800 feet in length. In a few areas, the hills are capped with sandstone. Slopes range from 1 to 12 percent.

This association makes up about 17 percent of the county. It is about 45 percent Durant soils, 5 percent Collinsville soils, and 50 percent minor areas of Bates, Burleson, Heiden, Ferris, Wilson, and other soils.

Durant soils are on the side slopes of the hills. These deep soils are very gently sloping to gently sloping and moderately well drained. Typically, they have a brownish loamy surface layer and a brownish clayey subsoil.

Collinsville soils are on the crest of ridges and on side slopes. These shallow soils are gently sloping to strongly sloping and well drained to somewhat excessively drained. Typically, they have a brownish loamy surface layer, a brownish loamy subsoil, and underlying material of hard sandstone.

Minor soils in the association include the well drained Bates soils in a complex with the Collinsville soils, the moderately well drained Burleson soils, the well drained Ferris and Heiden soils, and the somewhat poorly drained Wilson soils. All of these soils are in lower positions than the Collinsville soils.

Most of the soils in this association have medium potential for crops. Terraces, minimum tillage, cover crops, and good residue management help reduce runoff and prevent erosion.

The soils in this association have high potential for tame pastures and native grass. Proper grazing and controlling fires increase the amount of forage.

The soils in this association have low potential for woodland. Under natural conditions trees do not grow on these soils.

The soils in this association have low potential for most urban uses. The shallow depth of the Collinsville soils and the high shrink-swell potential in the subsoil of the Durant soils are the main limitations in using this association for building site development and sanitary facilities.

4. Ferris-Tarrant-Heiden association

Deep and shallow, very gently sloping to moderately steep, well drained soils that are clayey or cobbly and clayey throughout; on uplands

This association consists of hills and ridges that are drained by small streams. The hills are smooth and slightly convex with slopes of 200 to 1,000 feet in length. In many areas, the hills are capped with limestone. Slopes range from 2 to 15 percent.

This association makes up about 42 percent of the county. It is about 26 percent Ferris soils, 25 percent Tarrant soils, 15 percent Heiden soils, and 34 percent minor areas of Burleson, Durant, Purves, Wilson, and other soils.

Ferris soils are on the side slopes of hills. These deep soils are very gently sloping to strongly sloping and well drained. Typically, they have a brownish clayey surface layer; a mottled brownish, olive, and grayish clayey layer below the surface layer; and mottled brownish and grayish shaly clay underlying material.

Tarrant soils are on the crest and breaks of the hills. These shallow soils are very gently sloping to moderately steep and well drained. Typically, they have a brownish cobbly clay surface layer over hard limestone underlying material at a shallow depth.

Heiden soils are on the side slopes of hills. These deep soils are very gently sloping to gently sloping and well drained. Typically, they have a brownish clayey surface layer, a brownish and grayish clayey layer below the surface layer, and mottled grayish and yellowish shaly clay underlying material.

The deep, very gently sloping to gently sloping Ferris and Heiden soils in this association have low potential for crops. The shallow Tarrant soils are best suited to grass. The main concern in management is water erosion. Terracing, farming on the contour, and returning high amounts of crop residue help reduce erosion.

The deep, very gently sloping to strongly sloping Ferris and Heiden soils have medium potential for tame pastures and high potential for native grasses. The shallow Tarrant soils have low potential for tame pastures but are suited to native grasses. Proper grazing and preventing fires are the main concerns in managing tame pastures and native grasses to allow such grasses to produce the largest amounts of forage.

The soils in this association have low potential for woodland. Usually, trees do not grow under natural conditions on these soils.

The soils in this association have low potential for most urban uses. The shallow depth of the Tarrant soils and the high shrink-swell potential of the other soils in this association are the main limitations for building site development and sanitary facilities.

5. Frioton-Gracemont association

Deep, nearly level, well drained and somewhat poorly drained soils with a loamy surface layer over loamy sediments; on flood plains

This association consists of flood plains along most of the major streams. The flood plains are smooth, nearly level to slightly undulating, and range from 500 to 1,200 feet in width. This association is subject to occasional or frequent flooding. Slopes range from 0 to 1 percent.

This association makes up about 3 percent of the county. It is about 41 percent Frioton soils, 26 percent Gracemont soils, and 33 percent minor areas of Counts, Madill, and other soils.

Frioton soils are on broad, smooth flood plains. These deep soils are smooth to slightly undulating and well drained. Typically, they have a grayish loamy surface layer, a brownish loamy layer below the surface layer, and brownish gravelly loamy underlying material.

Gracemont soils are on lower positions of smoother slightly undulating flood plains than the Frioton soils. These deep soils are nearly level and somewhat poorly drained. Typically, they have a brownish loamy surface layer, a brownish loamy layer below the surface layer, and underlying material of brownish loamy sediments.

Minor soils in this association include the somewhat poorly drained Counts soils in slightly concave drainageways and the well drained Madill soils on smooth, nearly level or slightly undulating flood plains.

The Frioton soils in this association have high potential for crops. The main concern of management is occasional flooding. Planting close-grown crops helps to protect the soils during flooding. Crops grown on these soils respond well to a good cropping system, fertilizers, and residue management. The Gracemont soils have low potential for crops because they are subject to frequent flooding.

The soils in this association have high potential for tame pastures and native grasses. The amount and quality of forage can be increased by preventing fires and using proper grazing practices. Tame pasture grasses respond to fertilizers.

The soils in this association have medium potential for woodland. The main management concern is seedling mortality. Protecting the seedlings and other trees from fire helps prevent these soils from being denuded of trees and subjected to erosion.

The soils in this association have low potential for most urban uses. Flooding is the main limitation for building site development or sanitary facilities.

6. Konawa-Teller association

Deep, nearly level to sloping, well drained soils with a loamy surface layer and a loamy subsoil; on terraces

This association consists of nearly level to sloping terraces along the Red River. Slopes range from 0 to 6 percent.

This association makes up about 2 percent of the county. It is about 68 percent Konawa soils, 11 percent Teller soils, and 21 percent minor areas of Bastrop, Counts, Dougherty, Eufaula, and other soils.

Konawa soils are on terraces. These deep soils are very gently sloping to sloping and well drained. Typically, they have a brownish loamy surface layer, a brownish and reddish loamy subsoil, and yellowish loamy underlying material.

Teller soils are on slightly lower terraces than the Konawa soils. These deep soils are nearly level and well drained. Typically, they have a grayish loamy surface layer and a brownish loamy subsoil.

Minor soils in this association include the well drained Bastrop soils on terraces at higher positions, the somewhat poorly drained Counts soils in slightly concave drainageways, and the well drained Dougherty and somewhat excessively drained Eufaula soils in slightly higher positions.

The soils in this association have medium potential for crops. The main limitations for crops are controlling erosion and maintaining soil tilth and fertility. The condition of the soil can be improved by minimum tillage and returning adequate amounts of residue to the soil. Terraces and contour farming help control soil erosion on slopes of 1 percent or more.

The soils in this association have high potential for native grasses and tame pastures. The quality of these grasses can be improved by preventing fires, controlling grazing, proper stocking, and controlling weeds.

These soils have low potential for woodland. Trees do not grow to any significant height under natural conditions.

The soils in this association have high potential for most urban uses. There are no significant limitations for most sanitary facilities and building site development.

7. Konsil-Madill association

Deep, nearly level to moderately steep, well drained soils with a loamy surface layer and a loamy subsoil, on up-

lands, and soils with a loamy surface layer over loamy sediments, on flood plains

This association consists of hills, ridges, and flood plains of small streams. The hills are smooth and slightly convex with slopes of 200 to 1,000 feet in length. The slopes range from 1 to 15 percent. The flood plains are smooth, nearly level to slightly undulating, and range from 180 to 500 feet in width. The flood plains are subject to occasional flooding. Slopes range from 0 to 1 percent.

This association makes up about 18 percent of the county. It is about 87 percent Konsil soils, 8 percent Madill soils, and 5 percent minor areas of Bastrop, Counts, Durant, Gracemont, and Wilson soils.

Konsil soils are on side slopes and ridgetops. These deep, well drained soils are very gently sloping to moderately steep. Typically they have a grayish loamy surface layer, a reddish loamy upper part of the subsoil, and a yellowish loamy lower subsoil.

Madill soils are on smooth flood plains of small streams. These deep soils are nearly level to slightly undulating and well drained. Typically, they have a brownish loamy surface layer, a brownish loamy layer below the surface layer, and underlying material of brownish loamy sediments.

Minor soils in this association are the moderately well drained Durant soils and the somewhat poorly drained Wilson soils on nearly level to gently sloping broad ridges and on side slopes of hills. The other minor soils are the well drained Bastrop soils on broad terraces, the somewhat poorly drained Counts soils in slightly concave drainageways, and the somewhat poorly drained Gracemont soils on nearly level to slightly undulating flood plains lower than the Madill soils.

The soils in this association have medium potential for crops. The main concerns of management are water erosion and maintaining soil tilth and fertility on the uplands, and flooding on the small streams. Crops grown on these soils respond to a good cropping system, residue management, and fertilizers. For soils on the uplands, terraces and contour farming with minimum tillage help control soil erosion.

The soils in this association have high potential for native grasses and tame pastures. The quality and quantity of grasses can be increased by preventing fires, proper stocking, and proper grazing. Fertilizing tame pasture grasses increases the amount and quality of forage.

The Madill soils in the flood plains have medium potential for woodland. The Konsil soils on the uplands have low potential for woodland. Usually, trees grow but not to any significant height.

The Konsil soils on uplands have high potential for most urban uses. The main limitations are seepage and moderate permeability for sanitary facilities and shrink-swell potential for building site development. The Madill soils on the flood plains have low potential for building site development or sanitary facilities because they are subject to flooding.

Soil maps for detailed planning

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil, a brief description of the soil profile, and a listing of the principal hazards and limitations to be considered in planning management.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Konsil fine sandy loam, 1 to 3 percent slopes, is one of several phases in the Konsil series.

Some map units are made up of two or more major soils. These map units are called soil complexes.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Collinsville-Bates complex, 3 to 12 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

A description of each map unit follows.

1—Bastrop fine sandy loam, 0 to 1 percent slopes. This deep, well drained, nearly level soil is on high stream terraces. Slopes are smooth and plane. Most areas of this soil range from 15 to 300 acres, but some are as small as 5 acres.

Typically, the surface layer is reddish brown fine sandy loam about 10 inches thick. The upper part of the subsoil, to a depth of 60 inches, is reddish brown sandy clay loam. The lower part is red sandy clay loam that extends to about 80 inches.

This soil is medium in natural fertility and in organic matter content. Reaction is medium acid to neutral in the surface layer. Permeability is moderate, and the available water capacity is high. This soil has good tilth and can be worked throughout a wide moisture range.

Included with this soil in mapping are areas of Counts soils in concave areas and Dougherty soils on positions similar to those of this Bastrop soil. Also included on lower areas are soils in which the lower part of the subsoil has more sand than that of this Bastrop soil. These included soils make up about 10 to 15 percent of this map unit, but separate areas generally are less than 10 acres.

This Bastrop soil has high potential for row crops (fig. 1) and small grains. The management concerns for crops are maintaining soil tilth and fertility. Crops that produce large amounts of residue are needed in the cropping system. Adding fertilizer helps produce maximum crop residue. This organic matter helps improve water intake, maintain soil tilth, and prevent surface crusting. Winter cover crops on clean tilled land help control erosion. Tillage needs to be timely and kept to a minimum.

Figure 1.—Peanuts growing on Bastrop fine sandy loam, 0 to 1 percent slopes.

This soil has high potential for native grass and tame pasture. Bermudagrass or lovegrass and clovers are most commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of grass; the added plant growth protects the soil from erosion. The quality of native and tame pasture grasses can be also improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Generally, trees do not grow under natural conditions on this soil.

This soil has high potential for most urban uses. There are no significant limitations for sanitary landfill, dwellings, and small commercial buildings. Moderate seepage and permeability are the main limitations for sewage lagoons and septic tank absorption fields, respectively. Low strength is the main limitation for roads and streets. Most of these limitations can be overcome by proper design or by altering the soil.

This Bastrop soil is in capability class I and in Sandy Savannah range site; it is not assigned to a woodland group.

2—Bastrop fine sandy loam, 1 to 3 percent slopes. This deep, well drained, very gently sloping soil is on high stream terraces. Slopes are smooth and slightly convex. Most areas of this soil range from 15 to 500 acres; some are as small as 5 acres.

Typically, the surface layer is reddish brown fine sandy loam about 7 inches thick. The upper part of the subsoil, to a depth of about 36 inches, is reddish brown sandy clay loam. The middle part, to 70 inches, is yellowish red sandy clay loam. The lower part is red sandy clay loam that extends to about 80 inches.

This soil is medium in natural fertility and in organic matter content. Reaction is medium acid to neutral in the surface layer. Permeability is moderate, and the available water capacity is high. This soil has good tilth and can be worked throughout a wide moisture range.

Included with this soil in mapping are areas of Counts soils in concave areas, Dougherty soils on similar high stream terraces, and Konsil soils on steeper areas above the Bastrop soils. Also included on lower areas are soils that have more sand in the subsoil than this Bastrop soil; otherwise, the soils are similar. These included soils make up about 5 to 15 percent of this map unit, but separate areas generally are less than 8 acres.

This Bastrop soil has high potential for row crops and small grains. Management concerns for crops are controlling erosion and maintaining soil tilth and fertility. Terraces help prevent the soil from eroding. Adding fertilizer helps increase plant growth that provides more crop residue to help maintain soil tilth and fertility. Minimum tillage, contour farming on sloping areas, stripcropping, and the use of crop residues help in the control of soil erosion. Winter cover crops furnish additional soil protection against wind and water erosion.

The soil has high potential for native grass and tame pasture. Bermudagrass or lovegrass and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of grass; the added plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Generally, trees do not grow under natural conditions on this soil.

This soil has high potential for most urban uses. There are no significant limitations for sanitary landfill, dwellings, and small commercial buildings. Moderate seepage and permeability are the main limitations for sewage lagoons and septic tank absorption fields, respectively. Low strength is the main limitation for roads and streets. Most of these limitations can be overcome by proper design or by altering the soil.

This Bastrop soil is in capability subclass IIe and in Sandy Savannah range site; it is not assigned to a woodland group.

3—Burleson clay, 1 to 3 percent slopes. This deep, moderately well drained, very gently sloping soil is on smooth uplands. The slopes are smooth and slightly convex with small depressions caused by the shrinking and swelling of the expansive clays. Most areas of this soil are more than 100 acres, but some are as small as 15 acres.

Typically, the surface layer is very dark gray clay about 16 inches thick. The next layer to a depth of about 40 inches is dark gray clay and to about 62 inches is dark grayish brown clay. The underlying material is grayish brown clay that extends to a depth of about 74 inches.

This soil is high in natural fertility and organic matter content. It shrinks and develops wide cracks when dry and expands greatly when wet. Reaction is slightly acid to moderately alkaline in the surface layer. Permeability is very slow, and the available water capacity is high. This soil is difficult to till because the surface layer is clayey.

Included with this soil in mapping are intermingled areas of Heiden and Durant soils. Heiden soils make up about 10 percent and Durant soils make up about 5 percent of this map unit. Also included in about 10 percent of the area are soils in which the surface layer contains lime and is calcareous; otherwise, these soils are similar to the Burleson soil. Separate areas of these included soils are generally less than 3 acres.

This Burleson soil has high potential for row crops and small grains. The erosion hazard is moderate on areas of this soil used for clean tilled crops. For continuous high yields, adding fertilizer and returning large amounts of plant residue improve soil tilth, reduce surface crusting, increase the water intake rate, and prevent erosion. Terracing, contour farming, and using cover crops help control erosion.

This soil has high potential for native grass and tame pasture (fig. 2). Droughtiness limits pasture yield during the summer. Tame pasture grasses can be improved by controlling brush, fertilizing, proper stocking, and controlling grazing.

Figure 2.—Old World bluestem, such as King Ranch bluestem, has high potential on Burleson clay, 1 to 3 percent slopes.

This soil has low potential for woodland. Under natural conditions trees do not grow on this soil.

This soil has low potential for most urban uses. High shrink-swell potential is the main limitation for dwellings and small commercial buildings. High shrink-swell potential and low strength are the limitations for local roads and streets. Designs are needed for foundations and road beds to prevent cracking. The use of this soil for septic tank absorption fields is limited because of the very slow permeability rate.

This Burleson soil is in capability subclass IIe and in Blackclay Prairie range site; it is not assigned to a woodland group.

4—Collinsville-Bates complex, 3 to 12 percent slopes. This map unit consists of the shallow Collinsville soil and the moderately deep Bates soil. Areas of these soils are so intermingled that mapping them separately was not practical at the scale selected for mapping. These gently sloping to strongly sloping soils are on smooth hillcrests and side slopes. Most areas of these soils are 10 to 50 acres. Individual areas of each soil are 3 to 5 acres.

Collinsville fine sandy loam makes up about 67 percent of each mapped area. Typically, the surface layer is dark grayish brown fine sandy loam about 4 inches thick.

The subsoil, to a depth of about 14 inches, is brown fine sandy loam. The underlying material is yellowish brown, hard, fractured sandstone that extends to a depth of about 22 inches.

This Collinsville soil is high in natural fertility and organic matter content. Reaction is strongly acid to slightly acid throughout the profile. Permeability is moderate, and the available water capacity is low.

Bates fine sandy loam makes up about 23 percent of each mapped area. Typically, the surface layer is grayish brown fine sandy loam about 7 inches thick. The upper part of the subsoil, to a depth of about 14 inches, is grayish brown loam. The lower part, to about 26 inches, is brown clay loam. The underlying material is soft sandstone and thin layers of shale that extend to a depth of about 38 inches.

This Bates soil is high in natural fertility and organic matter content. The surface layer is strongly acid or medium acid. Permeability is moderate, and the available water capacity is medium.

Included in mapping are a few small areas of soils that are similar to Collinsville soil except that they are underlain by weakly cemented sandstone at a depth of 4 to 20 inches. Also included are very gently sloping Bates soils in a few areas of 5 to 20 acres. These included soils make up about 10 percent of this map unit, but separate areas generally are less than 5 acres.

These Collinsville and Bates soils have low potential for crops. The erosion hazard is severe if cultivated crops are grown.

These soils have medium potential for native grass and tame pasture. Bermudagrass or lovegrass and clover are most commonly used for hay and pasture. Fertilizing increases the amount of forage, and the added plant growth protects the soil from erosion. The quality of all grasses also can be improved by controlling grazing and protecting from fire.

These soils have low potential for woodland. Under natural conditions trees do not grow on this soil.

These soils have medium potential for most urban uses. Depth to rock is the main limitation for septic tank absorption fields, sewage lagoons, and trench sanitary landfills.

These soils are in capability subclass VIe. The Collinsville soil is in Shallow Prarie range site, and the Bates soil is in Loamy Prairie range site. These soils are not assigned to a woodland group.

5—Counts loam, 0 to 1 percent slopes. This deep, somewhat poorly drained, nearly level soil is on terraces. Slopes are smooth and slightly concave. Most areas are generally 15 to 40 acres.

Typically, the surface layer is brown loam about 7 inches thick. The subsurface layer is light gray loam to a depth of 12 inches. The upper part of the subsoil, to about 50 inches, is pale brown silty clay that has yellowish brown and gray mottles. The lower part, which extends to about 70 inches, is pale brown silty clay that has mostly gray mottles.

This soil is low in natural fertility and organic matter content. The surface layer is medium acid to neutral. Permeability is very slow, and the available water capacity is high.

Included with this soil in mapping, making up about 2 percent of mapped areas, are soils in mounds. These soils have a surface layer 16 to 30 inches thick and a transitional layer of clay loam about 8 inches thick above the clay subsoil layer. Also included are a few intermingled areas of Bastrop and Konawa soils. The included soils make up about 10 percent of the map unit, but separate areas are generally less than 5 acres.

This Counts soil has medium potential for row crops and small grains. The potential is limited because the soil is wet in the winter and spring and is droughty in the summer. The erosion hazard is slight if cultivated crops are grown. Minimum tillage, cover crops, contour farming, and returning large amounts of crop residue to the soil help reduce runoff and control erosion.

The potential is high for native grass and tame pasture. Fertilizer helps to increase the amount and improve the quality of tame pasture grasses. The quality of all grasses also can be improved by controlling brush, preventing fires, and controlling grazing.

This soil has medium potential for woodland production. There are no significant limitations for woodland use or management. Timber yields can be improved by protecting trees from fires, planting suitable species, removing or controlling inferior species, and selectively harvesting trees on a planned schedule.

This soil has low potential for most urban uses. High shrink-swell potential and wetness limit this soil for most urban uses. Low strength is an additional limitation for local roads and streets.

This Counts soil is in capability subclass IIw, in Loamy Savannah range site, and in woodland group 4o.

6—Dougherty loamy fine sand, 0 to 3 percent slopes. This deep, well drained, nearly level to very gently sloping soil is on high stream terraces. Slopes are smooth to slightly undulating. Most areas of this soil are 40 to 300 acres, but some smaller areas are 15 acres.

Typically, the surface layer is dark grayish brown loamy fine sand about 8 inches thick. The subsurface layer is light brown loamy fine sand about 20 inches thick. The upper part of the subsoil, to a depth of about 40 inches, is reddish brown sandy clay loam. The middle part, to 54 inches, is reddish yellow fine sandy loam. The underlying material, which extends to a depth of about 72 inches, is reddish yellow loamy fine sand.

This soil is low in natural fertility and organic matter content. Reaction is slightly acid or medium acid in the surface layer. Permeability is moderate, and the available water capacity is medium. This soil has good tilth and can be worked throughout a wide moisture range. The wind erosion hazard is severe if the soil is clean tilled of crop residue.

Included with this soil in mapping are areas of Konawa soils on similar positions to those of Dougherty soils and

Eufaula soils on steeper slopes. Also included are soils in depressional areas that are similar to the Counts soils except that they have a loamy fine sand surface layer. These included soils make up about 5 to 10 percent of this map unit; separate areas generally are less than 10 acres.

This Dougherty soil has medium potential for row crops (fig. 3) and small grains. Good tilth can be maintained by returning crop residue to the soil. The water erosion hazard is moderate if cultivated crops are grown. Soil blowing is a severe hazard if the surface is not protected by residue or cover crops during the windy season. Minimum tillage, the use of cover crops, and contour farming help reduce runoff and control erosion.

This soil has medium potential for native grass and tame pasture. Bermudagrass or lovegrass and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of grass; the additional plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Under natural conditions trees do not grow to a significant height on this soil.

This soil has high potential for most urban uses. There are no significant limitations for dwellings, small commercial buildings, roads, streets, septic tank absorption fields, and area sanitary landfills. Seepage is the main limitation for sewage lagoons and trench type sanitary landfills. Most of these limitations can be overcome by proper design or by altering the soil.

This Dougherty soil is in capability subclass IIIe and in Deep Sand Savannah range site; it is not assigned to a woodland group.

7—Durant loam, 1 to 3 percent slopes. This deep, moderately well drained, very gently sloping soil is on broad smooth uplands. Slopes are smooth and convex. Most areas are more than 100 acres; some are as small as 15 acres.

Typically, the surface layer is grayish brown loam about 10 inches thick. The upper part of the subsoil, to a depth of about 14 inches, is dark grayish brown silty clay loam. The middle part, to about 28 inches, is brown, mottled clay. The lower part, which extends to a depth of about 66 inches, is grayish brown and light olive brown, mottled clay.

Figure 3.—Potato harvest in process on Dougherty loamy fine sand, 0 to 3 percent slopes, which has medium potential for such crops.

This soil is high in natural fertility and organic matter content. The surface layer is medium acid or slightly acid. Permeability is very slow, and available water capacity is high. The soil has good tilth and can be worked through a moderate moisture range.

Included with this soil in mapping are a few intermingled areas of Burleson and Heiden soils. These included soils make up about 10 percent of this map unit, but separate areas are generally less than 3 acres.

This Durant soil has medium potential for row crops and small grains. The erosion hazard is moderate if cultivated crops are grown. Returning crop residue to the soil, minimum tillage, cover crops, and terraces help reduce runoff and control erosion.

This soil has high potential for tame pasture and native grass. The quality of grass can be improved by controlling brush, controlling grazing, proper grazing use, and protecting from fires. Fertilizing tame pasture grasses also increases the amount and quality of forage.

This soil has low potential for woodland. Under natural conditions trees do not grow on this soil.

This soil has low potential for most urban uses. High shrink-swell potential is the main limitation for dwellings and small commercial buildings. High shrink-swell potential and low strength are the limitations for local roads and streets.

This Durant soil is in capability subclass IIe and in Loamy Prairie range site. It is not assigned to a woodland group.

8—Durant clay loam, 1 to 5 percent slopes, eroded. This deep, moderately well drained, very gently sloping to gently sloping eroded soil is on prairie uplands. Part of the original surface layer has been removed by erosion in about 60 percent of the area. In about 25 percent of the area, the surface layer and the upper part of the subsoil have been mixed by tillage. Rills caused by water erosion are common throughout the area. A few gullies are present. The slopes are long and convex. Most areas are 10 to 40 acres, but smaller areas may occur.

Typically, the surface layer is dark grayish brown clay loam about 6 inches thick. The upper part of the subsoil, to a depth of 15 inches, is brown clay. The middle part, to about 48 inches, is light olive brown clay. The lower part, to a depth of about 70 inches, is light yellowish brown clay.

This soil is medium in natural fertility and organic matter content. Reaction is medium acid or slightly acid in the surface layer. Permeability is very slow, and the available water capacity is high. The soil has fair tilth and can be worked through a moderate moisture range.

Included with this soil in mapping are soils that have a silt loam surface layer that changes abruptly to gray clay but otherwise are similar to the Durant soil. Also included are a few intermingled areas of Burleson clay and Durant loam. These included soils make up about 15 percent of this map unit, but separate areas of this soil are generally less than 5 acres.

This Durant soil has low potential for crops. The potential is limited because of loss of topsoil and fertility by erosion. Surface crusting and very slow water intake are also limitations. The erosion hazard is severe if cultivated crops are grown. Cover crops, minimum tillage, terraces, farming on the contour, and returning large amounts of crop residue to the soil reduce surface crusting, improve water intake, and help prevent erosion. Because of the erosion hazard, close-growing crops that produce large amounts of residues are well suited to this soil.

This soil has high potential for native grass and medium potential for tame pasture. The quality of grass can be improved by controlling brush, proper grazing use, controlling grazing, and preventing fires. Fertilizing tame pasture grasses also increases the quality and amount of forage.

This soil has low potential for woodland. Under natural conditions trees do not grow on this soil.

This soil has low potential for most urban uses. High shrink-swell potential is the main limitation for dwellings and small commercial buildings. High shrink-swell potential and low strength are the limitations for local roads and streets.

This Durant soil is in capability subclass IVe and in Loamy Prairie range site; it is not assigned to a woodland group.

9—Eufaula loamy fine sand, 3 to 8 percent slopes. This deep, somewhat excessively drained, gently sloping to sloping soil is on stream terraces. Slopes are undulating to hummocky. Most areas of this soil are 10 to 60 acres, but some are as small as 5 acres.

Typically, the surface layer is grayish brown loamy fine sand about 4 inches thick. The subsurface layer is pink fine sand to a depth of about 50 inches. The subsoil to about 80 inches is pink fine sand with thin lenses of reddish yellow loamy fine sand.

This soil is low in natural fertility and organic matter content. Reaction is slightly acid or neutral in the surface layer. Permeability is rapid, and the available water capacity is low. The wind erosion hazard is severe if the surface is not protected by vegetation or mulch cover.

Included with this soil in mapping are areas of Dougherty soils on smooth slopes. The included soils make up about 5 to 15 percent of this map unit, but separate areas generally are less than 5 acres.

This Eufaula soil has low potential for row crops and small grains. The main limitations for crops are the severe wind erosion hazard, sandy texture, rapid permeability, and low available water capacity.

This soil has medium potential for native grass and low potential for tame pasture. Bermudagrass or lovegrass and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of forage; the added plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Under natural conditions trees do not grow to a significant height on this soil.

This soil has high potential for most urban uses. There are no significant limitations for septic tank absorption fields, dwellings, roads, and streets. Seepage is the main limitation for sewage lagoons and sanitary landfills. Slope is the main limitation for small commercial buildings. Most of these limitations can be overcome by proper design or by altering the soil.

This Eufaula soil is in capability subclass VIe and in Deep Sand Savannah range site; it is not assigned to a woodland group.

10—Ferris clay, 2 to 5 percent slopes, eroded. This deep, well drained, very gently sloping to gently sloping eroded soil is on uplands in prairie areas. The mapped areas have been in cultivation, and in about 40 percent of the area, the surface layer and subsoil were mixed by plowing. There are a few uncrossable gullies about 300 feet apart. Rills are common between the gullies. Slopes are smooth and slightly convex. Most areas are 15 to 40 acres, but there are smaller areas of 5 acres.

Typically, the surface layer is dark grayish brown clay about 5 inches thick. The next layer is grayish brown clay about 25 inches thick. The next layer, to a depth of about 54 inches, is light olive brown clay. The underlying material, which extends to about 64 inches, is light olive brown clayey shale.

This soil is high in natural fertility and medium in organic matter content. This soil is calcareous and moderately alkaline in the surface layer. Permeability is very slow, and the available water capacity is high. The erosion hazard is severe. This soil has poor tilth and can be worked throughout a narrow moisture range.

Included with this soil in mapping are areas of Burleson and Heiden soils on similar or lower slopes. Also included are Purves and Tarrant soils that are higher on the landscape. These included soils make up about 5 to 15 percent of this unit, but separate areas generally are less than 10 acres.

This Ferris soil has low potential for row crops and small grains. The main concerns of management are protecting the soil from erosion, increasing water intake, and maintaining soil tilth and soil fertility. A cropping system using small grains and adequate amounts of fertilizer for maximum crop residue increases water intake and controls erosion. Minimum tillage, maintaining vegetative cover or crop residue, terraces, waterways, and contour farming help reduce the rate of soil erosion. Gullies need to be shaped and put into permanent vegetation in a few areas. Tame pasture grasses and legumes help reduce loss of soil by erosion.

This soil has high potential for native grass and medium potential for tame pasture. Bermudagrass or King Ranch bluestem and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of forage; the additional plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Under natural conditions trees generally do not grow on this soil.

This soil has low potential for most urban uses. Slope is the main limitation for sewage lagoons. Very slow permeability and clayey texture are the main limitations for septic tank absorption fields and trench type sanitary landfills. Very high shrink-swell potential is the main limitation for dwellings and small commercial buildings. Very high shrink-swell potential and low strength are the main limitations for local roads and streets. Most of these limitations can be overcome by proper design or by altering the soil.

This Ferris soil is in capability subclass IVe and Blackclay Prairie range site; it is not assigned to a woodland group.

11—Ferris clay, 2 to 5 percent slopes, severely eroded. This deep, well drained, very gently sloping to gently sloping, severely eroded soil is on uplands. Slopes are smooth and may be both convex and concave. All of this map unit has been in cultivation. The surface layer has been partly or completely removed by sheet and rill erosion in about 50 percent of the area. Gullies are common and range from 1 to 6 feet in depth and from 10 to 20 feet in width. Many rills are between the gullies. Most areas of this soil are 5 to 20 acres, but there are smaller areas of 2 or 3 acres.

Typically, the surface layer is dark grayish brown clay about 6 inches thick. The next layer is grayish brown clay about 20 inches thick. The next layer, to a depth of about 48 inches, is olive gray clay. The underlying material, which extends to about 60 inches, is light olive gray shaly clay.

This soil is medium in natural fertility and low in organic matter content. Reaction is moderately alkaline in the surface layer. Permeability is very slow, and the available water capacity is high. The erosion hazard is very severe. This soil has poor tilth and can be worked throughout a limited moisture range.

Included with this soil in mapping are areas of Purves soil on crests of ridges, Burleson soils on less sloping areas, and Tarrant soils on crests of ridges and breaks to more sloping areas. These included soils make up about 15 to 25 percent of this map unit, but separate areas generally are less than 5 acres.

This Ferris soil has low potential for row crops and small grains. The main concerns are severe erosion and maintenance of soil tilth and soil fertility. Cultivated areas returned to permenent vegetation such as tame pasture plants or native grasses help reduce erosion.

This soil has low potential for native grass and tame pasture. Fertilizing, diverting runoff, and shaping gully banks help when establishing tame pasture plants. Bermudagrass or King Ranch bluestem and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of grass; the additional plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Generally, under natural conditions trees do not grow on this soil.

This soil has low potential for most urban uses. Slope is the main limitation for sewage lagoons. Very slow permeability and clayey texture are the main limitations for septic tank absorption fields and trench sanitary landfills. Very high shrink-swell potential is the main limitation for dwellings and small commercial buildings. Very high shrink-swell potential and low strength are the main limitations for local roads and streets. Most of these limitations can be overcome by proper design or by altering the soil.

This Ferris soil is in capability subclass VIe and in Eroded Clay range site; it is not assigned to a woodland group.

12—Ferris-Tarrant complex, 5 to 12 percent slopes. This map unit of deep Ferris soils and shallow Tarrant soils are on upland breaks. These well drained, clayey soils are intermingled in such an intricate pattern that mapping them separately was not practical at the scale used for mapping. The Tarrant soil occurs on crests and breaks, and the Ferris soil is on the side slopes. Most areas of these soils are 10 to 200 acres. Individual areas of each soil are 1 to 5 acres.

Ferris clay makes up about 70 percent of each mapped area. Typically, the surface layer is grayish brown clay about 8 inches thick. The next layer, to a depth of 24 inches, is mottled light olive gray and olive clay. The next layer, to about 43 inches, is light olive gray and light olive brown clay. The underlying material, which extends to about 60 inches, is mottled light olive brown to olive gray shaly clay.

This Ferris soil is high in natural fertility and organic matter content. Reaction is moderately alkaline in the surface layer. Permeability is very slow, and the available water capacity is high.

Tarrant cobbly clay makes up about 20 percent of each mapped area. Typically, the surface layer is dark gray cobbly clay about 6 inches thick. The next layer is dark brown cobbly clay about 5 inches thick. The underlying material is hard, fractured limestone that extends to a depth of about 60 inches.

This Tarrant soil is high in natural fertility and organic matter content. This soil is moderately alkaline and calcareous in the surface layer. Permeability is moderately slow, and the available water capacity is low.

Included with these soils in mapping are areas of Burleson and Heiden soils on lower slopes than Ferris and Tarrant soils and Purves soils on ridge crests. The included soils make up about 10 percent of this map unit, but separate areas generally are less than 15 acres.

These Ferris and Tarrant soils have low potential for row crops and small grains. The main limitation for cultivation is slope and the severe hazard of water erosion.

The potential is low for native grass and tame pasture. Bermudagrass or King Ranch bluestem and clovers are used in a few areas for tame pasture. Fertilizing tame pasture increases the amount and improves the quality of grass and protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

The potential is low for woodland. Generally, under natural conditions trees do not grow on these soils.

The potential is low for most urban uses. Slope is the main limitation for sewage lagoons. Very slow permeability and clayey texture of the Ferris soils and shallow depth to bedrock of the Tarrant soils are the main limitations for septic tank absorption fields and sanitary landfills. Very high shrink-swell potential of the Ferris soils is the main limitation for dwellings and small commercial buildings. Very high shrink-swell potential and low strength are limitations for local roads and streets. Most of these limitations can be overcome by proper design or by altering the soil.

These Ferris and Tarrant soils are in capability subclass VIe; the Ferris soil is in Blackclay Prairie range site and the Tarrant soil is in Very Shallow range site; they were not assigned to a woodland group.

13—Frioton silty clay loam. This deep, well drained, nearly level soil is on flood plains of local streams. Slopes range from 0 to 1 percent and are smooth or slightly undulating. Most areas of this soil are 5 to 150 acres, but some are as small as 3 acres.

Typically, the surface layer is very dark gray silty clay loam about 12 inches thick. The next layer is very dark grayish brown silty clay loam to about 30 inches. The next layer is dark grayish brown silty clay loam to a depth of about 48 inches. The underlying material is dark grayish brown gravelly silty clay loam that extends to a depth of about 74 inches.

This soil is high in natural fertility and organic matter content. Reaction is mildly alkaline or moderately alkaline in the surface layer. Permeability is moderately slow, and the available water capacity is high. This soil has good tilth and can be worked throughout a wide moisture range. This soil is subject to occasional flooding.

Included with this soil in mapping are areas of Madill soils on slightly higher positions than this Frioton soil and Gracemont soils in lower areas. The included soils make up about 5 to 20 percent of this map unit, but separate areas generally are less than 5 acres.

This Frioton soil has high potential for row crops and small grains. The main limitations for crops are occasional flooding and maintenance of soil tilth. Cover crops grown during the late fall, winter, and spring months prevent excessive loss of soil during flooding. The planting of spring crops should be delayed until after the flood period. Most crops that produce large amounts of residue can be grown continuously if fertilizer is added to stimulate plant growth for maximum crop residue. Minimum tillage and maintenance of the organic matter content help to maintain good soil tilth and increase the intake of water. The use of this soil for tame pasture or woodland helps protect this soil during flooding.

This soil has medium potential for native grass and high potential for tame pasture. Bermudagrass or tall fescue and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of forage; the added plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has medium potential for woodland production. The main management concern is seedling mortality. Trees can be improved by preventing fires, planting suitable species, removing or controlling inferior species, and selectively harvesting trees on a planned schedule.

This soil has low potential for most urban uses. High shrink-swell potential and low strength are the main limitations for roads and streets. Flooding is the main limitation for septic tank absorption fields, sewage lagoons, sanitary landfills, dwellings, and small commercial buildings. The flood hazard can be reduced but not completely eliminated by upstream flood control structures. The potential flood hazard is high for houses built in the flood plain.

This Frioton soil is in capability subclass IIw, Loamy Bottomland range site, and woodland group 3o.

14—Gracemont fine sandy loam. This deep, somewhat poorly drained, nearly level soil is on flood plains. Slopes range from 0 to 1 percent and are smooth or slightly undulating. Most areas of this soil are 5 to 100 acres, but some are as small as 3 acres.

Typically, the surface layer is light brown fine sandy loam about 16 inches thick. The next layer is light brown fine sandy loam about 28 inches thick. The underlying material is brown loam that extends to a depth of about 66 inches.

This soil is medium in natural fertility and low in organic matter content. Reaction is moderately alkaline in the surface layer but ranges to neutral in some profiles. Permeability is moderate or moderately rapid, and the available water capacity is high. This soil has good tilth and can be worked throughout a wide moisture range. This soil is subject to frequent flooding.

Included with this soil in mapping are areas of Frioton and Madill soils on higher positions than the Gracemont soil. Also included are soils that have a surface layer of clay loam, but otherwise the profile is similar to the profile of this Gracemont soil. These included soils make up about 15 to 25 percent of this map unit, but separate areas generally are less than 8 acres.

This Gracemont soil has low potential for row crops and small grains. The main limitations are flooding and wetness.

This soil has high potential for native grass and tame pasture. Bermudagrass or tall fescue and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of forage; the additional plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires. A grass mulch will improve soil tilth and protect the soil from erosion during floods.

This soil has medium potential for woodland production. Seasonal wetness and flooding are the main limitations for woodland use and management. Trees can be improved by preventing fires, planting suitable species, removing or controlling inferior species, and selectively harvesting trees on a planned schedule.

This soil has low potential for most urban uses. Flooding is the main limitation for septic tank absorption fields, sewage lagoons, sanitary landfills, dwellings, small commercial buildings, roads, and streets. The flood hazard can be reduced but not completely eliminated by upstream flood control structures. The potential flood hazard is high for houses built in the flood plain.

This Gracement soil is in capability subclass Vw, Subirrigated range site, and woodland group 3w.

15—Heiden clay, 2 to 5 percent slopes. This deep, well drained, very gently sloping to gently sloping soil is on uplands. Slopes are smooth and slightly convex. Most areas of this soil are 10 to 40 acres, but some are 5 acres.

Typically, the surface layer is dark grayish brown clay about 8 inches thick. The next layer is grayish brown clay to a depth of about 20 inches, light yellowish brown clay to about 36 inches, and light gray clay to about 54 inches. The underlying material to a depth of about 65 inches is coarsely mottled light brownish gray and olive yellow shaly clay.

This soil is high in natural fertility and organic matter content. Reaction is moderately alkaline throughout. Permeability is very slow, and the available water capacity is high. This soil shrinks and cracks when dry and expands greatly when wet. It has poor tilth and can be worked only through a narrow moisture range.

Included with this soil are intermingled areas of Burleson, Durant, Ferris, and Tarrant soils. Also included are soils that are less than 40 inches deep over limestone or shale but otherwise the profile is similar to the profile of this Heiden soil. The included soils make up about 30 percent of this map unit, but separate areas are generally less than 5 acres.

This Heiden soil has medium potential for growing row crops and small grains. The erosion hazard is moderate if cultivated crops are grown. Minimum tillage, returning high amounts of crop residue, terracing, and farming on the contour help improve soil tilth, reduce surface crusting, increase water intake, and reduce erosion.

This soil has high potential for native grass and tame pasture. The quality of all grasses can be improved by preventing fires, proper stocking, and controlling weeds. Fertilizing tame pastures increases the amount and improves the quality of the forage.

This soil has low potential for woodland. Generally trees do not grow under natural conditions on this soil.

This soil has low potential for most urban uses. Very high shrink-swell potential is the main limitation for dwellings and small commercial buildings. Very high shrink-swell potential and low strength are the main limitations for local roads and streets. Special designs are needed for building foundations to prevent cracking. Very slow permeability is the main limitation for septic tank absorption fields. This limitation can be partly overcome by increasing the size of the absorption area or modifying the soil.

This Heiden soil is in capability subclass IIIe and in Blackclay Prairie range site; it is not assigned to a woodland group.

16—Heiden stony clay, 2 to 5 percent slopes. This deep, well drained, very gently sloping to gently sloping soil is on uplands. Slopes are smooth and convex. Stones cover 5 to 10 percent of the surface and make up 5 to 10 percent of the surface layer. Most areas are 15 to 300 acres, but some are as small as 5 acres.

Typically, the surface layer is dark grayish brown stony clay about 8 inches thick. The next layer is light yellowish brown clay to a depth of about 36 inches and light gray clay to about 54 inches. The underlying material to a depth of about 80 inches is coarsely mottled light brownish gray and olive yellow shaly clay.

This soil is high in natural fertility and organic matter content. Reaction is moderately alkaline throughout. Permeability is very slow, and the available water capacity is high. This soil shrinks and cracks when dry and expands greatly when wet.

Included with this soil in mapping are intermingled areas of Burleson, Durant, Ferris, and Tarrant soils. Also included are soils that are similar to this Heiden soil except that they are less than 40 inches deep to shale and stones make up more than 10 percent of the surface layer. These included soils make up about 20 percent of this map unit, but separate areas generally are less than 10 acres.

This Heiden soil has low potential for row crops and small grains. Stones in the surface layer are a severe limitation for cultivation.

This soil has high potential for native grass (fig. 4) and medium potential for tame pasture. Tame pasture is difficult to establish on this soil because of the stony surface layer. Bermudagrass or tall fescue and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of the forage; the additional plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

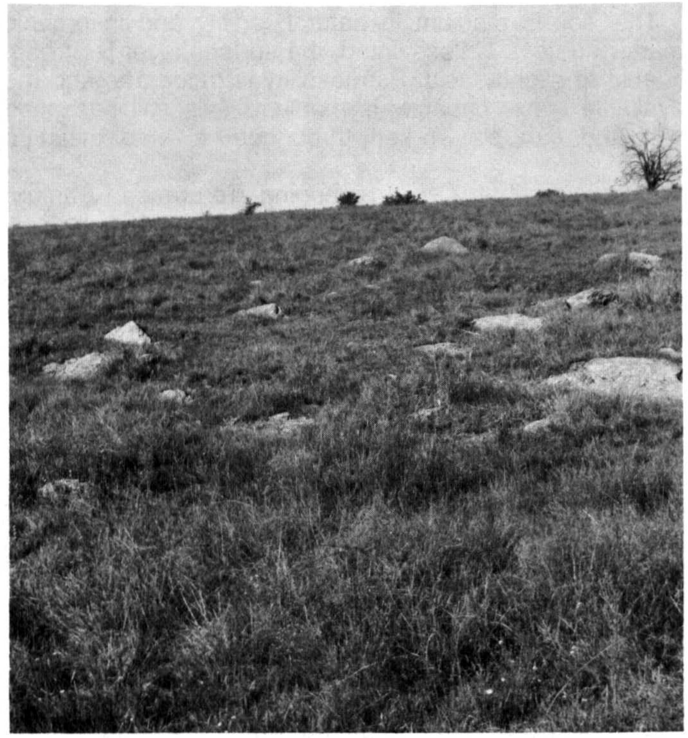


Figure 4.—Native vegetation for pasture has high potential on a stony surface area of Heiden stony clay, 2 to 5 percent slopes; range site is Blackclay Prairie.

This soil has low potential for woodland. Generally, under natural conditions trees do not grow on this soil.

This soil has low potential for most urban uses; slope and surface stones are the main limitations for sewage lagoons. Very high shrink-swell potential is the main limitation for dwellings and small commercial buildings. Very high shrink-swell potential and low strength are the main limitations for local roads and streets. Very slow permeability is the main limitation for septic tank absorption fields. Most of these limitations can be overcome by proper design or by altering the soil.

This Heiden soil is in capability subclass VIs and in Blackclay Prairie range site; it is not assigned to a woodland group.

17—Konawa fine sandy loam, 1 to 3 percent slopes. This deep, well drained, very gently sloping soil is on high stream terraces. Slopes are smooth to undulating. Most areas are from 10 to 100 acres, but some are as small as 5 acres.

Typically, the surface layer is brown fine sandy loam about 12 inches thick. The upper part of the subsoil, to a depth of about 44 inches, is reddish brown sandy clay loam. The lower part is yellowish red fine sandy loam to about 62 inches. The underlying material is reddish yellow fine sandy loam that extends to a depth of about 80 inches.

This soil is medium in natural fertility and in organic matter content. Unless limed, the surface layer is strongly acid to slightly acid. Permeability is moderate, and the available water capacity is medium. This soil has good tilth and can be worked throughout a wide moisture range.

Included with this soil in mapping are areas of Bastrop soils on slightly higher positions than this Konawa soil, Dougherty soils on similar positions, and Counts soils in slightly concave areas. These included soils make up about 15 to 25 percent of this map unit, but separate areas generally are less than 5 acres.

This Konawa soil has high potential for row crops and small grains. The main management concerns are the hazard of erosion, maintaining soil structure, and maintaining fertility. A vegetative cover or crop residue on the surface during periods in which erosion is critical helps reduce soil loss. The soil tilth can be maintained or improved by returning adequate amounts of organic matter to the soil. Adequate amounts of crop residue left on the soil surface at crop seeding time plus terraces, contour farming, and grassed waterways help reduce erosion.

This soil has high potential for native grass and tame pasture. Bermudagrass or lovegrass and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of the forage; the additional plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Under natural conditions trees do not grow to any significant height on this soil.

This soil has high potential for most urban uses. There are no significant limitations for septic tank absorption fields, area sanitary landfills, dwellings, and small commercial buildings. Seepage is the main limitation for sewage lagoons. Most of these limitations can be overcome by proper design or by altering the soil.

This Konawa soil is in capability subclass IIe and in Sandy Savannah range site; it is not assigned to a woodland group.

18—Konawa fine sandy loam, 1 to 5 percent slopes, eroded. This deep, well drained, very gently sloping to gently sloping, eroded soil is on high stream terraces. The surface layer has been thinned by erosion. In about 40 percent of the area, the surface layer and subsoil have been mixed by plowing. In some areas, a few uncrossable gullies are about 350 feet apart and rills are common between the gullies. Slopes are smooth and slightly convex. Most areas of this soil are 8 to 60 acres, but some are as small as 5 acres.

Typically, the surface layer is light brown fine sandy loam about 6 inches thick. The upper part of the subsoil, to a depth of about 15 inches, is yellowish red sandy clay loam. The middle part, to 30 inches, is reddish yellow sandy clay loam. The lower part is yellowish red fine sandy loam that extends to about 64 inches.

This soil is low in natural fertility and in organic matter content. Unless limed, the surface layer is strongly acid to slightly acid. Permeability is moderate, and the available water capacity is medium. This soil has fair tilth and can be worked throughout a wide moisture range.

Included with this soil in mapping are areas of Bastrop soils on slightly higher positions than this Konawa soil, Dougherty soils on similar positions, and Eufaula soils on steeper areas. These included soils make up about 15 to 25 percent of this map unit, but separate areas generally are less than 5 acres.

This Konawa soil has low potential for row crops and medium potential for small grains. The main limitations for crops are the crusty surface and the severe erosion hazard. Using cover crops, returning maximum amounts of crop residue to the soil, terracing, and contour farming help reduce runoff and erosion. Supplying adequate amounts of fertilizer also helps to provide additional plant residues.

This soil has high potential for native grass and tame pasture. Bermudagrass or lovegrass and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of the forage; this additional plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Trees do not grow to any significant height on this soil.

This soil has high potential for most urban uses with no significant limitations for septic tank absorption fields, area sanitary landfills, dwellings, and small commercial buildings. Seepage is the main limitation for sewage lagoons. Most of these limitations can be overcome by proper design or by altering the soil.

This Konawa soil is in capability subclass IIIe and Sandy Savannah range site; it is not assigned to a woodland group.

19—Konawa fine sandy loam, 2 to 6 percent slopes, gullied. This deep, well drained, very gently sloping to sloping very severely eroded soil is on high stream terraces. The soil has been deeply gullied by water erosion. Gullies range from 3 to 20 feet in depth and from 8 to 40 feet in width and are from 100 to 300 feet apart. Between gullies, the surface layer of the soil has been removed by erosion in about 50 percent of the area. In about 20 percent of the area, the surface layer and the upper part of the subsoil have been mixed by past cultivation. In these areas, the surface layer is a mixture of fine sandy loam and sandy clay loam. Slopes are smooth and convex. Most areas of this soil range from 5 to 150 acres, but some are as small as 3 acres.

Typically, the surface layer is light brown fine sandy loam about 4 inches thick. The upper part of the subsoil, to a depth of about 20 inches, is yellowish red sandy clay loam. The middle part, to 36 inches, is reddish yellow sandy clay loam. The underlying material is reddish yellow fine sandy loam that extends to a depth of about 66 inches.

This soil is low in natural fertility and low in organic matter content. Unless limed, the surface layer is strongly acid to slightly acid. Permeability is moderate, and the available water capacity is medium.

Included with this soil in mapping are areas of Bastrop soils on higher areas than this Konawa soil, Dougherty soils on more gently sloping areas, and Konsil soils on higher parts of the landscape. These included soils make up about 20 percent of this map unit, but separate areas generally are less than 10 acres.

This Konawa soil has low potential for row crops and small grains. It is too gullied for cropland and is best suited to a permanent cover of grass.

This soil has medium potential for native grass and low potential for tame pasture. Renovating and planting grass in gullied areas help control erosion. Bermudagrass or lovegrass and clovers are most commonly used in tame pasture. Fertilizing tame pasture increases the amount of forage and improves the vigor of the grass stand; the improved grass coverage protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Trees do not grow to any significant height on this soil.

This soil has medium potential for most urban uses. This unit requires land shaping and smoothing, with extensive cuts and fills required. After shaping and smoothing, there are no significant limitations for septic tank absorption fields, area sanitary landfills, and dwellings. The main limitations are seepage for sewage lagoons, slope for small commercial buildings, and low strength for roads and streets. Most of these limitations can be overcome by proper design or by altering the soil.

This Konawa soil is in capability subclass VIe and Eroded Sandy Savannah range site; it is not assigned to a woodland group.

20—Konsil fine sandy loam, 1 to 3 percent slopes. This deep, well drained, very gently sloping soil is on uplands. Slopes are smooth and convex. Most areas of this soil are 5 to 60 acres, but some are as small as 3 acres.

Typically, the surface layer is grayish brown fine sandy loam about 7 inches thick. The subsurface layer is light brownish gray fine sandy loam about 5 inches thick. The upper part of the subsoil, to a depth of about 26 inches, is yellowish red sandy clay loam. The middle part, to 44 inches, is reddish yellow sandy clay loam. The lower part to a depth of about 66 inches is mottled brown to reddish yellow sandy clay loam.

This soil is medium in natural fertility and in organic matter content. Unless limed, the surface layer is slightly acid to medium acid. Permeability is moderate, and the available water capacity is medium. This soil has good tilth and can be worked throughout a wide moisture range.

Included with this soil in mapping are a few areas of Bastrop soils on stream terraces in lower positions than this Konsil soil. Also included are intermingled areas of soils in which the subsoil layer is brownish in the upper part; otherwise, they have a profile similar to the profile of this Konsil soil. These included soils make up about 30 percent of this map unit, but separate areas generally are less than 5 acres.

This Konsil soil has high potential for row crops and small grains. The main management concerns are controlling erosion and maintaining soil structure and fertility. Terraces and waterways have helped reduce soil loss in many areas. Adding fertilizer increases plant growth, which provides more crop residue to help maintain soil structure and fertility. Contour farming, stripcropping, and crop residues help control water erosion. Winter cover crops furnish additional soil protection against wind and water erosion. Minimum tillage should be used.

This soil has high potential for native grasses and medium potential for tame pastures. Bermudagrass or lovegrass and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of forage; the added plant growth protects the soil from erosion. The quailty of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Trees do not grow to a significant height on this soil.

This soil has high potential for most urban uses. There are no significant limitations for sanitary landfills. Moderate permeability and seepage are the main limitations for septic tank absorption fields and sewage lagoons, respectively. Moderate shrink-swell potential is the main limitation for dwellings and small commercial buildings. Moderate shrink-swell potential and low strength are the main limitations for local roads and streets. Most of these limitations can be overcome by proper design for the physical conditions of the soil or by altering the soil.

This Konsil soil is in capability subclass IIe and in Sandy Savannah range site; it is not assigned to a woodland group.

21—Konsil fine sandy loam, 1 to 5 percent slopes, eroded. This deep, well drained, very gently sloping to gently sloping eroded soil occurs on uplands. In about 40 percent of the area, the surface layer and subsoil were mixed by plowing. There are a few uncrossable gullies from 2 to 6 feet in depth and about 350 feet apart. Rills are common between the gullies. Slopes are smooth and slightly convex. Most areas are 10 to 20 acres, but smaller areas are 5 acres.

Typically, the surface layer is yellowish brown fine sandy loam about 6 inches thick. The subsurface layer is light yellowish brown fine sandy loam about 3 inches thick. The upper part of the subsoil, to a depth of about

40 inches, is reddish yellow sandy clay loam. The lower part to a depth of about 65 inches is strong brown sandy clay loam with gray mottles and a few streaks of clean sand grains.

This soil is low in natural fertility and organic matter content. Unless limed, the surface layer is medium acid to slightly acid. Permeability is moderate, and the available water capacity is medium. This soil has good tilth and can be worked throughout a wide moisture range.

Included with this soil in mapping are a few areas of Bastrop soils on terraces in lower positions. Also included are intermingled areas of soils in which the upper part of the subsoil is brownish; otherwise, the profile is similar to the profile of this Konsil soil. These included soils make up about 25 percent of this map unit, but separate areas are generally less than 5 acres.

This Konsil soil has medium potential for growing row crops and small grains. The erosion hazard is severe if cultivated crops are grown. Good tilth can be maintained by returning crop residue to the soil. Minimum tillage, the use of cover crops, terraces, and contour farming help reduce runoff and control erosion.

This soil has high potential for native grass and for tame pasture. Bermudagrass or lovegrass and clovers are commonly used for hay and pasture. The quality and quantity of tame pasture grasses can be improved by adding fertilizer. The quality of all grasses also can be improved by proper stocking, controlling weeds and brush, preventing burning, and properly controlled grazing.

This soil has low potential for woodland. Trees do not grow to a significant height on this soil.

This soil has high potential for most urban uses. Slow permeability and seepage are the main limitations for septic tank absorption fields and sanitary landfills, respectively. Shrink-swell potential is the main limitation for dwellings and small commercial buildings. Moderate shrink-swell potential and low strength are the main limitations for local roads and streets. These limitations can be easily overcome.

This Konsil soil is in capability subclass IVe and in Sandy Savannah range site; it is not assigned to a woodland group.

22—Konsil fine sandy loam, 1 to 5 percent slopes, gullied. This deep, well drained, very gently sloping to gently sloping, very severely eroded soil is on uplands. This soil is on hill crests and side slopes. This soil has been deeply gullied by water erosion.

Gullies are from 5 to 30 feet in depth, from 10 to 40 feet in width, and from 50 to 200 feet apart. Between gullies, the surface layer of the soil has been removed by erosion in about 60 percent of the area. In about 20 percent of the area, the surface layer and the upper part of the subsoil have been mixed by past cultivation. In these areas, the surface layer is fine sandy loam, loamy fine sand, or sandy clay loam. Most areas of this map unit are 10 to 100 acres, but some are as small as 5 acres.

Typically, the surface layer is yellowish brown fine sandy loam about 4 inches thick. The subsurface layer is pale brown fine sandy loam about 8 inches thick. The upper part of the subsoil to a depth of about 34 inches is reddish yellow sandy clay loam. The lower part to a depth of about 62 inches is yellowish brown sandy clay loam that has gray mottles.

Konsil soils are low in natural fertility and organic matter content. Unless limed, the surface layer is medium acid to slightly acid. Permeability is moderate, and the available water capacity is medium.

Included with this unit in mapping are areas of Bastrop soils on terraces in lower positions. Also included are intermingled areas of soils in which the upper part of the subsoil is brownish; otherwise, the profile is similar to the profile of this Konsil soil. These included soils make up about 25 percent of this map unit, but some areas are less than 5 acres.

This Konsil soil has low potential for cultivated crops. The main limitations are deep, uncrossable gullies and a very severe erosion hazard.

This soil has medium potential for native grass and tame pasture plants. The main concerns of management are very severe erosion and maintenance of soil structure and soil fertility. Formerly cultivated areas need improvement of permanent vegetation such as tame pasture plants, native grasses, or trees to reduce soil erosion. Use of fertilizers, diverting overhead water, and shaping gully banks are needed for establishing tame pasture plants. The quality and quantity of all grasses also can be improved by controlled grazing, proper stocking, controlling weeds or brush, and protection from fire.

This soil has low potential for growing trees. Trees do not grow to a significant height on this soil.

This soil has medium potential for most urban uses. The gullies need to be shaped, smoothed, and filled in some areas. Moderate shrink-swell potential is the main limitation for dwellings and small commercial buildings. Moderate shrink-swell potential and low strength are the main limitations for local roads and streets. These limitations can be easily overcome.

This Konsil soil is in capability subclass VIe and in Eroded Sandy Savannah range site; it is not assigned to a woodland group.

23—Konsil fine sandy loam, 3 to 5 percent slopes. This deep, well drained, gently sloping soil is on uplands. Slopes are smooth and convex. Individual areas are 8 to 60 acres, but there are smaller areas of 5 acres.

Typically, the surface layer is reddish gray fine sandy loam about 9 inches thick. The subsurface layer is pinkish gray fine sandy loam about 5 inches thick. The upper part of the subsoil to a depth of about 32 inches is yellowish red sandy clay loam. The middle part to 48 inches is reddish yellow sandy clay loam. The lower part to a depth of about 70 inches is reddish yellow sandy clay loam that has reddish mottles.

This soil is medium in natural fertility and medium in organic matter content. Unless limed, the surface layer is slightly acid to medium acid. Permeability is moderate, and the available water capacity is medium. This soil has good tilth and can be worked throughout a wide moisture range.

Included with this soil in mapping are a few areas of Bastrop soils on terraces in lower positions and a few areas of Konsil soils with 5 to 8 percent slopes. Also included are intermingled areas of soils with a profile similar to the profile of this Konsil soil, but the upper part of the subsoil is brownish. These included soils make up about 25 percent of this map unit, but separate areas generally are less than 5 acres.

This soil has medium potential for row crops and small grains. The main management concerns for crops are controlling soil erosion and maintaining soil tilth and fertility. Terraces and grassed waterways help reduce soil loss in many areas. Adding fertilizer increases plant growth that provides crop residues to help maintain soil structure and fertility. Minimum tillage, contour farming, stripcropping, and the use of crop residues help control soil erosion. Winter cover crops furnish additional soil protection against wind and water erosion.

This soil has high potential for native grass and medium potential for tame pasture. Bermudagrass or lovegrass and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and the quality of forage; the additional plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Trees do not grow to a significant height on this soil.

The soil has high potential for most urban uses. There are no significant limitations for sanitary landfills. Moderate permeability and seepage are the main limitations for septic tank absorption fields and sewage lagoons. Moderate shrink-swell potential is the main limitation for dwellings and small commercial buildings. Moderate shrink-swell potential and low strength are the main limitations for local roads and streets. Most of these limitations can be overcome by proper design or by altering the soil.

This Konsil soil is in capability subclass IIIe and in Sandy Savannah range site; it is not assigned to a woodland group.

24—Konsil fine sandy loam, 8 to 15 percent slopes. This deep, well drained, strongly sloping to moderately steep soil is on uplands. Slopes are smooth and convex. Most areas of this soil are 10 to 300 acres, but some are as small as 5 acres.

Typically, the surface layer is reddish brown fine sandy loam about 6 inches thick. The subsurface layer is light yellowish brown fine sandy loam about 8 inches thick. The upper part of the subsoil, to a depth of about 32 inches, is reddish brown sandy clay loam. The middle part, to 50 inches, is reddish yellow sandy clay loam. The lower part to a depth of about 72 inches is red sandy clay loam.

This soil is medium in natural fertility and medium in organic matter content. Unless limed, the surface layer is slightly acid. Permeability is moderate, and the available water capacity is medium.

Included with this soil in mapping are a few areas of Bastrop soils on terraces and a few areas of Konsil soils on 5 to 8 percent slopes. Also included are intermingled areas of soils with a profile similar to the profile of this Konsil soil, but the subsoil is brownish in the upper part. These included soils make up about 25 percent of this map unit, but separate areas generally are less than 5 acres.

This soil has low potential for row crops and small grains. The main limitation in using this soil for crops is the severe erosion hazard on the strongly sloping to moderately steep slopes. This soil is best suited to a permanent cover of grass (fig. 5).

This soil has high potential for native grass and medium potential for tame pasture. Bermudagrass or lovegrass and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of forage; the additional plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has medium potential for woodland. Trees do not grow to a significant height on this soil.

This soil has low potential for most urban uses with no significant limitations for trench sanitary landfill. Moderate permeability and slope are the main limitations for septic tank absorption fields and area sanitary landfills, respectively. Slope is the main limitation for dwellings, small commercial buildings, sewage lagoons, roads, and streets. Most of these limitations can be overcome by proper design or by altering the soil.

This Konsil soil is in capability subclass VIe and in Sandy Savannah range site; it is not assigned to a woodland group.

25—Madill fine sandy loam. This deep, well drained, nearly level soil is on flood plains of local streams. Slopes range from 0 to 1 percent and are smooth or slightly undulating. Most areas of this soil are 45 to 200 acres, but some are as small as 15 acres.

Typically, the surface layer is brown fine sandy loam about 4 inches thick. The next layer is pale brown fine sandy loam to a depth of about 30 inches. The next lower layer is pale brown loam to about 48 inches. The underlying material is pale brown loam that extends to a depth of about 68 inches.

This soil is medium in natural fertility and in organic matter content. Reaction is medium acid or slightly acid in the surface layer. Permeability is moderately rapid, and the available water capacity is medium. This soil has

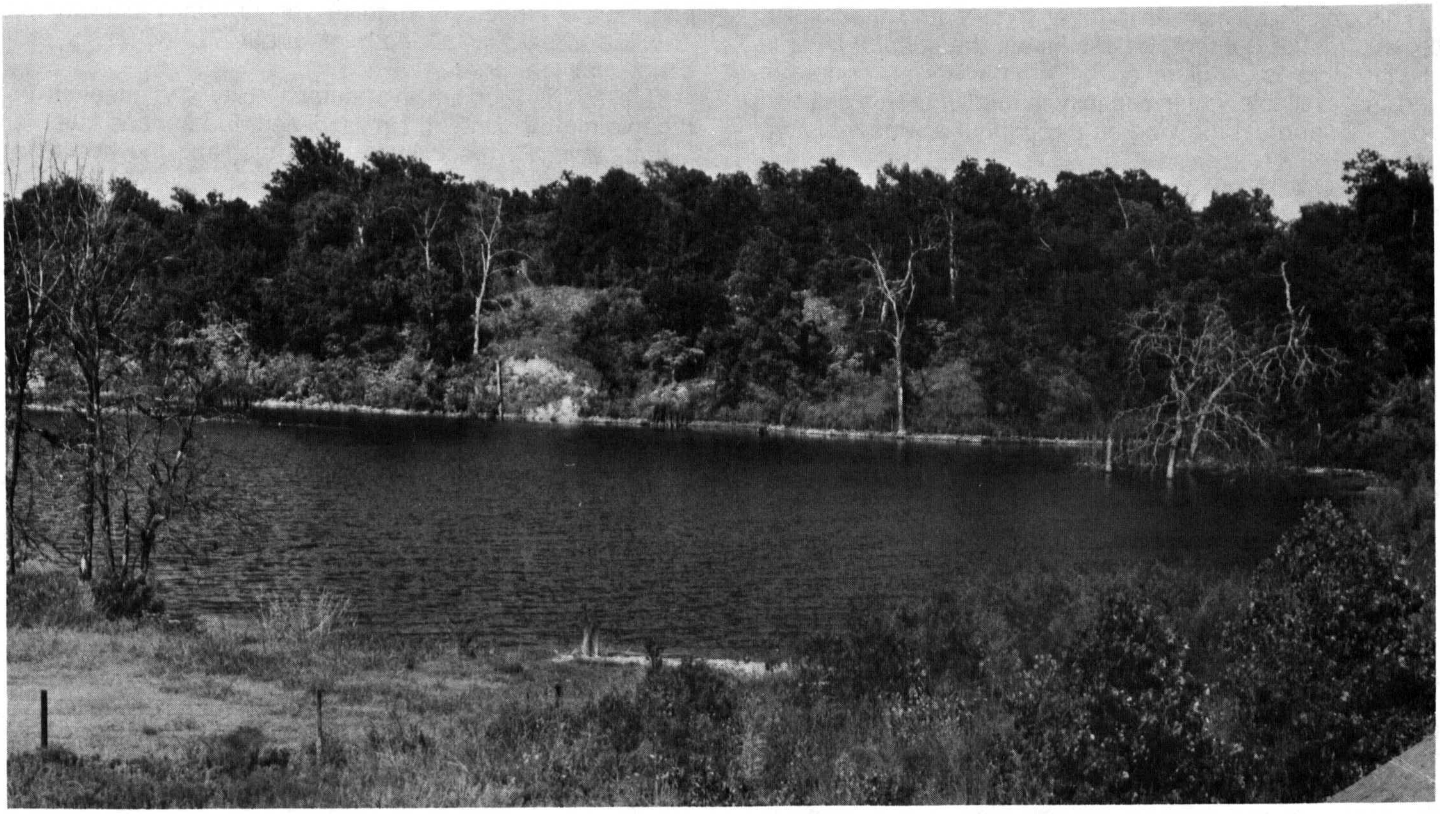


Figure 5.—Water is impounded behind a grade stabilization structure constructed as part of a roadfill. The soil, Konsil fine sandy loam, 8 to 15 percent slopes, is best suited to permanent cover of grass because of the severe erosion hazard.

good tilth and can be worked throughout a wide moisture range. It is subject to occasional flooding.

Included with this soil in mapping are about 230 acres of soils in lower positions along the Washita River. These included soils typically are redder and more alkaline than the Madill soil. Also included are somewhat poorly drained soils that have dark gray and gray buried lower layers; otherwise, the profile is similar to the profile of this Madill soil. These included soils make up about 5 to 15 percent of this map unit, but separate areas generally are less than 10 acres.

This Madill soil has high potential for row crops and small grains. The main concerns in management are occasional flooding and maintenance of soil tilth and fertility. Cover crops grown during the late fall, winter, and spring months prevent excessive soil loss during flooding. The planting of spring crops is often delayed until after the usual flood period. Most crops that produce large amounts of residue can be grown continuously where plant food is added for maximum crop residue. Minimum tillage and maintenance of the organic matter content of this soil helps maintain good soil tilth and increase the intake of water. Using this soil for tame pasture or woodland reduces soil loss during the flood period.

This soil has high potential for native grass and tame pasture. Bermudagrass or tall fescue and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of forage; the additional plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has medium potential for woodland production. The main management concern is seedling mortality. Trees can be improved by protecting them from fire, planting suitable species, removing or controlling inferior species, and selectively harvesting trees on a planned schedule.

This soil has low potential for most urban uses. Flooding is the main limitation for septic tank absorption fields, sewage lagoons, sanitary landfills, dwellings, small commercial buildings, roads, and streets. The flood hazard can be reduced but not completely eliminated by upstream flood control structures and land treatments. The potential flood hazard is high for houses built in the flood plain.

This Madill soil is in capability subclass IIw, Loamy Bottomland range site, and woodland group 3o.

26—Purves clay, 2 to 5 percent slopes. This shallow, well drained, very gently sloping to gently sloping soil is on uplands. Slopes are smooth and slightly convex. Most areas of this soil are 15 to 200 acres, but some are as small as 5 acres.

Typically, the surface layer is very dark gray clay about 10 inches thick. The next layer, about 6 inches thick, is dark gray clay. The underlying material below 10 inches and to a depth of 24 inches is hard, fractured limestone.

This soil is high in natural fertility and organic matter content. The surface layer is calcareous and moderately alkaline. Permeability is moderately slow, and the available water capacity is low. This soil has poor tilth and can be worked throughout a narrow moisture range.

Included with this soil in mapping are areas of Tarrant soils on similar positions and Burleson and Heiden soils on lower areas. Also included are small areas of soils that have a loamy and reddish profile; otherwise, they are similar to this Purves soil. These included soils make up about 15 to 25 percent of this map unit, but separate areas generally are less than 10 acres.

This soil has low potential for row crops and small grains. The main limitations for crops are shallow rooting depth, low available water capacity, and clayey texture. Minimum tillage and the addition of crop residues help maintain good soil tilth. Terraces and contour farming help reduce runoff and control erosion. Maintaining a vegetative cover on the soil helps reduce soil loss.

This soil has medium potential for native grass and low potential for tame pasture. Bermudagrass or King Ranch bluestem and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of forage; the additional plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Trees generally do not grow under natural conditions on this soil.

This soil has low potential for most urban uses. Shallow depth to hard bedrock is the main limitation for septic tank absorption fields, sewage lagoons, sanitary landfills, dwellings, small commercial buildings, roads, and streets. This limitation can be overcome for some uses by proper design or by altering the soil.

This Purves soil is in capability subclass IVe and Shallow Prairie range site; it is not assigned to a woodland group.

27—Tarrant cobbly clay, 2 to 15 percent slopes. This shallow, well drained, very gently sloping to moderately steep soil is on ridge crests of the uplands. Slopes are smooth and convex to broken. Most areas are 15 to 200 acres, but some are 5 acres.

Typically, the surface layer is very dark grayish brown cobbly clay about 6 inches thick. The next layer is dark brown cobbly clay about 5 inches thick. The underlying material from 11 inches to a depth of about 22 inches is hard, fractured limestone.

This soil is high in natural fertility and organic matter content. The surface layer is moderately alkaline and calcareous. Permeability is moderately slow, and the available water capacity is low. This soil has a shallow root zone.

Included with this soil in mapping are areas of Purves soils on similar positions and Heiden and Ferris soils on lower areas than this Tarrant soil. These included soils make up about 15 percent of this map unit, but separate areas generally are less than 10 acres.

This Tarrant soil has low potential for row crops and small grains. The main limitation is shallow depth to bedrock and cobbles in the surface layer. This soil is best suited to grass.

This soil has low potential for native grass and tame pasture. In a few areas bermudagrass and clovers are used for tame pasture. Fertilizing tame pasture increases the amount and the quality of forage; the additional plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Generally trees do not grow under natural conditions on this soil.

This soil has low potential for most urban uses. Depth to hard bedrock is the main limitation for septic tank absorption fields, sewage lagoons, trench sanitary landfills, dwellings, small commercial buildings, roads, and streets. This limitation can be overcome for some uses by proper design or by altering the soil.

This Tarrant soil is in capability subclass VIIs and in Very Shallow range site; it is not assigned to a woodland group.

28—Teller fine sandy loam, 0 to 1 percent slopes. This deep, well drained, nearly level soil is on stream terraces. Slopes are smooth. Most areas of this soil are 10 to 300 acres, but some are as small as 5 acres.

Typically, the surface layer is dark reddish gray fine sandy loam about 16 inches thick. The upper part of the subsoil, to a depth of about 24 inches, is reddish brown fine sandy loam. The middle part, to about 58 inches, is reddish brown sandy clay loam. The lower part is brown fine sandy loam that extends to a depth of about 80 inches.

This soil is high in natural fertility and high in organic matter content. Reaction is slightly acid or medium acid in the surface layer. Permeability is moderate, and the available water capacity is high. This soil has good tilth and can be worked throughout a wide moisture range.

Included with this soil in mapping are areas of Konawa soils on slightly higher positions, Bastrop soils on higher terraces, and Counts soils on slightly concave areas. Also included are soils that have a profile similar to the profile of this Teller soil except that the surface layer is sandy. These included soils make up about 10 to 20 percent of this map unit, but separate areas generally are less than 5 acres.

This Teller soil has high potential for row crops and small grains. The main management concerns are the maintenance of organic matter, soil tilth, and fertility. A vegetative cover or crop residue kept on the surface reduces soil erosion. Adding fertilizer and returning adequate amounts of organic materials to the soil help maintain good soil tilth. Minimum tillage also helps maintain good soil tilth. Adequate amounts of crop residue left on the soil surface at crop seeding time help reduce soil blowing and wind damage to the crop.

This soil has high potential for native grass and tame pasture. Bermudagrass or lovegrass and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of forage; the additional plants growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Under natural conditions trees generally do not grow on this soil.

This soil has high potential for most urban uses. There are no significant limitations for area sanitary landfills, dwellings, and small commercial buildings. The main limitation is seepage for sewage lagoons and low strength for roads and streets. Most of these limitations can be overcome by proper design or by altering the soil.

This Teller soil is in capability class I and Loamy Prairie range site; it is not assigned to a woodland group.

29—Wilson loam, 0 to 1 percent slopes. This deep, somewhat poorly drained, nearly level soil is on uplands. Slopes are smooth and slightly concave. Most areas of this soil are 5 to 80 acres, but some are as small as 3 acres.

Typically, the surface layer is grayish brown loam about 6 inches thick. The upper part of the subsoil, to a depth of about 36 inches, is gray clay. The lower part is light gray clay that extends to a depth of about 70 inches.

This soil is high in natural fertility and organic matter content. Reaction is medium acid to neutral in the surface layer. Permeability is very slow, and the available water capacity is high. This soil has poor tilth and can be worked throughout a narrow moisture range.

Included with this soil in mapping are areas of Burleson, Durant, and Heiden soils on more sloping areas than this Wilson soil. These included soils make up about 15 percent of this map unit, but separate areas generally are less than 5 acres.

This Wilson soil has medium potential for row crops and small grains. The main management concerns for crops are wetness in the winter and spring months and droughtiness in the summer. In addition, the surface becomes very hard and crusty. The erosion hazard is slight if cultivated crops are grown. Minimum tillage, cover crops, contour farming, and returning high amounts of crop residue to the soil will help reduce surface crusting, reduce runoff, and control erosion.

This soil has high potential for native grass and tame pasture. Bermudagrass or tall fescue and clovers are commonly used in tame pasture. Fertilizing tame pasture increases the amount and improves the quality of forage; the additional plant growth protects the soil from erosion. The quality of native and tame pasture grasses also can be improved by controlling grazing, proper stocking, and preventing fires.

This soil has low potential for woodland. Trees generally do not grow under natural conditions on this soil.

This soil has low potential for most urban uses. There are no significant limitations for sewage lagoons. The main limitations are very slow permeability and wetness for septic tank absorption fields; clayey texture for trench sanitary landfills; and high shrink-swell potential and wetness for dwellings, small commercial buildings, and local roads and streets. Low strength is an additional limitation for local roads and streets.

This Wilson soil is in capability subclass 3w and Claypan Prairie range site; it is not assigned to a woodland group.

Use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and pasture

Odos G. Henson, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Soil maps for detailed planning." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

More than 67,000 acres in the survey area was used for crops and pasture in 1974, according to the Soil Conservation Service land use inventory. Of this total, about 41,000 acres was used for permanent pasture; 18,000 acres, for row crops; 6,000 acres, for close-growing crops, mainly wheat and oats; and 10,000 acres, for hay and tame pasture. The rest was idle land.

The soils in Marshall County have good potential for increased production of food.

Acreage in crops and pasture has gradually been decreasing as more and more land is used for urban development. In 1974 there were about 3,000 acres of urban and built-up land in the survey area, and this figure has been growing at the rate of about 20 acres per year. The use of this soil survey to help make land use decisions that will influence the future role of farming in the survey area is discussed in the section "General soil map for broad land use planning."

Soil erosion is the major concern on about one-third of the cropland and pasture in Marshall County. If slope is more than 1 percent, erosion is a hazard. Burleson, Bastrop, Durant, Konsil, and Purves soils, for example, have slopes of 1 percent or more.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Burleson, Durant, Ferris, and Heiden soils. Erosion also reduces productivity on soils that tend to be droughty, such as Dougherty loamy fine sand. Second, soil erosion on farmland results in sedimentation of streams. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water for municipal use, for recreation, and for fish and wildlife.

In many sloping fields, tilling or preparing a good seedbed is difficult on clayey spots because the original friable surface soil has been eroded away. Such spots are common in areas of moderately eroded Ferris soils.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps vegetative cover on the soil for extended periods can hold soil erosion losses to amounts that will not reduce the productive capacity of the soils. On livestock farms, which require pasture and hay, the legume and grass forage crops in the cropping system reduce erosion on sloping land, provide nitrogen, and improve tilth for the following crop.

A cropping system that provides substantial vegetative cover is required to control erosion. Minimizing tillage and leaving crop residue on the surface help increase infiltration and reduce the hazards of runoff and erosion. These practices can be adapted to most soils in the survey area, but they are more difficult to use successfully on the eroded soils and on the soils that have a clayey surface layer, such as Burleson, Ferris, and Heiden soils.

Terraces and diversions reduce the length of slope and reduce runoff and erosion. They are not practical on deep sandy soils such as Dougherty soils. Durant soils, for example, are suitable for terraces. Purves soils are less suitable for terraces and diversions because of a clayey subsoil, which would be exposed in terrace channels, and bedrock at a depth of less than 20 inches.

Contouring and contour stripcropping are erosion control practices in the survey area. They are best adapted to soils that have smooth, uniform slopes, including most areas of the sloping Burleson, Bastrop, Durant, Ferris, and Heiden soils.

Soil blowing is a hazard on the sandy Dougherty soils. Soil blowing can damage these soils if winds are strong and the soils are dry and do not have vegetative cover or surface mulch. Maintaining vegetative cover, surface mulch, or rough surfaces through proper tillage minimizes soil blowing on these soils.

Information for the design of erosion control practices for each kind of soil is available in the local office of the Soil Conservation Service.

Soil drainage is the major management need on a small acreage used for crops and pasture in the survey area. Some soils are so wet that the production of crops common to the area is limited or generally not possible. These are the somewhat poorly drained Counts and Gracemont soils, which make up about 3,000 acres in the survey area.

Soil fertility is naturally low in some soils on uplands in the survey area. The soils on flood plains, such as Frioton soils, are naturally higher in plant nutrients than most soils on timbered uplands.

Many soils that developed on timbered uplands are acid in their natural state. If they have never been limed, applications of ground limestone are required to raise the pH level sufficiently for good growth of alfalfa and other crops that grow only on nearly neutral soils. Available phosphorus and nitrogen levels are naturally low in most of these soils. On all soils additions of lime and fertilizer should be based on the results of soil tests, on the need of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to apply.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth are granular and porous.

Many of the soils used for crops in the survey area have a surface layer of silt loam that is light in color and low in content of organic matter. Generally the structure of such soils is weak, and intense rainfall causes the formation of a crust on the surface. Once the crust forms, it reduces infiltration and increases runoff. Regular additions of crop residue, manure, and other organic material can help improve soil tilth and reduce crust formation.

The dark colored Burleson, Ferris, and Heiden soils are clayey, and tilth is a concern because the soils often stay wet until late in spring. If they are wet when plowed, they tend to be very cloddy when dry and good seedbeds are difficult to prepare. Fall plowing on such wet soils generally results in good tilth in the spring.

Field crops suited to the soils and climate of the survey area include many that are not now commonly grown. Grain sorghum, peanuts, and soybeans are the main row crops. Potatoes, and similar crops can be grown if economic conditions are favorable.

Wheat is the common close-growing crop. Rye, barley, and oats could be grown, and grass seed could be produced from King Ranch bluestem, fescue, switchgrass, or lovegrass.

Special crops grown commercially in the survey area are vegetables, small fruits, tree fruits, and nursery plants. A small acreage is used for melons, potatoes, green beans, sweet corn, tomatoes, peppers, and other vegetables and small fruits. In addition, larger areas can be used for other special crops such as grapes and vegetables. Apples and peaches are the most important tree fruits grown in the survey area.

Latest information and suggestions for growing special crops can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Farming and other land uses are competing for large areas of the survey area. About 3,000 acres was urban or built-up land in 1974. Much of this acreage was well suited as cropland. Each year additional land is being developed for urban uses in Madill and other small towns in the survey area.

In general, the soils in the survey area that are well suited to crops are also well suited to urban development. The data about specific soils in this soil survey can be used in planning future land use patterns. Potential productive capacity in farming should be weighed against soil limitations and potential for nonfarm development.

Management of soils for tame pasture plants

General guidelines for managing soils for tame pasture plants are described in this section. Those desiring more detailed information about management of soils can refer to the section "Soil maps for detailed planning."

More than 41,000 acres, or over 15 percent of the acreage in this county, is in tame pasture plants. The trend is toward converting cropland and woodland and, to a lesser degree, rangeland to pasture.

The principal grass is improved bermudagrass. Some of the better pastures of bermudagrass are overseeded with legumes that provide additional plant food, which improves the quality and increases the quantity of forage.

Some bermudagrass pastures are overseeded with fescue grass. This grass mixture is especially adapted to soils on flood plains where additional moisture is available. Fescue provides grazing in nearly all months and furnishes added protein for livestock during the months when bermudagrass is dormant.

Fescue is an important grass in the county. It provides a sufficient quantity of forage for grazing on soils that have large amounts of available moisture. Fescue is used in the pasture program with other forages to furnish grazing that has quality protein during late fall and spring. To maintain a vigorous stand, it needs to be fertilized in early spring and in early fall; when planted alone, it should not be grazed during summer.

Weeping lovegrass for pasture is limited in the county. It is a warm-season perennial bunchgrass suited to well drained loamy and sandy soils. It begins growth earlier in the spring than bermudagrass and remains green later in the fall. It responds well to fertilizer, especially nitrogen. It becomes less palatable to cattle as it matures.

Small grains, planted on cropland to supplement permanent grasses in the pasture program, provide grazing and additional protein for livestock during late fall and spring (fig. 6). Small grains need to be seeded and fertilized in late summer or early fall to obtain the maximum amount of forage. Small grains can be grazed until maturity, or livestock can be removed in spring to allow the plants to grow a seed crop for harvest. Wheat, oats, barley, and rye are the main small grains used for grazing.

Sudangrass, an annual grass, is also used on some areas to supplement permanent grasses. It provides grazing during summer, or the forage can be harvested for hay. In some areas, sudangrass is allowed to grow until frost and is grazed in the winter. Fertilizer should be used for maximum growth.

Tame pature management.—The kinds of soil and suitable plants must be considered in tame pasture management. Good pastures can be achieved by maintaining the desired kind and stand of plants. Plants must have vigor to keep a proper balance in the stand. Grazing needs to be compatible with the growth of pasture plants.

Proper grazing and rotation grazing help lengthen the life of most tame pasture plants. Deferred grazing during

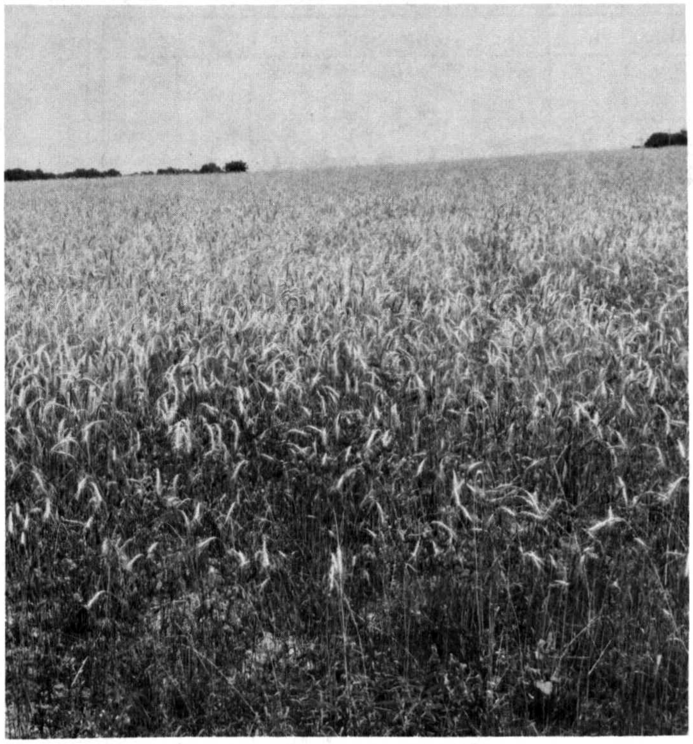


Figure 6.—Rye and vetch cover crop, on an area of Dougherty loamy fine sand, 0 to 3 percent slopes, are part of a tame pasture program.

the time that tame pasture plants are under the most stress is beneficial. This allows the plants to regain vigor by helping to maintain a large root system where food can be stored for the next growing season; the total amount of forage will increase.

Plant food contributes to more vigorous pasture plants. It helps increase the amount of forage and lengthen the lifespan of the plants. Large amounts of plant food, especially nitrogen, are needed when legumes are not grown with grass. Nitrogen may by supplied by commercial fertilizer. Lime may be necessary to adjust the acidity of the soil for the kinds of plant desired.

Desirable plants can be maintained in the stand only by controlling the invasion of undesirable plants. Weeds need to be controlled. Brush control is essential on soils on which trees grow. A mowing, or spraying, helps reduce weeds and brush.

Planning a pasture program.—A planned pasture program helps provide the desired amount of forage during each month of the year. A study of the growth habits of the different plants assures adequate forage each month. The months that various kinds of forage plants grow are indicated in figure 7. The percentage of each plant's annual growth is illustrated. For example, bermudagrass makes 20 percent of its yearly growth for grazing during the month of June.

Soils vary in their ability to produce forage for grazing. The Frioton soil produces more forage than the Purves soil primarily because it furnishes more moisture to the plant. The total yearly production of each soil for various kinds of pasture plants is given in animal-unit-months (AUM) in table 5. An animal unit month is the amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days. A bermudagrass pasture on Frioton silty clay loam, for example, will furnish grazing for one animal unit for about 7.5 months during 1 year.

In planning a pasture program, one must consider the total yearly production of the pasture plant in animal-unit-months (table 5) and the amount of growth the plant will make for a certain month (fig. 7). Bermudagrass, which makes 20 percent of its annual growth during June, will provide grazing for 1.5 animals on an acre of the Frioton soil in June (7.5 AUM X 20 percent = 1.5 AUM). A pasture of 50 acres would then furnish grazing for 75 animals (50 acres X 1.5 AUM = 75 AUM) during June. Personnel in the Soil Conservation Service or County Extension Service can assist in planning a total pasture program for your farm.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Improved Bermudagrass				9	18	20	16	14	10	9	4	
Improved Bermudagrass & Tall Fescue Combination	10	10	14	19	9	9	5	9	5			10
Tall Fescue	13	13	13	20	18	7					3	13
King Ranch Bluestem Caucasian Bluestem					8	22	14	27	14	15		
Lovegrass	3	3		13	25	25	13	6				12
Sudan						14	29	29	21	7		
Wheat Grazeout	5	11	29	29	14						5	7
Rye & Ryegrass Grazeout	6	10	17	24	20	11					6	6
Switchgrass	6				27	18	15	12	9		7	6
Native Grass (continuous use)	6	6	6	6	14	14	14	7	7	7	7	6
Native Grass (deferred)	7	7	7				22	22		11	12	12

Figure 7.—Forage calendar projects percentage of grazing available from different pasture plants throughout the year.

Land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at two levels: capability class and subclass. These levels are defined in the following paragraphs.

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

Class I soils have slight limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Soil maps for detailed planning."

Rangeland

Ernest C. Snook, range conservationist, Soil Conservation Service, helped prepare this section.

About 44 percent of Marshall County is rangeland. More than half of the farm income is derived from livestock, principally cattle. Cow-calf or steer operations, or both, are dominant in the county.

On many ranches the forage produced on rangeland is supplemented by crop stubble and small grain. In winter the native forage is often supplemented with protein concentrate. Calves and yearlings are creep fed to increase market weight on some ranches.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 7 shows, for each soil in the survey area, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as or are suited to rangeland are listed. Explanation of the column headings in table 7 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre reduced to a common percent of air dry moisture.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Woodland management and productivity

Norman E. Smola, forester, Soil Conservation Service, helped prepare this section.

The information presented in this section will be useful to woodland owners and operators in developing and carrying out plans for establishing and maintaining tree resources.

Natural stands of commercial timber occupy less than 4 percent of Marshall County. Soils capable of supporting commercial forest species constitute about 4 percent of the county's land area.

The principal commercial species are eastern cottonwood and southern red oak. The species harvested in lesser amounts include ash, black walnut, hackberry, hickory, pecan, and bur oak.

Table 8 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 8, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. Site index was calculated at age 30 years for eastern cottonwood and at 50 years for all other species. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

Woodland understory vegetation

Understory vegetation consists of grasses, forbs, shrubs, and other plants. Some woodland, if well managed, can produce enough understory vegetation to support grazing of livestock or wildlife, or both, without damage to the trees.

The quantity and quality of understory vegetation vary with the kind of soil, the age and kind of trees in the canopy, the density of the canopy, and the depth and condition of the litter. The density of the canopy determines the amount of light that understory plants receive.

Table 9 shows, for each soil suitable for woodland use, the potential for producing understory vegetation. The total production of understory vegetation includes the herbaceous plants and the leaves, twigs, and fruit of woody plants up to a height of 4 1/2 feet. It is expressed in pounds per acre of air-dry vegetation in favorable, normal, and unfavorable years. In a favorable year, soil moisture is above average during the optimum part of the growing season; in a normal year, soil moisture is average; and in an unfavorable year, it is below average.

Table 9 also lists the common names of the characteristic vegetation on each soil and the percentage composition, by air-dry weight, of each kind of plant. The table shows the kind and percentage of understory plants expected under a canopy density that is most nearly typical of woodland in which the production of wood crops is highest.

Recreation

The soils of the survey area are rated in table 10 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 10, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas (fig. 8).

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife habitat

Jerome F. Sykora, biologist, Soil Conservation Service, helped prepare this section.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 11, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair*

Figure 8.—Public recreation facilities are on Tarrant cobbly clay, 2 to 15 percent slopes, next to Lake Texoma.

indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be established, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

Charles E. Bollinger, assistant state conservation engineer, and Jesse L. McMasters, area engineer, helped prepare this section.

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 12 shows, for each kind of soil, the degree and kind of limitations for building site development; table 13, for sanitary facilities; and table 15, for water management. Table 14 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 12. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 12 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 12 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 13 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, or *poor*, which, respectively, mean about the same as the terms *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 13 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 14 by ratings of good, fair, or poor. The texture, thickness, and organic matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 16 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 14 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 16.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 15 the degree of soil limitation and soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Soil and site limitations are expressed as slight, moderate, and severe. *Slight* means that the soil properties and site features are generally favorable for the specified use and that any limitation is minor and easily overcome. *Moderate* means that some soil properties or site features are unfavorable for the specified use but can be overcome or modified by special planning and design. *Severe* means that the soil properties and site features are so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is required.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Aquifer-fed excavated ponds are bodies of water made by excavating a pit or dugout into a ground-water aquifer. Excluded are ponds that are fed by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Ratings in table 15 are for ponds that are properly designed, located, and constructed. Soil properties and site features that affect aquifer-fed ponds are depth to a permanent water table, permeability of the aquifer, quality of the water, and ease of excavation.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 21.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering index properties

Table 16 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number.

Fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and chemical properties

Table 17 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Soil and water features

Table 18 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes is not considered flooding.

Table 18 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 18 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 18.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavations.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil horizon.

Physical and chemical analyses of selected soils

The results of physical analysis of several typical pedons in the survey area are given in table 19 and the results of chemical analysis in table 20. The data are for soils sampled at carefully selected sites. The pedons are typical of the soils of the survey area. Soil samples were analyzed by the Soil Morphology, Genesis and Classification Laboratory, Department of Agronomy, Oklahoma State University.

Most determinations, except those for grain-size analysis, were made on soil material smaller than 2 millimeters in diameter. Measurements reported as percent or quantity of unit weight were calculated on an oven-dry basis. The methods used in obtaining the data are indicated in the list that follows. The codes in parentheses refer to published methods (*4*).

Sand—(0.05-2.0 mm fraction) weight percentages of materials less than 2 mm (3A1).
Silt—(0.002-0.05 mm fraction) pipette extraction, weight percentages of all materials less than 2 mm (3A1).
Clay—(fraction less than 0.002 mm) pipette extraction, weight percentages of materials less than 2 mm (3A1).
Extractable bases—ammonium acetate pH 7.0, uncorrected; calcium (6N2), magnesium (602), sodium (6P2), potassium (6Q2).
Cation-exchange capacity—ammonium acetate, pH 7.0 (5A1a).
Base saturation—ammonium acetate, pH 7.0 (5C1).
Reaction (pH)—1:1 water dilution (8C1a).
Organic matter—peroxide digestion (6A3).
Total phosphorus—perchloric acid; colorimetry (6S1a).

Engineering index test data

Table 21 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the soils in the survey area. The soil samples were tested by the Oklahoma Department of Transportation, Materials Division.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM); and Shrinkage—T 92 (AASHTO); D 427 (ASTM).

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*5*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 22, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Fluvent (*Fluv*, meaning river, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Udifluvents (*Udi*, meaning humid horizonation, plus *fluvent*, the suborder of the Entisols that has a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Udifluvents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is coarse-loamy, mixed, nonacid, thermic Typic Udifluvents.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil series and morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*3*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*5*). Unless otherwise stated, colors in the descriptions are for dry soils. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Soil maps for detailed planning."

Bastrop series

The Bastrop series consists of deep, well drained, moderately permeable soils that formed in loamy sediments. These nearly level to very gently sloping soils are on high stream terraces. Slopes are 0 to 3 percent.

Bastrop soils are associated with Counts, Dougherty, Konawa, Konsil, and Teller soils. Counts soils are in lower positions than Bastrop soils and are in the fine family. Dougherty, Konawa, and Teller soils are on lower terraces and have an argillic horizon that decreases in clay content by more than 20 percent from the maximum at a depth of 60 inches. Also Teller soils have a mollic epipedon. Konsil soils are on uplands and have a lower base saturation.

Typical pedon of Bastrop fine sandy loam, 1 to 3 percent slopes, 700 feet north and 50 feet west of the southeast corner of sec. 4, T. 7 S., R. 4 E.

Ap—0 to 10 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak fine granular structure; slightly hard, very friable; neutral; gradual smooth boundary.

B21t—10 to 32 inches; reddish brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; moderate coarse prismatic structure parting to moderate fine subangular blocky; very hard, friable; clay films on faces of peds; neutral; gradual smooth boundary.

B22t—32 to 60 inches; reddish brown (2.5YR 5/4) sandy clay loam, reddish brown (2.5YR 4/4) moist; weak coarse prismatic structure parting to weak fine subangular blocky; hard, friable; clay films on faces of peds; slightly acid; gradual smooth boundary.

B23t—60 to 80 inches; red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) moist; weak medium subangular blocky structure; hard, friable; clay films on faces of peds; slightly acid.

Solum thickness is more than 60 inches. The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 5 or 6, and chroma of 2 to 4. Where the moist value is less than 3.5, this horizon is less than 10 inches thick. Reaction is medium acid to neutral.

The B2t horizon has hue of 2.5YR or 5YR, value of 4 to 6, and chroma of 4 to 6. This horizon is sandy clay loam or loam, and reaction ranges from medium acid to neutral.

In some pedons, there is a C horizon with hue of 7.5YR or 5YR, value of 5 or 6, and chroma of 4 to 6. This horizon is loam or sandy clay loam that has strata of fine sandy loam or loamy sand. Reaction ranges from slightly acid to mildly alkaline.

Bates series

The Bates series consists of moderately deep, well drained, moderately permeable soils that formed in residuum weathered from acid sandstone. These gently sloping to sloping soils occur on uplands. Slopes are 3 to 8 percent.

Bates soils are near the Collinsville and Durant soils. Collinsville soils are in a similar position as Bates soils, but their solum is only 4 to 20 inches thick. Durant soils are in a lower position and are in the fine family.

Typical pedon of Bates fine sandy loam is in an area of Collinsville-Bates complex, 3 to 12 percent slopes, 2,000 feet east and 600 feet south of the northwest corner of sec. 4, T. 7 S., R. 6 E.

A1—0 to 7 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; slightly hard, very friable; medium acid; gradual smooth boundary.

B1—7 to 14 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable; medium acid; gradual smooth boundary.

B2t—14 to 26 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; hard, firm; continuous clay films on faces of peds; few fine black concretions; medium acid; abrupt smooth boundary.

Cr—26 to 38 inches; soft sandstone with thin beds of soft shale.

Thickness of the solum and depth to sandstone ranges from 20 to 40 inches. Fragments of sandstone less than 3 inches in diameter make up less than 15 percent, by volume, of the solum. Thickness of the mollic epipedon ranges from 8 to 16 inches.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 2 or 3. Reaction is strongly acid or medium acid.

The B1 horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. This horizon is loam or fine sandy loam. Reaction ranges from strongly acid to slightly acid.

The B2t horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 6. In some pedons, mottles in shades of red or brown are present in the lower part. This horizon is sandy clay loam or clay loam. Reaction ranges from strongly acid to slightly acid.

These soils as mapped in Marshall County are taxadjuncts to the Bates series. They differ from the Bates soils by being drier and warmer for longer periods than the Bates series. Behavior, use, and management are closely similar to those of the Bates series.

Burleson series

The Burleson series consists of deep, moderately well drained, very slowly permeable soils that formed in clayey sediments (fig. 9). These very gently sloping soils are on smooth uplands. Slopes are 1 to 3 percent.

Burleson soils are near the Durant, Ferris, Heiden, Purves, Tarrant, and Wilson soils. Durant and Wilson soils are in similar positions as Burleson soils but they have a loamy A horizon and an argillic horizon. Ferris and Heiden soils are on slopes in higher positions and have chroma of 1.5 or more in the A horizon. Purves and Tarrant soils are on ridge crests in higher positions, and they are shallow over limestone.

Typical pedon of Burleson clay, 1 to 3 percent slopes, is 2,500 feet south and 400 feet east of the northwest corner of sec. 28, T. 6 S., R. 5 E.

A11—0 to 16 inches; very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; moderate fine blocky structure; very hard, very firm; mildly alkaline; gradual wavy boundary.

A12—16 to 40 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate medium blocky structure; very hard, very firm; shiny faces on peds; common intersecting slickensides below a depth of 20 inches; mildly alkaline; gradual wavy boundary.

AC1—40 to 62 inches; dark grayish brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) moist; moderate fine blocky structure; very hard, very firm; few fine vertical streaks of dark gray material; common distinct grooved intersecting slickensides; few fine soft bodies of calcium carbonate; calcareous in seams, moderately alkaline; diffuse wavy boundary.

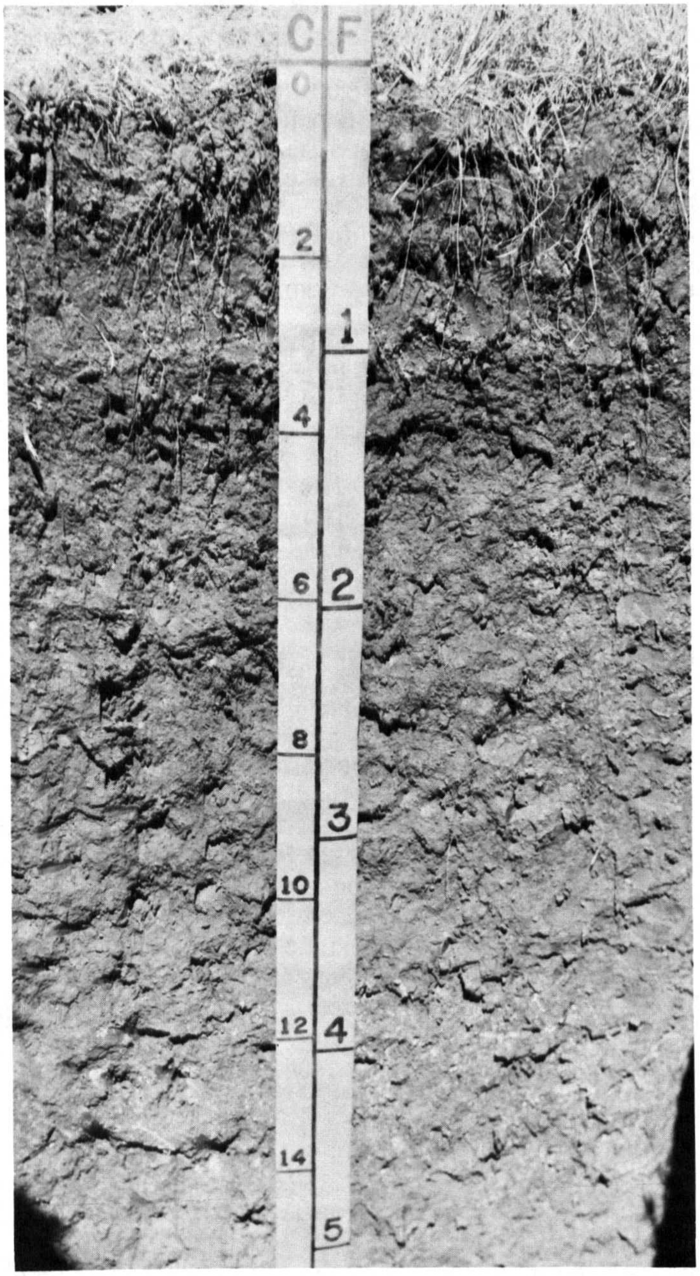


Figure 9.—Profile of Burleson clay, 1 to 3 percent slopes. Depths are shown in centimeters (C) and feet (F). Multiply the figure on the left by 10 to determine the depth in centimeters.

AC2—62 to 74 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak medium blocky structure; very hard, very firm; few fine vertical streaks of dark gray material; common fine concretions of calcium carbonate; calcareous, moderately alkaline.

Calcareous shale or limestone occurs at depths ranging from 60 to 100 inches. The A horizon and AC horizon are cyclic, and the thickness ranges from 40 to 80 inches. The thickness of the A horizon ranges from 6 inches to 48 inches but averages about 42 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of less than 1.5. Reaction ranges from slightly acid to moderately alkaline. The microdepressions are usually slightly acid.

The AC horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 1 to 3 with gray streaks and brownish or yellowish mottles in many pedons. Bodies of calcium carbonate are few to common. The AC horizon is mildly alkaline or moderately alkaline.

Collinsville series

The Collinsville series consists of shallow, well drained or somewhat excessively drained, moderately rapidly permeable soils that formed in residuum weathered from sandstone. These gently sloping to strongly sloping soils are on uplands. Slopes are 3 to 12 percent.

Collinsville soils are near the Bates and Durant soils. Bates soils, which are in a similar position as Collinsville soils, have a solum that is 20 to 40 inches thick. Durant soils are deep, have an argillic horizon, and are in a lower position on the slope.

Typical pedon of Collinsville fine sandy loam is in an area of Collinsville-Bates complex, 3 to 12 percent slopes, 800 feet west and 1,000 feet south of the northeast corner of sec. 5, T. 7 S., R. 6 E.

A1—0 to 4 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; hard, friable; medium acid; clear smooth boundary.

B—4 to 14 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; hard, friable; about 20 percent fragments of sandstone by volume; medium acid; clear smooth boundary.

R—14 to 22 inches; yellowish brown, hard, fractured sandstone.

Depth to sandstone ranges from 4 to 20 inches. Reaction of the soil ranges from strongly acid to slightly acid.

The A horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. Fragments of sandstone less than 3 inches in diameter range from 0 to 10 percent by volume.

Most pedons have a B horizon that has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 or 4. The B horizon is loam or fine sandy loam with fragments of sandstone less than 3 inches in diameter ranging from 5 to 30 percent, by volume.

Some pedons have a C horizon with colors and textures similar to those of the B horizon. This horizon lacks structure. Fragments of sandstone range from 5 to 35 percent, by volume.

These soils are taxadjuncts to the Collinsville series. They differ from the Collinsville soils by being drier and warmer for longer periods than the series. Behavior, use, and management are closely similar to those of the Collinsville series.

Counts series

The Counts series consists of deep, somewhat poorly drained, very slowly permeable soils that formed in material weathered from shales or clayey sediments. These nearly level soils are on smooth and slightly concave terraces. The Counts soils have a perched water table at a depth of 1 to 2 feet during the winter and spring months. Slopes are 0 to 1 percent.

The Counts soils are near the Bastrop, Konawa, and Teller soils. Bastrop, Konawa, and Teller soils are in higher well drained positions on the terrace than Counts soils, and they have an argillic horizon with hue redder than 10YR.

Typical pedon of Counts loam, 0 to 1 percent slopes, is 2,600 feet north and 2,000 feet west of the southeast corner of sec. 31, T. 6 S., R. 4 E.

A1—0 to 7 inches; brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak fine granular structure; slightly hard, friable; slightly acid; clear smooth boundary.

A2—7 to 12 inches; light gray (10YR 7/2) loam, light brownish gray (10YR 6/2) moist; weak fine granular structure; slightly hard, friable; medium acid; abrupt wavy boundary.

B21t—12 to 28 inches; pale brown (10YR 6/3) silty clay, brown (10YR 4/3) moist; common medium distinct yellowish brown (10YR 5/8) mottles; moderate medium blocky structure; very hard, very firm; continuous clay films on faces of peds; medium acid, gradual wavy boundary.

B22t—28 to 50 inches; pale brown (10YR 6/3) silty clay, brown (10YR 5/3) moist; many coarse distinct gray (10YR 5/1) mottles; moderate medium blocky structure; very hard, very firm; continuous clay films on faces of peds; neutral; gradual wavy boundary.

B23t—50 to 70 inches; pale brown (10YR 6/3) silty clay, brown (10YR 5/3) moist; many coarse distinct gray (5Y 5/1) and few coarse faint yellowish brown (10YR 5/8) mottles; weak coarse blocky structure; very hard, very firm; thin patchy clay films on faces of peds; mildly alkaline.

The thickness of the solum is more than 60 inches. Thickness of the A1 and A2 horizons ranges from 6 to 16 inches. Most pedons have an abrupt textural change between the A1 and A2 horizons, but in many pedons, the textural change is gradual.

The A1 horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 2 or 3. Reaction ranges from medium acid to neutral.

The A2 horizon has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 2 or 3. Reaction is medium acid or slightly acid.

The B2t horizon has hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 2 to 4. The lower part of this horizon has mottles in shades of red, brown, or gray. Reaction ranges from medium acid to mildly alkaline.

These soils as mapped in Marshall County are taxadjuncts to the Counts series. They have a B2t horizon with chroma of 2 in about 50 percent of the pedons. In addition, the A horizon is less acid. Use, behavior, and management are closely similar to those of the Counts soils.

Dougherty series

The Dougherty series consists of deep, well drained, moderately permeable soils. Dougherty soils formed in sandy and loamy sediments (fig. 10). These nearly level to very gently sloping soils are on high stream terraces. Slopes are 0 to 3 percent.

Dougherty soils are associated with Bastrop, Konawa, and Eufaula soils. Bastrop soils are on higher stream terraces than Dougherty soils and have a fine sandy loam A horizon less than 20 inches thick. Eufaula soils are on steeper slopes and are more sandy throughout. Konawa soils are in lower positions and have a fine sandy loam A horizon less than 20 inches thick.

Typical pedon of Dougherty loamy fine sand, 0 to 3 percent slopes, is 2,640 feet east and 300 feet south of the northwest corner of sec. 6, T. 8 S., R. 5 E.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; slightly acid; clear smooth boundary.

A2—8 to 28 inches; light brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 4/4) moist; single grain; slightly hard, very friable; medium acid; clear smooth boundary.

B21t—28 to 40 inches; reddish brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; moderate medium prismatic structure parting to medium subangular blocky; very hard, friable; clay films on faces of peds; medium acid; gradual smooth boundary.

B3—40 to 54 inches; reddish yellow (5YR 6/6) fine sandy loam; yellowish red (5YR 5/6) moist; weak coarse prismatic structure; hard, friable; medium acid; gradual smooth boundary.

C—54 to 72 inches; reddish yellow (5YR 6/8) loamy fine sand, yellowish red (5YR 5/8) moist; massive; slightly hard, friable; medium acid.

Solum thickness is more than 50 inches. Thickness of the A horizon ranges from 20 to 40 inches.

The Ap horizon or A1 horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4. Reaction is medium acid or slightly acid.

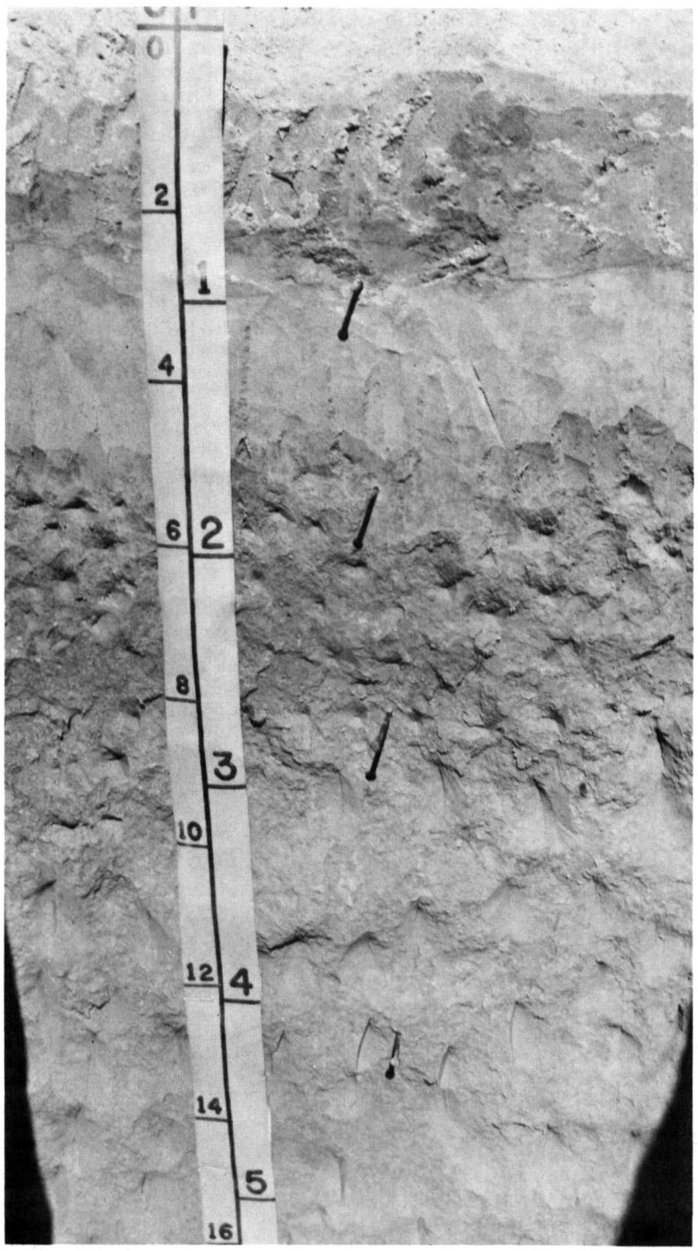


Figure 10.—Profile of Dougherty loamy fine sand, 0 to 3 percent slopes. Depths are shown in centimeters (C) and feet (F). Multiply the figure on the left by 10 to determine the depth in centimeters.

The A2 horizon has hue of 10YR or 7.5YR, value of 5 to 7, and chroma of 2 to 4. Reaction is medium acid or slightly acid.

The B horizon has hue of 2.5YR or 5YR, value of 4 to 6, and chroma of 4 to 8. It is sandy clay loam or fine sandy loam, and the clay content ranges from 18 to 30 percent. Reaction is medium acid or slightly acid.

The C horizon has the same colors as the B horizon. It is fine sandy loam or loamy fine sand, and reaction is medium acid or slightly acid.

Durant series

The Durant series consists of deep, moderately well drained, very slowly permeable soils that formed in alkaline shales or clay beds. These very gently sloping to gently sloping soils are on broad smooth uplands. Slopes are 1 to 5 percent.

Durant soils are near the Bates, Burleson, Collinsville, and Wilson soils. Bates and Collinsville soils are in higher positions than Durant soils and have formed from material weathered from sandstone. Burleson soils are on similar slopes and are clayey throughout. Wilson soils are lower and do not have a mollic epipedon.

Typical pedon of Durant loam, 1 to 3 percent slopes, 1,700 feet west and 200 feet south of the northeast corner of sec. 3, T. 6 S., R. 6 E.

A1—0 to 10 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.

B1—10 to 14 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark grayish brown (10YR 3/2) moist: moderate fine subangular blocky structure; hard, firm; medium acid; gradual smooth boundary.

B21t—14 to 28 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist: common medium distinct yellowish red (5YR 5/6) mottles; moderate medium subangular blocky structure; very hard, very firm; thin continuous clay films on faces of peds; medium acid; gradual smooth boundary.

B22t—28 to 50 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; few fine faint yellowish brown mottles; weak medium subangular blocky structure; very hard, very firm; thin continuous clay films on faces of peds; neutral; gradual smooth boundary.

B3—50 to 66 inches; light olive brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) moist; few fine faint grayish brown mottles; weak coarse blocky structure; very hard, very firm; common fine concretions of calcium carbonate and few fine black concretions; moderately alkaline.

The solum thickness ranges from 50 to more than 60 inches. The depth to concretions of calcium carbonate ranges from 30 to 50 inches.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. Reaction is medium acid or slightly acid.

The B1 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 to 4. It is clay loam, silty clay loam, or clay, and reaction ranges from strongly acid to slightly acid.

The B2t horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 or 5, and chroma of 2 to 6. It is mottled in shades of red, brown, or gray. Reaction ranges from medium acid to neutral.

The B3 horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 6. It is mottled in shades of red, brown, or gray, and reaction ranges from slightly acid to moderately alkaline.

Eufaula series

The Eufaula series consists of deep, somewhat excessively drained, rapidly permeable soils. These soils formed in material weathered from predominantly sandy sediments. These gently sloping to sloping soils are on stream terraces. Slopes are 3 to 8 percent.

Eufaula soils are associated with Dougherty and Konawa soils. Dougherty and Konawa soils are in lower positions and are in the loamy family.

Typical pedon of Eufaula loamy fine sand, 3 to 8 percent slopes, is 300 feet south and 200 feet west of the northeast corner of sec. 15, T. 8 S., R. 6 E.

A1—0 to 4 inches; grayish brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak fine granular structure; loose, very friable; slightly acid; clear wavy boundary.

A21—4 to 50 inches; pink (7.5YR 7/4) fine sand; light brown (7.5YR 6/4) moist; single grain; loose; very friable; slightly acid; clear wavy boundary.

A22&B2t—50 to 80 inches; pink (7.5YR 7/4) fine sand, light brown (7.5YR 6/4) moist; single grain; loose, with lamellae of reddish yellow (5YR 6/6) loamy fine sand, yellowish red (5YR 5/6) moist; massive; slightly hard, friable; bands are discontinuous and wavy 1/8 inch to 1 inch thick and 1 to 4 inches apart; clay films bridging sand grains (B2t); slightly acid.

The thickness of the solum is 72 to 100 inches. Thickness of the A horizon ranges from 40 to 60 inches.

The A1 horizon has hue of 10YR or 7.5YR, value of 4 to 7, and chroma of 2 to 4. Reaction is slightly acid or neutral.

The A2 horizon has hue of 10YR, 7.5YR, or 5YR, value of 6 to 8, and chroma of 2 to 4. It is fine sand or loamy fine sand, and reaction ranges from medium acid to neutral.

The B2t horizon has hue of 2.5YR, 5YR, or 7.5YR, value of 4 to 6, and chroma of 6 to 8. It is fine sandy loam or loamy fine sand, but the texture control section is predominantly loamy fine sand. Reaction is medium acid or slightly acid.

Ferris series

The Ferris series consists of deep, well drained, very slowly permeable soils. These soils formed in material weathered from shaly clay or shales under a cover of native grasses. These very gently sloping to strongly sloping soils are on uplands. Slopes are 2 to 12 percent.

Ferris soils are associated with Burleson, Heiden, Purves, and Tarrant soils. Burleson and Heiden soils are on adjacent slopes or in lower positions than Ferris soils, and they have an A horizon with value of less than 3.5 and thickness of 12 inches or more. Purves and Tarrant soils are usually on ridge crests and are shallow to limestone.

Typical pedon of Ferris clay from an area of Ferris-Tarrant complex, 5 to 12 percent slopes, is 800 feet west and 1,540 feet south of the northeast corner of sec. 16, T. 6 S., R. 6 E.

A1—0 to 8 inches; grayish brown (2.5Y 5/2) clay, very dark grayish brown (2.5Y 3/2) moist; moderate fine granular structure; very hard, firm; 1/2 inch soil mulch on surface; few fine concretions of calcium carbonate; calcareous, moderately alkaline; gradual wavy boundary.

AC1—8 to 24 inches; mottled light olive gray (5Y 6/2) and olive (5Y 5/4) clay; moderate medium blocky structure; very hard, very firm; common shiny pressure faces; few fine black concretions; few fine shells; calcareous, moderately alkaline; gradual smooth boundary.

AC2—24 to 43 inches; mottled light olive gray (5Y 6/2) and light olive brown (2.5Y 5/6) clay; moderate medium blocky structure; very hard, very firm; common medium and coarse intersecting slickensides below a depth of 30 inches; parallelepipeds have long axes tilled up to 40 percent from horizontal; many shiny pressure faces; common fine black concretions; some organic stains on faces of peds; common fine shells; calcareous, moderately alkaline; gradual smooth boundary.

C—43 to 60 inches; coarsely mottled light olive brown (2.5Y 5/6) and olive gray (5Y 5/2) shaly clay that has few fine mottles of reddish yellow; weak medium blocky structure mixed with coarse blocky rock (shale) structure; very hard, very firm; few slickensides in upper horizon; many shiny pressure faces; common fine black concretions; many fine shells; organic stains on faces of some peds; calcareous, moderately alkaline.

The depth to shale ranges from 40 to more than 60 inches. Deep and wide cracks are common during dry periods.

The A1 horizon or Ap horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 6, and chroma of 2 or 3. This horizon is less than 12 inches thick in pedons where the moist value is less than 3.5.

The AC horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 7, and chroma of 2 to 6. Some pedons lack mottles in the upper part. Concretions of calcium carbonate make up 2 to 25 percent, by volume, of this horizon.

The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7, and chroma of 2 to 8, or it is coarsely mottled in these colors. It is shaly clay or shale.

Frioton series

The Frioton series consists of deep, well drained, moderately slowly permeable soils. These soils formed in loamy and clayey alluvium (fig. 11). These nearly level soils are on flood plains. Slopes are 0 to 1 percent.

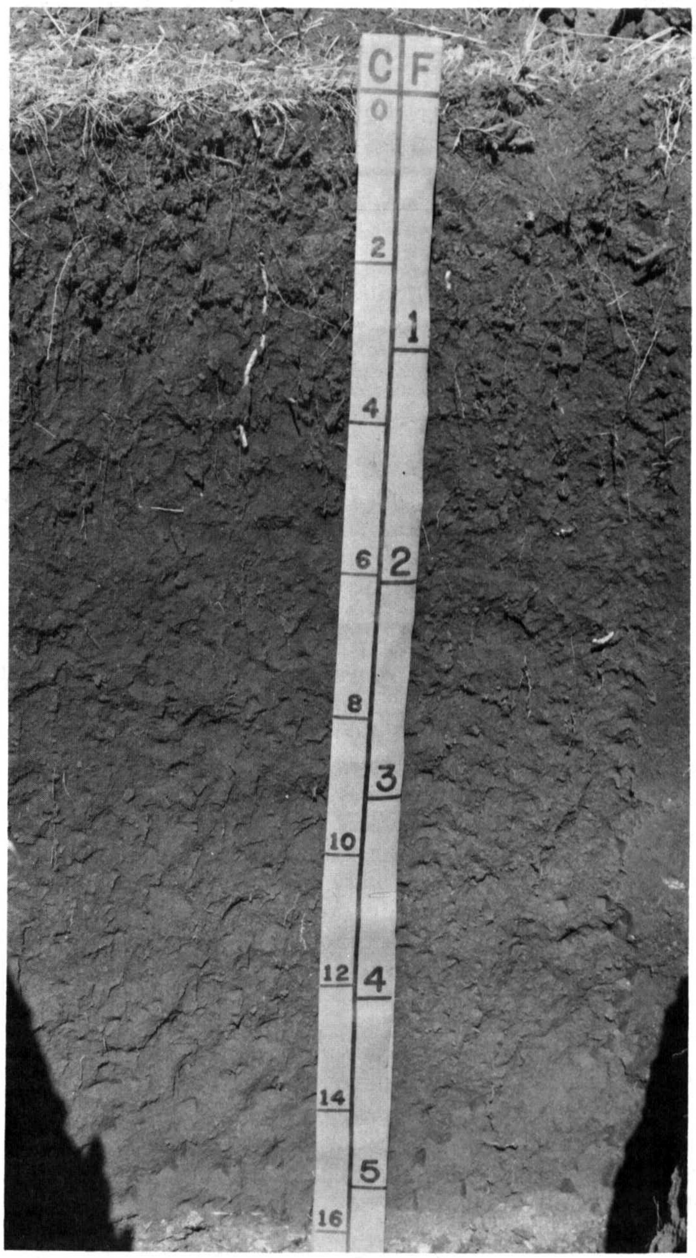


Figure 11.—Profile of Frioton silty clay loam. Depths are shown in centimeters (C) and feet (F). Multiply the figure on the left by 10 to determine the depth in centimeters.

Frioton soils are associated with Gracemont and Madill soils. Gracemont and Madill soils are on flood plains in downstream positions, and they lack a mollic epipedon.

Typical pedon of Frioton silty clay loam is 1,000 feet west and 700 feet north of the southeast corner of the northeast quarter of sec. 36, T. 5 S., R. 5 E.

A11—0 to 12 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate fine granular structure; hard, firm; calcareous, moderately alkaline; gradual smooth boundary.

A12—12 to 30 inches; very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; calcareous, moderately alkaline; gradual smooth boundary.

A13—30 to 48 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; hard, firm; calcareous, moderately alkaline; clear smooth boundary.

C—48 to 74 inches; dark grayish brown (10YR 4/2) gravelly silty clay loam; very dark grayish brown (10YR 3/2) moist; massive; hard, firm; fragments of limestone make up 15 percent by volume; calcareous, moderately alkaline.

Thickness of the mollic epipedon is more than 24 inches. The particle size control section is silty clay loam, clay loam, or gravelly clay loam and ranges from 35 to 40 percent clay. Fragments of limestone in most pedons range from 5 to 15 percent, by volume, of the solum.

The A horizon has hue of 10YR, value of 3 to 5, and chroma of 1 to 3. Reaction is moderately alkaline or mildly alkaline.

The C horizon has hue of 10YR, value of 4 to 6, and chroma of 2 or 3. Some pedons have thin strata of more loamy or clayey texture.

Gracemont series

The Gracemont series consists of deep, somewhat poorly drained, moderately or moderately rapidly permeable soils that formed in sandy and loamy alluvium. These nearly level soils are on flood plains. They have an apparent water table at a depth of 1/2 foot to 3 feet during the winter and spring months. Slopes are 0 to 1 percent.

Gracemont soils are associated with Frioton and Madill soils. Frioton soils are in higher positions than Gracemont soils and in the fine family. Madill soils are higher, are well drained, and do not have free carbonates in the A horizon.

Typical pedon of Gracemont fine sandy loam is 800 feet east and 300 feet north of the southwest corner of sec. 11, T. 6 S., R. 3 E.

A1—0 to 16 inches; light brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 5/4) moist; weak fine granular structure; slightly hard, very friable; calcareous, moderately alkaline; gradual smooth boundary.

C1—16 to 44 inches; light brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 5/4) moist; massive; slightly hard, very friable; few thin strata of finer and coarser materials; water table at 24 inches; calcareous, moderately alkaline; clear smooth boundary.

C2—44 to 66 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) moist; massive; hard, firm; common thin strata of coarser and finer materials; calcareous, moderately alkaline.

The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 to 6, and chroma of 2 to 6. Where moist value and chroma are 3.5 or less, this horizon is less than 10 inches thick. Reaction is moderately alkaline, and the soil calcareous. In some pedons reaction ranges from neutral to moderately alkaline in the upper 10 inches.

The C horizon has hue of 5YR or 7.5YR, value of 4 to 6, and chroma of 4 to 8. It has strata of loamy fine sand, fine sandy loam, or clay loam.

Heiden series

The Heiden series consists of deep, well drained, very slowly permeable soils that formed in shaly clay (fig. 12). These very gently sloping to gently sloping soils are on uplands. Slopes are 2 to 5 percent.

Heiden soils are near Burleson, Ferris, Purves, and Tarrant soils. Burleson soils are on slopes adjacent to Heiden soils in less sloping areas, and they have an A horizon more than 12 inches thick and a chroma of 1.5 or less. Ferris soils are on adjacent or steeper slopes, and the A horizon is less than 12 inches thick where the moist value is less than 3.5. Purves and Tarrant soils are on ridge crests and are shallow to limestone bedrock.

Typical pedon of Heiden clay, 2 to 5 percent slopes, 800 feet east and 1,320 feet north of the southwest corner of sec. 10, T. 6 S., R. 6 E.

A11—0 to 8 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate fine blocky structure; very hard, very firm; shiny surfaces on faces of peds; calcareous, moderately alkaline; gradual wavy boundary.

A12—8 to 20 inches; grayish brown (10YR 5/2) clay, very dark grayish brown (10YR 3/2) moist; moderate fine blocky structure; common intersecting slickensides; tilted parallelepipeds; very hard, very firm; common fine concretions of calcium carbonate; calcareous, moderately alkaline; diffuse wavy boundary.

AC1—20 to 36 inches; light yellowish brown (2.5Y 6/4) clay, light olive brown (2.5Y 5/4) moist; moderate medium blocky structure; common intersecting slickensides; tilted parallelepipeds; very hard, very firm; many fine concretions of calcium carbonate; calcareous, moderately alkaline; gradual smooth boundary.

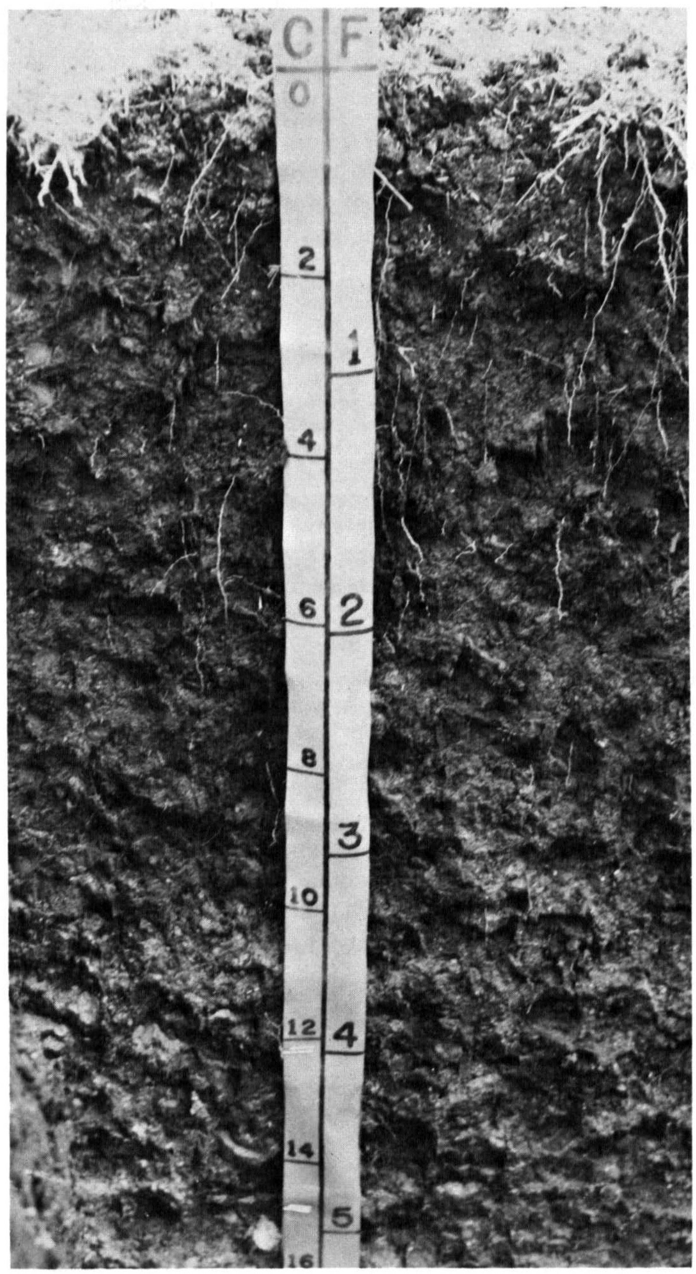


Figure 12.—Profile of Heiden clay, 2 to 5 percent slopes. Depths are shown in centimeters (C) and feet (F). Multiply the figure on the left by 10 to determine the depth in centimeters.

AC2—36 to 54 inches; light gray (2.5Y 7/2) clay, light brownish gray (2.5Y 6/2) moist; weak coarse blocky structure; common intersecting slickensides; very hard, very firm; common fine concretions of calcium carbonate; calcareous, moderately alkaline; gradual wavy boundary.

C—54 to 65 inches; coarsely mottled light brownish gray (2.5Y 6/2) and olive yellow (2.5Y 6/6) shaly clay; massive; very hard, very firm; calcareous, moderately alkaline.

The combined thickness of the A and AC horizons ranges from about 40 to 60 inches. The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5, and chroma of 1 to 3. Where the chroma is less than 1.5, this horizon is less than 12 inches thick.

The AC horizon has hue of 10YR, 2.5Y, or 5Y, value of 5 to 7, and chroma of 2 to 4.

The C horizon has hue of 2.5Y or 5Y, value of 5 to 7, and chroma of 2 to 6.

Konawa series

The Konawa series consists of deep, well drained, moderately permeable soils that formed in loamy and sandy sediments. These very gently sloping to sloping soils are on high stream terraces. Slopes are 1 to 6 percent.

Konawa soils are associated with Bastrop, Counts, Dougherty, Eufaula, and Teller soils. Bastrop soils are on slightly higher positions than Konawa soils and do not decrease in clay content in the lower subsoil. Counts soils are in slightly concave areas and are in the fine family. Dougherty and Eufaula soils are on higher positions. Dougherty soils are arenic, and Eufaula soils are psammentic. Teller soils are in slightly lower positions, and they have a mollic epipedon.

Typical pedon of Konawa fine sandy loam, 1 to 3 percent slopes, 1,320 feet west and 800 feet north of the southeast corner of sec. 15, T. 8 S., R. 5 E.

Ap—0 to 12 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; slightly hard, very friable; slightly acid; clear smooth boundary.

B21t—12 to 30 inches; reddish brown (2.5YR 5/4) sandy clay loam, reddish brown (2.5YR 4/4) moist; moderate coarse prismatic structure parting to weak medium subangular blocky; very hard, firm; clay films on faces of peds; medium acid; gradual smooth boundary.

B22t—30 to 44 inches; reddish brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; weak coarse prismatic structure; hard, firm; clay films on faces of peds; medium acid; gradual smooth boundary.

B3—44 to 62 inches; yellowish red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; weak coarse prismatic structure; hard, firm; medium acid; gradual smooth boundary.

C—62 to 80 inches; reddish yellow (5YR 6/6) fine sandy loam, yellowish red (5YR 5/6) moist; weak coarse prismatic structure; hard, friable; medium acid.

Solum thickness is more than 50 inches. Thickness of the A horizon is less than 20 inches.

The A horizon has hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 2 to 4. Unless limed, this horizon ranges from strongly acid to slightly acid.

Many pedons have an A2 horizon with hue of 5YR, 7.5YR, or 10YR, value of 5 to 7, and chroma of 2 to 4. Reaction ranges from strongly acid to slightly acid.

The B2t horizon has hue of 2.5YR or 5YR, value of 4 to 6, and chroma of 4 to 6. It is sandy clay loam or fine sandy loam, and reaction is strongly acid or medium acid.

The B3 horizon has hue of 2.5YR or 5YR, value of 4 to 6, and chroma of 4 to 8. It is fine sandy loam or sandy clay loam, and reaction is slightly acid or medium acid.

The C horizon has hue of 2.5YR or 5YR, value of 4 to 7, and chroma of 4 to 8. It is fine sandy loam or loamy fine sand, and reaction is medium acid or slightly acid.

Konsil series

The Konsil series consists of deep, well drained, moderately permeable soils that formed in loamy sediments. These very gently sloping to moderately steep soils are on uplands. Slopes range from 1 to 15 percent.

Konsil soils are associated with Bastrop soils. Bastrop soils are lower on stream terraces and have a higher base saturation than Konsil soils.

Typical pedon of Konsil fine sandy loam, 3 to 5 percent slopes, 1,000 feet west and 500 feet south of the northeast corner of sec. 32, T. 4 S., R. 4 E.

A1—0 to 9 inches; reddish gray (5YR 5/2) fine sandy loam, dark reddish gray (5YR 4/2) moist; weak fine granular structure; slightly hard, very friable; slightly acid; gradual smooth boundary.

A2—9 to 14 inches; pinkish gray (5YR 6/2) fine sandy loam, reddish gray (5YR 5/2) moist; weak fine granular structure; slightly hard, very friable; medium acid; clear smooth boundary.

B21t—14 to 32 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure; very hard, firm; medium acid; gradual smooth boundary.

B22t—32 to 48 inches; reddish yellow (5YR 6/6) sandy clay loam, yellowish red (5YR 5/6) moist; few medium red (2.5YR 4/6) mottles; medium coarse prismatic structure breaking to moderate medium blocky; very hard, firm; medium acid; gradual smooth boundary.

B23t—48 to 70 inches; reddish yellow (5YR 6/6) sandy clay loam, yellowish red (5YR 5/6) moist; common medium distinct red (2.5YR 5/8) mottles; moderate coarse prismatic structure breaking to moderate medium blocky; very hard, very firm; medium acid.

The thickness of the solum is more than 60 inches. Thickness of the A horizon ranges from 4 to 15 inches.

The A1 or Ap horizon has hue of 10YR, 7.5YR, or 5YR, value of 5 or 6, and chroma of 2 to 4. Unless limed, this horizon is slightly acid or medium acid. The A2 horizon is 1 or 2 units of value higher than the A1 and usually slightly more acid.

The B2t horizon has hue of 5YR or 2.5YR, value of 5 or 6, and chroma of 4 to 6. In the lower part, in some pedons, this horizon has hue of 7.5YR or 10YR and has mottles in shades of red, brown, or gray. Reaction is strongly acid or medium acid.

Madill series

The Madill series consists of deep, well drained, moderately rapidly permeable soils that formed in loamy and sandy alluvium. These nearly level soils are on narrow flood plains. Slopes are 0 to 1 percent.

Madill soils are associated with Frioton soils. Frioton soils are on flood plains in upstream positions and have a mollic epipedon.

Typical pedon of Madill fine sandy loam is 1,000 feet north and 50 feet west of the southeast corner of sec. 7, T. 6 S., R. 4 E.

A1—0 to 4 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; weak fine granular structure; soft, friable; organic stains in some root channels; slightly acid; smooth boundary.

C1—4 to 30 inches; pale brown (10YR 6/3) fine sandy loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable; few thin strata of dark yellowish brown (10YR 4/4) loam; organic stains in pores; slightly acid; clear smooth boundary.

C2—30 to 48 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; massive; slightly hard, friable; medium acid; clear smooth boundary.

C3—48 to 68 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; massive; hard, friable; medium acid.

Buried soils are in some pedons at depths below 40 inches.

The A horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. Reaction is medium acid or slightly acid.

The C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4. It is loam or fine sandy loam, and in some pedons it is stratified with loamy fine sand below a depth of 40 inches. Reaction ranges from medium acid to neutral above a depth of 40 inches and from medium acid to moderately alkaline below 40 inches.

Purves series

The Purves series consists of shallow, well drained, moderately slowly permeable soils that formed in residuum weathered from limestone. These very gently sloping to gently sloping soils are usually on ridge crests, but some areas are just above drainageways, on uplands. Slopes are 2 to 5 percent.

Purves soils are associated with Burleson, Ferris, Heiden, and Tarrant soils. Burleson, Ferris, and Heiden soils are usually in lower positions than Purves soils and are deep soils. Tarrant soils are in similar positions, but they are clayey skeletal.

Typical pedon of Purves clay, 2 to 5 percent slopes, is 2,600 feet west and 1,200 feet north of the southeast corner of sec. 14, T. 5 S., R. 5 E.

A11—0 to 10 inches; very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; strong coarse granular structure; very hard, very firm; about 5 percent by volume of fragments of limestone less than 10 inches in diameter; calcareous, moderately alkaline; gradual smooth boundary.

A12ca—10 to 16 inches; dark gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; strong coarse granular and very fine subangular blocky structure; very hard, very firm; about 15 percent by volume of fragments of limestone less than 10 inches in diameter, fragments have coating of secondary calcium carbonate on lower side; few fine concretions of calcium carbonate; calcareous, moderately alkaline; abrupt smooth boundary.

R—16 to 24 inches; hard, fractured limestone.

Solum thickness ranges from 8 to 20 inches. The A11 horizon has hue of 10YR, value of 3 to 5, and chroma of 1 to 3. Fragments of limestone range from 0 to 10 percent, by volume, of this horizon.

The A12ca horizon has the same colors as the A11 horizon. It is silty clay loam or clay. Fragments of limestone less than 10 inches in diameter range from 0 to 35 percent, by volume, of this horizon.

Tarrant series

The Tarrant series consists of shallow, well drained, moderately slowly permeable soils that formed in residuum weathered from limestone. These very gently sloping to moderately steep soils are on ridge crests of uplands. Slopes are 2 to 15 percent.

Tarrant soils are near the Burleson, Ferris, Heiden, and Purves soils. Burleson, Ferris, and Heiden soils are in lower positions than Tarrant soils and are deep, clayey soils. Purves soils are in similar positions and have less than 35 percent limestone fragments in the control section.

Typical pedon of Tarrant cobbly clay, 2 to 15 percent slopes, is 3,000 feet north and 500 feet east of the southwest corner of sec. 2, T. 6 S., R. 5 E.

A11—0 to 6 inches; very dark grayish brown (10YR 3/2) cobbly clay, very dark brown (10YR 2/2) moist; strong medium granular structure; very hard, firm;

about 35 percent fragments of limestone by volume; calcareous, moderately alkaline; clear wavy boundary.

A12ca—6 to 11 inches; dark brown (10YR 3/3) cobbly clay, very dark brown (10YR 2/2) moist; moderate medium granular structure; very hard, firm; about 45 percent fragments of limestone by volume; coatings of calcium carbonate on underside of most cobbles; calcareous, moderately alkaline; abrupt wavy boundary.

R—11 to 22 inches; hard, fractured limestone.

The solum thickness and depth to bedrock range from 6 to 20 inches. The A horizon has hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 to 3. Many pedons have chroma of 1 in the upper 6 inches. This horizon is cobbly or stony silty clay or clay in the lower part. The amount of coarse fragments ranges from 35 to 80 percent, by volume, with fragments larger than 3 inches in diameter ranging from 25 to 40 percent, by volume.

These Tarrant soils as mapped in Marshall County are taxadjuncts to the Tarrant series. They differ by being moist for longer periods, and in about 40 percent of the pedons, the color in the upper part of the A horizon has chroma of 1. Use, behavior, and management are closely similar to those of the Tarrant series.

Teller series

The Teller series consists of deep, well drained, moderately permeable soils that formed in loamy sediments. These nearly level soils are on stream terraces. Slopes are 0 to 1 percent.

Teller soils are associated with Bastrop, Counts, and Konawa soils. Bastrop, Counts, and Konawa soils lack a mollic epipedon. Bastrop soils are on higher terraces than Teller soils and have an argillic horizon that does not, at a depth of 60 inches, decrease in clay by more than 20 percent from the maximum. Counts soils are in lower concave positions, are more clayey, and have a high, perched water table part of the year. Konawa soils are in slightly higher positions.

Typical pedon of Teller fine sandy loam, 0 to 1 percent slopes, is 1,320 feet south and 50 feet east of the northwest corner of sec. 11, T. 8 S., R. 4 E.

A1—0 to 16 inches; dark reddish gray (5YR 4/2) fine sandy loam, dark reddish brown (5YR 3/2) moist; weak fine granular structure; slightly hard, very friable; slightly acid; gradual smooth boundary.

B1—16 to 24 inches; reddish brown (5YR 5/3) fine sandy loam, reddish brown (5YR 4/3) moist; moderate medium granular and moderate medium subangular blocky structure; hard, friable; slightly acid; gradual smooth boundary.

B21t—24 to 40 inches; reddish brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; medium coarse prismatic structure parting to moderate medium subangular blocky; hard, firm; patchy clay films on faces of peds; slightly acid; gradual smooth boundary.

B22t—40 to 58 inches; reddish brown (5YR 5/4) sandy clay loam, dark reddish brown (5YR 4/4) moist; medium coarse prismatic structure parting to moderate medium subangular blocky; hard, firm; patchy clay films on faces of peds; slightly acid; clear smooth boundary.

B3—58 to 80 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; massive; slightly hard, very friable; slightly acid.

Thickness of the solum ranges from 60 inches to more than 70 inches. Thickness of the A horizon ranges from 12 to 20 inches.

The A horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 or 5, and chroma of 2 or 3. Reaction is medium acid or slightly acid.

The B1 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 2 to 4. It is fine sandy loam, loam, or very fine sandy loam, and reaction is medium acid or slightly acid.

The B2t horizon has hue of 2.5YR or 5YR, value of 4 or 5, and chroma of 4 to 6. It is sandy clay loam or clay loam and ranges from 20 to 30 percent clay. Reaction is medium acid or slightly acid.

The B3 horizon has hue of 2.5YR, 5YR, or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It is loam, very fine sandy loam, or fine sandy loam, and reaction is medium acid or slightly acid.

Some pedons have a C horizon that is similar in color to the B3 horizon. It is fine sandy loam or very fine sandy loam, and reaction is slightly acid or neutral.

Wilson series

The Wilson series consists of deep, somewhat poorly drained, very slowly permeable soils that formed in materials weathered from predominantly clayey sediments. These nearly level soils are on smooth uplands. A perched water table is at a depth of 1 foot or less during the winter and spring months. The slopes are 0 to 1 percent.

Wilson soils are associated with Durant and Burleson soils. Durant soils are in higher positions than Wilson soils and have a mollic epipedon. Burleson soils are in higher positions and are clayey throughout the profile.

Typical pedon of Wilson loam, 0 to 1 percent slopes, is 1,200 feet north and 1,900 feet east of the southwest corner of sec. 20, T. 5 S., R. 7 E.

Ap—0 to 6 inches; grayish brown (10YR 5/2) loam; very dark grayish brown (10YR 3/2) moist; massive; very hard, friable; medium acid; abrupt wavy boundary.

B21tg—6 to 14 inches; gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; weak coarse blocky structure;

extremely hard, very firm; clay films on faces of peds; few fine black concretions; grayish brown loam coatings on the vertical faces of some peds; medium acid; gradual wavy boundary.

B22tg—14 to 36 inches; gray (10YR 6/1) clay, gray (10YR 5/1) moist; few fine faint brown mottles; moderate medium blocky structure; extremely hard, very firm; clay films on faces of peds; few fine black concretions; grayish brown loam coatings on the vertical faces of some peds; neutral; gradual wavy boundary.

B3g—36 to 70 inches; light gray (10YR 7/1) clay, gray (10YR 6/1) moist; weak coarse blocky structure; extremely hard, very firm; clay films on faces of peds; few fine concretions of calcium carbonate and few fine black concretions; moderately alkaline.

Thickness of the solum is more than 60 inches. Thickness of the A horizon is 10 inches or less in most pedons but ranges to 15 inches in slightly concave areas.

The Ap or A1 horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 or 2. Reaction ranges from medium acid to neutral.

Some pedons have a light gray loam A2 horizon about 1 inch thick. Reaction is medium acid to neutral.

The B21tg horizon has hue of 10YR, value of 4 or 5, and chroma of 1. It is clay or silty clay, and reaction ranges from medium acid to neutral.

The B22tg horizon or B3g horizon has hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 1 or 2. Reaction is neutral to moderately alkaline. In some pedons this horizon has crystals of gypsum.

Formation of the soils

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineral composition of the parent material and the tilt of the bedrock; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the parent material. Few generalizations can be made regarding the effects of any one factor because the effects of each are modified by the other four.

Parent material

Parent material is one of the most influential factors of soil formation in the county. It sets the limits of the chemical and mineral composition of the soil, and it influences the rate of soil development. Parent material is the unconsolidated material from which soil is formed.

Marshall County has several kinds of parent material, each of which produces a different kind of soil. Soils that formed in material weathered from shale, such as Ferris soils, have a clayey subsoil. Those that formed in material weathered from sandstone, such as Bates soils, have a loamy subsoil. Soils that formed in material weathered from limestone, such as Purves soils, have an adequate supply of bases. Examples of soils that formed in clayey, loamy, or sandy sediments are Burleson, Bastrop, and Eufaula soils.

Climate

The moist, subhumid continental climate of Marshall County is characterized by high-intensity rainfall. Moisture and warm temperatures have promoted the formation of distinct horizons in many of the soils. Differences in soils, however, cannot be attributed to climate because the climate is uniform throughout the county. Heavy rains have caused rapid runoff that has eroded many of the soils. This erosion is an indirect effect of climate.

Plants and animals

Plants, burrowing animals, insects, and soil micro-organisms have a direct influence on the formation of soil. Native vegetation, such as trees or grasses, or both, has a bearing on the amount of organic matter and on the amounts and kinds of plant nutrients in the soil and on the type of soil structure and soil consistence. Durant and Burleson soils, for example, formed under native grasses. The fibrous roots of these native grasses promote good granular structure that is high in organic matter content. This type of vegetation reduces loss of soil nutrients by the recycling and feeding abilities of the deep grass roots. Consequently, the soils that formed under grass in Marshall County tend to have more bases and organic matter than the soils that formed under trees. Dougherty and Konsil soils, which formed under trees, are lower in plant nutrients and organic matter content than soils that formed under grass.

During the past century, man has altered this soil-forming process by removing the native vegetation over much of the county. Lack of adequate conservation measures has resulted in much soil loss through sheet and gully erosion. Where some of the surface layer has been removed and gullies have formed, eroded phases of soils are mapped. An example is Konsil fine sandy loam, 1 to 5 percent slopes, gullied.

Relief

Relief affects soil formation through its influence on moisture, drainage, erosion, temperature, and plant cover. The relief of Marshall County is determined largely by the resistance of underlying parent material to weathering and geological erosion.

The effects of relief on soil formation are illustrated by two different soils, Burleson and Tarrant soils. Burleson soils generally are in areas of less sloping relief. Surface runoff is less, and more water percolates through these soils to influence the loss, gain, or transfer of soil constituents. Tarrant soils typically are in areas of more sloping relief and have a less clearly defined profile than Burleson soils. On the more sloping soils, much rainwater runs off instead of moving through the soil to help in the formation of a deeper solum.

Time

Time as a factor cannot be measured strictly in years. The length of time needed for the development of genetic horizons depends on the intensity and intersections of the soil-forming factors in promoting the loss, gain, transfer, or transformation of soil constituents that are necessary to form soil horizons. Soils that do not have definite horizons are young or immature. Mature soils have approached equilibrium with their environment and tend to have a well defined horizon of clay accumulation.

The soils of Marshall County range from young to old. Some of the mature soils are those of the Durant and Wilson series on uplands. Dougherty and Konawa soils are younger; they have clearly defined horizons. Tarrant soils are young soils; they have had sufficient time to develop clearly defined horizons, but because they are sloping, geological erosion has taken away soil material almost as fast as it has formed. Madill and Frioton soils on flood plains have been developing for such a short time that they show little horizon development.

Active processes of soil formation

Active processes that have influenced the formation of horizons in the soils of Marshall County are accumulation of organic matter, leaching of calcium carbonates and bases, and translocation of silicate clay minerals. In most soils, more than one of these processes have been active in the development of horizons.

The addition of organic matter to the surface layer by native grasses has contributed to the granular structure. The surface layer is high in content of organic matter in soils such as Durant soils and is called a mollic epipedon in the soil classification system. Konsil soils formed under trees and contain less organic matter than Durant soils; their surface layer is called an ochric epipedon in the classification system.

Leaching of carbonates and bases is active in the formation of soils. The accumulation of calcium carbonates and bases in the lower part of the B horizon of Durant soils indicates the depth to which water has percolated. Konsil soils have been leached to the extent that they lack accumulation of calcium carbonates. More bases have been leached from the B horizon of these soils, and this is reflected by their base saturation. Soils on flood plains, such as Frioton soils, are recharged with bases when flooding occurs. The more acid Madill soils have not been leached, but they receive sediments from neutral to acid soils. Ferris soils formed over weathered shale beds and clayey sediments and are high in carbonates. Calcium carbonates in Ferris soils are related to the nature of the parent materials.

The translocation of silicate clay minerals is a very important factor in establishing the properties and classification of soils. Clay films on ped surfaces, bridging sand grains, and increases in total clay are used in the field as evidence of argillic horizons. Many soils, including Durant and Konsil soils, have an argillic horizon. The varying degrees of translocation of silicate clay minerals and the kind of parent material in which a soil formed have resulted in wide variations in the texture and other properties of the argillic horizon in different soils. Dougherty and Konsil soils have a subsurface layer that is more intensely leached of silicate clay minerals than the surface layer of other soils in the county.

Grasses bring bases to the surface, and this retards leaching and the formation of an A2 horizon. Geological erosion on soils such as Tarrant soils hinders horizon development through soil losses. The sediment on Madill and Gracemont soils and other soils on flood plains was deposited so recently that there has not been enough time for the formation of horizons.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Medium	6 to 9
High	9 to 12
Very high	More than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Broad-base terrace. A ridge-type terrace built to control erosion by diverting runoff along the contour at a nonscouring velocity. The terrace is 10 to 20 inches high and 15 to 30 feet wide and has gently sloping sides, a rounded crown, and a dish-shaped channel along the upper side. It may be nearly level or have a grade toward one or both ends.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms. The Lco horizon is a limnic layer that contains many fecal pellets.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Depth to rock. Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Fragile (in tables). Soil material that is easily damaged by use or disturbance.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gilgai. Commonly a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of Vertisols—clayey soils having a high coefficient of expansion and contraction with changes in moisture content.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip.—Water is applied slowly and under low pressure through such applicators as orifices, emitters, porous tubing, or perforated pipe on the surface of or in the soil.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous areas. Areas that have little or no natural soil and support little or no vegetation.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Open space. A relatively undeveloped green or wooded area provided mainly within an urban area to minimize feelings of congested living.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management, for example, differences in slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Saprolite (geology). Soft, earthy, clay-rich, thoroughly decomposed rock formed in place by chemical weathering of igneous and metamorphic rock. In soil science, saprolite is any unconsolidated residual material underlying the soil and grading to hard bedrock below.

Salty water (in tables.) Water that is too salty for consumption by livestock.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio. The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	Less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the low lands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded 1951-74, Tishomingo, Okla.]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	53.5	28.9	41.2	79	5	17	1.48	.52	2.25	3	1.5
February---	59.0	32.8	45.9	81	10	45	2.03	.68	3.10	4	1.1
March------	66.1	40.3	53.2	89	17	192	2.94	1.16	4.37	5	.2
April------	75.6	51.0	63.3	91	28	399	4.78	2.43	6.70	6	0
May--------	82.4	59.3	70.9	94	38	648	4.65	2.24	6.62	7	0
June-------	90.0	67.6	78.8	101	50	864	3.76	1.66	5.47	5	0
July-------	95.2	71.0	83.1	105	56	1,026	2.62	.82	4.06	4	0
August-----	95.2	69.3	82.3	106	55	1,001	2.49	.90	3.76	4	0
September--	87.6	62.7	75.2	101	42	756	5.08	1.87	7.73	5	0
October----	77.8	51.3	64.6	94	29	453	3.91	.81	6.38	4	0
November---	65.0	39.8	52.5	83	18	136	2.65	.81	4.12	3	0
December---	55.9	31.6	43.8	79	9	34	2.20	.95	3.21	4	.3
Year-------	75.3	50.5	62.9	107	3	5,571	38.59	28.82	47.74	54	3.1

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded 1951-74, Tishomingo, Okla.]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	March 29	April 7	April 20
2 years in 10 later than--	March 23	April 2	April 14
5 years in 10 later than--	March 12	March 21	April 3
First freezing temperature in fall:			
1 year in 10 earlier than--	November 3	October 26	October 20
2 years in 10 earlier than--	November 10	October 30	October 24
5 years in 10 earlier than--	November 22	November 9	October 31

TABLE 3.--GROWING SEASON

[Recorded 1951-74, Tishomingo, Okla.]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	227	206	189
8 years in 10	237	215	196
5 years in 10	254	232	210
2 years in 10	272	249	223
1 year in 10	281	258	230

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1	Bastrop fine sandy loam, 0 to 1 percent slopes	2,200	0.8
2	Bastrop fine sandy loam, 1 to 3 percent slopes	3,910	1.5
3	Burleson clay, 1 to 3 percent slopes	8,710	3.2
4	Collinsville-Bates complex, 3 to 12 percent slopes	2,830	1.1
5	Counts loam, 0 to 1 percent slopes	1,020	0.4
6	Dougherty loamy fine sand, 0 to 3 percent slopes	7,210	2.7
7	Durant loam, 1 to 3 percent slopes	10,060	3.7
8	Durant clay loam, 1 to 5 percent slopes, eroded	8,990	3.3
9	Eufaula loamy fine sand, 3 to 8 percent slopes	1,300	0.5
10	Ferris clay, 2 to 5 percent slopes, eroded	16,810	6.2
11	Ferris clay, 2 to 5 percent slopes, severely eroded	1,450	0.5
12	Ferris-Tarrant complex, 5 to 12 percent slopes	13,880	5.2
13	Frioton silty clay loam	5,200	1.9
14	Gracemont fine sandy loam	1,930	0.7
15	Heiden clay, 2 to 5 percent slopes	7,920	2.9
16	Heiden stony clay, 2 to 5 percent slopes	8,150	3.0
17	Konawa fine sandy loam, 1 to 3 percent slopes	1,350	0.5
18	Konawa fine sandy loam, 1 to 5 percent slopes, eroded	6,160	2.3
19	Konawa fine sandy loam, 2 to 6 percent slopes, gullied	6,850	2.5
20	Konsil fine sandy loam, 1 to 3 percent slopes	1,290	0.5
21	Konsil fine sandy loam, 1 to 5 percent slopes, eroded	15,220	5.6
22	Konsil fine sandy loam, 1 to 5 percent slopes, gullied	12,610	4.7
23	Konsil fine sandy loam, 3 to 5 percent slopes	7,620	2.8
24	Konsil fine sandy loam, 8 to 15 percent slopes	22,630	8.4
25	Madill fine sandy loam	4,410	1.6
26	Purves clay, 2 to 5 percent slopes	21,640	8.0
27	Tarrant cobbly clay, 2 to 15 percent slopes	24,720	9.2
28	Teller fine sandy loam, 0 to 1 percent slopes	590	0.2
29	Wilson loam, 0 to 1 percent slopes	1,870	0.7
	Water	40,910	15.2
	Total	269,440	100.0

TABLE 5.--GRAZING YIELDS

[Grazing yields per acre (AUM[1]) of crops and pasture. All yields were estimated for a high level of management. Absence of a yield figure indicates the crop or grass is seldom grown or is not suited]

Soil name and map symbol	Improved bermuda-grass	Improved bermuda-grass and tall fescue combination	Tall fescue	King Ranch bluestem	Lovegrass	Sudan-grass	Wheat grazeout	Rye and ryegrass grazeout	Switch-grass
	AUM[1]	AUM	AUM	AUM	AUM	AUM	AUM	AUM	AUM
1-----Bastrop	7.0	6.5	5.5	7.5	7.5	4.0	4.7	5.1	2.5
2-----Bastrop	7.0	6.0	5.0	7.0	7.0	3.8	4.4	4.8	2.3
3-----Burleson	6.5	6.5	6.0	6.5	5.5	3.4	4.3	4.8	2.0
4-----Collinsville	3.5	---	---	3.5	---	---	---	---	---
5-----Counts	6.5	6.5	6.0	6.5	---	3.2	4.0	4.2	3.0
6-----Dougherty	5.5	---	---	---	6.5	3.0	3.2	3.7	2.0
7-----Durant	6.0	---	---	6.0	6.0	3.4	4.0	4.2	1.9
8-----Durant	5.5	---	---	5.5	5.5	2.5	3.8	4.0	1.7
9-----Eufaula	4.0	---	---	---	5.0	---	---	---	---
10-----Ferris	4.5	4.5	4.0	4.5	---	---	3.6	3.8	1.5
11-----Ferris	3.5	---	---	3.5	---	---	---	---	---
12-----Ferris-Tarrant	4.0	---	---	4.0	---	---	---	---	---
13-----Frioton	7.5	---	7.0	7.0	---	4.0	4.5	4.8	2.9
14-----Gracemont	8.0	8.0	7.5	---	---	---	---	---	2.9
15-----Heiden	5.5	5.0	4.5	5.5	---	3.0	3.8	4.1	1.9
16-----Heiden	4.0	---	---	4.5	---	---	---	---	---
17-----Konowa	7.0	6.5	5.5	7.0	7.5	3.8	4.6	5.1	2.3
18-----Konowa	6.5	6.0	5.0	6.5	7.0	3.6	4.3	4.8	1.9
19-----Konowa	6.0	---	---	6.0	6.5	2.6	3.6	4.1	1.8
20-----Konsil	7.5	6.5	5.5	7.5	7.5	3.8	4.0	4.4	2.3
21-----Konsil	6.0	---	---	6.0	7.0	---	---	---	---

See footnotes at end of table.

TABLE 5.--GRAZING YIELDS--Continued

Soil name and map symbol	Improved bermuda-grass	Improved bermuda-grass and tall fescue combination	Tall fescue	King Ranch bluestem	Lovegrass	Sudan-grass	Wheat grazeout	Rye and ryegrass grazeout	Switch-grass
	AUM[1]	AUM	AUM	AUM	AUM	AUM	AUM	AUM	AUM
22: Konsil	5.0	---	---	6.0	6.0	2.1	---	3.8	---
23: Konsil	7.0	6.0	5.0	7.0	7.5	2.6	3.8	4.2	2.1
24: Konsil	4.0	---	---	4.5	3.5	---	---	---	---
25: Madill	7.5	7.0	6.5	---	---	4.0	5.0	5.5	3.0
26: Purves	3.5	---	---	4.0	---	2.8	3.4	3.6	1.5
27: Tarrant	---	---	---	3.5	---	---	---	---	---
28: Teller	7.5	6.5	5.5	7.5	7.5	3.8	4.7	5.2	2.5
29: Wilson	5.5	---	6.0	---	---	2.4	3.0	3.4	1.6

[1]AUM (animal-unit-month) is a term used to express the amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, five goats) for a period of 30 days.

TABLE 6.--YIELDS PER ACRE OF CROPS

[Yields are those that can be expected under a high level of management. Absence of a soil or yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Map symbol and soil name	Wheat	Grain sorghum	Peanuts	Soybeans	Alfalfa hay
	Bu	Bu	Lb	Bu	Ton
1 Bastrop	---	70	1,250	---	---
2 Bastrop	---	55	1,200	---	---
3 Burleson	30	65	---	25	---
4 Collinsville-Bates	---	---	---	---	---
5 Counts	30	50	1,000	25	---
6 Dougherty	20	30	1,300	---	---
7 Durant	35	50	1,200	28	---
8 Durant	---	40	1,000	20	---
9 Eufaula	---	---	---	---	---
10 Ferris	22	35	---	---	---
11 Ferris	---	---	---	---	---
12 Ferris-Tarrant	---	---	---	---	---
13 Frioton	35	65	1,550	30	4.0
14 Gracemont	---	---	---	---	---
15 Heiden	25	55	---	---	---
16 Heiden	---	---	---	---	---
17 Konawa	30	50	1,500	26	---
18 Konawa	20	35	---	---	---
19 Konawa	---	---	---	---	---
20 Konsil	30	55	1,300	---	---
21 Konsil	20	40	1,000	---	---
22 Konsil	---	---	---	---	---

TABLE 6.--YIELDS PER ACRE OF CROPS--Continued

Map symbol and soil name	Wheat	Grain sorghum	Peanuts	Soybeans	Alfalfa hay
	Bu	Bu	Lb	Bu	Ton
23-------------------------- Konsil	25	50	1,300	---	---
24-------------------------- Konsil	---	---	---	---	---
25-------------------------- Madill	30	60	1,600	25	3.5
26-------------------------- Purves	20	25	---	---	---
27-------------------------- Tarrant	---	---	---	---	---
28-------------------------- Teller	35	55	1,800	---	3.5
29-------------------------- Wilson	30	55	1,000	25	---

TABLE 7.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

Map symbol and soil name	Range site name	Total production		Characteristic vegetation	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
1, 2--------------- Bastrop	Sandy Savannah-----------------	Favorable	5,000	Little bluestem----------------	50
		Normal	4,000	Indiangrass-------------------	10
		Unfavorable	2,000	Switchgrass-------------------	5
				Purpletop---------------------	5
				Sideoats grama----------------	5
				Fall witchgrass---------------	5
				Post oak----------------------	5
				Blackjack oak-----------------	5
				Lindheimer hackberry----------	5
3------------------ Burleson	Blackclay Prairie--------------	Favorable	7,000	Little bluestem----------------	40
		Normal	5,500	Indiangrass-------------------	15
		Unfavorable	4,000	Big bluestem------------------	15
				Sideoats grama----------------	5
				Tall dropseed-----------------	5
4*:					
Collinsville------	Shallow Prairie----------------	Favorable	3,500	Little bluestem----------------	30
		Normal	2,300	Big bluestem------------------	15
		Unfavorable	1,500	Indiangrass-------------------	10
				Switchgrass-------------------	10
				Sideoats grama----------------	10
				Tall dropseed-----------------	5
				Longspike tridens-------------	5
				Pale echinacea----------------	5
				Heath aster-------------------	5
Bates-------------	Loamy Prairie------------------	Favorable	7,000	Big bluestem------------------	35
		Normal	5,500	Little bluestem----------------	25
		Unfavorable	4,500	Indiangrass-------------------	12
				Switchgrass-------------------	5
				Leadplant---------------------	5
5------------------ Counts	Loamy Savannah-----------------	Favorable	5,000	Big bluestem------------------	25
		Normal	3,500	Indiangrass-------------------	15
		Unfavorable	2,500	Little bluestem----------------	10
				Switchgrass-------------------	5
				Purpletop---------------------	5
				Heath aster-------------------	3
				Tickclover--------------------	2
				Post oak----------------------	5
6------------------ Dougherty	Deep Sand Savannah-------------	Favorable	4,000	Little bluestem----------------	25
		Normal	2,800	Big bluestem------------------	10
		Unfavorable	2,000	Sand bluestem-----------------	10
				Indiangrass-------------------	5
				Switchgrass-------------------	5
				Purpletop---------------------	5
				Arrowfeather threeawn---------	5
				Scribner panicum--------------	5
				Sideoats grama----------------	5
				Lespedeza---------------------	5
7, 8--------------- Durant	Loamy Prairie------------------	Favorable	6,500	Little bluestem----------------	25
		Normal	4,550	Big bluestem------------------	20
		Unfavorable	3,250	Indiangrass-------------------	10
				Switchgrass-------------------	10
				Canada wildrye----------------	5
				Sideoats grama----------------	5
				Hairy grama-------------------	5
				Tall dropseed-----------------	5
				Lespedeza---------------------	5
				Dotted gayfeather-------------	5

See footnote at end of table.

TABLE 7.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Map symbol and soil name	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
9: Eufaula	Deep Sand Savannah	Favorable	4,000	Little bluestem	25
		Normal	2,800	Big bluestem	10
		Unfavorable	2,000	Indiangrass	5
				Switchgrass	5
				Purpletop	5
				Arrowfeather threeawn	5
				Scribner panicum	5
				Sideoats grama	5
				Lespedeza	5
10: Ferris	Blackclay Prairie	Favorable	6,200	Little bluestem	30
		Normal	4,400	Indiangrass	15
		Unfavorable	3,200	Big bluestem	15
				Switchgrass	5
				Eastern gamagrass	5
				Virginia wildrye	5
				Sideoats grama	5
				Meadow dropseed	5
11: Ferris	Eroded Clay	Favorable	2,000	Sideoats grama	30
		Normal	1,400	Littlebluestem	10
		Unfavorable	1,000	Big bluestem	10
				Switchgrass	5
				Eastern gamagrass	5
				Virginia wildrye	5
				Indiangrass	5
				Meadow dropseed	5
				Hairy grama	5
				Perennial sunflower	3
				Bigtop dalea	3
12*:					
Ferris	Blackclay Prairie	Favorable	6,200	Little bluestem	30
		Normal	4,400	Indiangrass	15
		Unfavorable	3,200	Big bluestem	15
				Switchgrass	5
				Eastern gamagrass	5
				Virginia wildrye	5
				Sideoats grama	5
				Meadow dropseed	5
Tarrant	Very Shallow	Favorable	1,800	Sideoats grama	20
		Normal	1,400	Silver bluestem	15
		Unfavorable	800	Little bluestem	10
				Green sprangletop	10
				Indiangrass	5
				Fall witchgrass	5
				Live oak	5
13: Frioton	Loamy Bottomland	Favorable	7,000	Switchgrass	20
		Normal	4,600	Big bluestem	15
		Unfavorable	3,000	Little bluestem	10
				Beaked panicum	10
				Sedge	10
				Florida paspalum	5
14: Gracemont	Subirrigated	Favorable	9,000	Switchgrass	25
		Normal	7,800	Sand bluestem	20
		Unfavorable	7,000	Indiangrass	10
				Eastern gamagrass	10
				Beaked panicum	10
				Canada wildrye	5
				Maximilian sunflower	5
				Eastern cottonwood	5
				Scribner panicum	5
				Purpletop	5

See footnote at end of table.

TABLE 7.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Map symbol and soil name	Range site name	Total production		Characteristic vegetation	Compo-sition
		Kind of year	Dry weight		
			Lb/acre		Pct
15, 16 Heiden	Blackclay Prairie	Favorable	6,500	Little bluestem	50
		Normal	4,700	Big bluestem	15
		Unfavorable	3,500	Indiangrass	10
17, 18 Konawa	Sandy Savannah	Favorable	4,500	Little bluestem	25
		Normal	3,800	Big bluestem	20
		Unfavorable	2,500	Indiangrass	5
				Switchgrass	5
				Purpletop	5
				Scribner panicum	5
19 Konawa	Eroded Sandy Savannah	Favorable	2,500	Little bluestem	30
		Normal	1,600	Indiangrass	10
		Unfavorable	1,250	Splitbeard bluestem	10
				Big bluestem	5
				Switchgrass	5
				Purpletop	5
				Purple lovegrass	5
				Carolina jointtail	5
20, 21 Konsil	Sandy Savannah	Favorable	5,000	Little bluestem	45
		Normal	4,100	Indiangrass	10
		Unfavorable	3,500	Big bluestem	10
				Post oak	10
				Purpletop	5
				Sand lovegrass	5
				Blackjack oak	5
22 Konsil	Eroded Sandy Savannah	Favorable	2,400	Little bluestem	30
		Normal	1,600	Indiangrass	10
		Unfavorable	1,250	Big bluestem	5
				Purpletop	5
				Switchgrass	5
				Purple lovegrass	5
				Jointtail	5
				Blackjack oak	5
23, 24 Konsil	Sandy Savannah	Favorable	6,500	Little bluestem	45
		Normal	5,000	Indiangrass	10
		Unfavorable	3,500	Big bluestem	10
				Post oak	10
				Purpletop	5
				Sand lovegrass	5
				Switchgrass	5
				Scribner panicum	5
				Blackjack oak	5
25 Madill	Loamy Bottomland	Favorable	7,000	Switchgrass	20
		Normal	6,100	Indiangrass	15
		Unfavorable	4,500	Big bluestem	10
				Sedge	10
				Little bluestem	5
				Panicum	5
26 Purves	Shallow Prairie	Favorable	4,000	Little bluestem	30
		Normal	2,500	Indiangrass	15
		Unfavorable	1,800	Big bluestem	10
				Sideoats grama	10
				Switchgrass	5
				Hairy grama	5
				Silver bluestem	5

See footnote at end of table.

TABLE 7.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Map symbol and soil name	Range site name	Total production		Characteristic vegetation	Compo-sition
		Kind of year	Dry weight		
			Lb/acre		Pct
27 Tarrant	Very Shallow	Favorable	1,800	Sideoats grama	20
		Normal	1,400	Silver bluestem	15
		Unfavorable	800	Little bluestem	10
				Hairy grama	10
				Indiangrass	5
				Texas grama	5
				Live oak	5
28 Teller	Loamy Prairie	Favorable	6,000	Little bluestem	25
		Normal	4,200	Big bluestem	20
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Canada wildrye	5
				Sideoats grama	5
				Blue grama	5
				Tall dropseed	5
				Dotted gayfeather	5
29 Wilson	Claypan Prairie	Favorable	4,800	Little bluestem	45
		Normal	3,200	Indiangrass	10
		Unfavorable	2,200	Big bluestem	10
				Virginia wildrye	5
				Vine-mesquite	5
				Florida paspalum	5
				Sideoats grama	5
				Texas needlegrass	5
				Silver bluestem	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Map symbol and soil name	Ordination symbol	Management concerns			Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Common trees	Site index	
5----------------- Counts	4o	Slight	Slight	Slight	Shortleaf pine------ Southern red oak---- Eastern redcedar----	60 60 40	Shortleaf pine, eastern redcedar, loblolly pine.
13----------------- Frioton	3o	Slight	Slight	Slight	Southern red oak---- Common hackberry---- Pecan--------------- Water hickory-------	77 --- --- ---	Eastern cottonwood, pecan.
14----------------- Gracemont	3w	Slight	Slight	Slight	Eastern cottonwood--	86	Eastern cottonwood.
25----------------- Madill	3o	Slight	Slight	Slight	Eastern cottonwood-- Pecan--------------- Green ash----------- Black walnut--------	86 --- --- ---	Eastern cottonwood, black walnut, bur oak, pecan, green ash.

TABLE 9.--WOODLAND UNDERSTORY VEGETATION

[Only the soils suitable for production of commercial trees are listed]

Map symbol and soil name	Total production		Characteristic vegetation	Composition
	Kind of year	Dry weight		
		Lb/acre		Pct
5----------------- Counts	Favorable Normal Unfavorable	3,500 2,500 1,800	Big bluestem----- Little bluestem----- Sedge----- Indiangrass----- Switchgrass----- Longspike tridens----- Panicum-----	20 10 10 5 5 5 5
13----------------- Frioton	Favorable Normal Unfavorable	3,000 2,100 1,600	Sedge----- Beaked panicum----- Panicum----- Little bluestem----- Florida paspalum-----	40 10 10 5 5
14----------------- Gracemont	Favorable Normal Unfavorable	5,000 4,100 3,500	Switchgrass----- Indiangrass----- Canadian wildrye----- Sedge----- Maximilian sunflower----- Tall dropseed----- Cottonwood-----	30 10 10 10 5 5 5
25----------------- Madill	Favorable Normal Unfavorable	3,000 2,100 1,600	Sedge----- Beaked panicum----- Panicum----- Little bluestem----- Florida paspalum-----	40 10 10 5 5

TABLE 10.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails
1----- Bastrop	Slight-----	Slight-----	Slight-----	Slight.
2----- Bastrop	Slight-----	Slight-----	Moderate: slope.	Slight.
3----- Burleson	Moderate: percs slowly, too clayey.	Moderate: too clayey, percs slowly.	Severe: too clayey.	Moderate: too clayey.
4*:				
Collinsville-----	Severe: depth to rock.	Moderate: small stones.	Severe: depth to rock, slope, small stones.	Moderate: small stones.
Bates-----	Slight-----	Slight-----	Moderate: slope, depth to rock.	Slight.
5----- Counts	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness, percs slowly.	Moderate: wetness.
6----- Dougherty	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
7----- Durant	Severe: percs slowly.	Slight-----	Severe: percs slowly.	Slight.
8----- Durant	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.
9----- Eufaula	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.
10----- Ferris	Moderate: too clayey, percs slowly.	Moderate: too clayey, percs slowly.	Moderate: too clayey, percs slowly, slope.	Moderate: too clayey.
11----- Ferris	Moderate: too clayey, percs slowly.	Moderate: too clayey, percs slowly.	Severe: slope.	Moderate: too clayey.
12*:				
Ferris-----	Moderate: too clayey, percs slowly, slope.	Moderate: too clayey, slope, percs slowly.	Severe: slope.	Moderate: too clayey.
Tarrant-----	Severe: large stones, depth to rock.	Severe: large stones.	Severe: slope, large stones, depth to rock.	Severe: large stones.
13----- Frioton	Severe: floods.	Moderate: floods, too clayey.	Moderate: floods, too clayey.	Moderate: floods.
14----- Gracemont	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: floods.	Moderate: floods, wetness.

See footnote at end of table.

TABLE 10.--RECREATIONAL DEVELOPMENT--Continued

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails
15 Heiden	Moderate: percs slowly, too clayey.	Moderate: percs slowly, too clayey.	Moderate: too clayey, percs slowly, slope.	Moderate: too clayey.
16 Heiden	Moderate: percs slowly, too clayey.	Moderate: percs slowly, too clayey.	Severe: too clayey.	Moderate: too clayey.
17, 18, 19 Konawa	Slight	Slight	Moderate: slope.	Slight.
20, 21, 22, 23 Konsil	Slight	Slight	Moderate: slope.	Slight.
24 Konsil	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
25 Madill	Severe: floods.	Slight	Moderate: floods.	Slight.
26 Purves	Moderate: too clayey.	Moderate: too clayey.	Severe: depth to rock, too clayey.	Moderate: too clayey.
27 Tarrant	Severe: large stones, depth to rock.	Severe: large stones.	Severe: slope, large stones, depth to rock.	Severe: large stones.
28 Teller	Slight	Slight	Slight	Slight.
29 Wilson	Severe: percs slowly, wetness.	Severe: wetness, percs slowly.	Severe: percs slowly, wetness.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Map symbol and soil name	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
1, 2-----Bastrop	Good	Good	Good	---	---	Poor	Very poor.	Good	---	Very poor.
3-----Burleson	Good	Good	Poor	---	---	Very poor.	Very poor.	Fair	---	Very poor.
4*:										
Collinsville-----	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Bates-----	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
5-----Counts	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
6-----Dougherty	Fair	Fair	Good	---	---	Poor	Very poor.	Fair	---	Very poor.
7-----Durant	Good	Good	Good	---	---	Poor	Poor	Good	---	Poor.
8-----Durant	Good	Good	Good	---	---	Poor	Very poor.	Good	---	Very poor.
9-----Eufaula	Fair	Fair	Fair	---	---	Very poor.	Very poor.	Fair	---	Very poor.
10-----Ferris	Fair	Good	Fair	---	---	Very poor.	Very poor.	Fair	---	Very poor.
11-----Ferris	Poor	Fair	Fair	---	---	Very poor.	Very poor.	Fair	---	Very poor.
12*:										
Ferris-----	Poor	Fair	Fair	---	---	Very poor.	Very poor.	Fair	---	Very poor.
Tarrant-----	Very poor.	Very poor.	Fair	---	Poor	Very poor.	Very poor.	Poor	---	Very poor.
13-----Frioton	Good	Good	Fair	Good	Good	Poor	Very poor.	Good	Good	Very poor.
14-----Gracemont	Poor	Fair	Fair	Good	Good	Fair	Poor	Fair	Good	Poor
15-----Heiden	Fair	Good	Fair	---	---	Poor	Very poor.	Fair	---	Very poor.
16-----Heiden	Poor	Poor	Fair	---	---	Very poor.	Very poor.	Poor	---	Very poor.
17, 18, 19-----Konawa	Good	Good	Good	---	---	Poor	Very poor.	Good	---	Very poor.
20, 21, 22, 23, 24-Konsil	Good	Good	Good	Good	---	Very poor.	Very poor.	Good	---	Very poor.
25-----Madill	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

See footnote at end of table.

TABLE 11.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
26------------------ Purves	Fair	Good	Poor	---	---	Poor	Very poor.	Fair	---	Very poor.
27------------------ Tarrant	Very poor.	Very poor.	Fair	---	Poor	Very poor.	Very poor.	Poor	---	Very poor.
28------------------ Teller	Good	Good	Good	---	---	Poor	Very poor.	Good	---	Very poor.
29------------------ Wilson	Fair	Fair	Good	---	---	Fair	Fair	Fair	---	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
1, 2: Bastrop	Slight	Slight	Slight	Slight	Moderate: low strength.
3: Burleson	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
4*:					
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Moderate: low strength.
5: Counts	Severe: too clayey, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness	Severe: low strength, shrink-swell.
6: Dougherty	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
7, 8: Durant	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
9: Eufaula	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
10, 11: Ferris	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
12*:					
Ferris	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength.
Tarrant	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.
13: Frioton	Severe: floods.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: low strength, shrink-swell.
14: Gracemont	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: floods, wetness.
15: Heiden	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
16: Heiden	Severe: too clayey, cutbanks cave.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
17, 18: Konawa	Slight	Slight	Slight	Slight	Moderate: low strength.

See footnote at end of table.

TABLE 12.--BUILDING SITE DEVELOPMENT--Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
19 Konawa	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength.
20, 21, 22 Konsil	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.
23 Konsil	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Moderate: low strength, shrink-swell.
24 Konsil	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: slope, low strength.
25 Madill	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
26 Purves	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
27 Tarrant	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.
28 Teller	Slight	Slight	Slight	Slight	Moderate: low strength.
29 Wilson	Severe: wetness, too clayey.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength, wetness.

* See description of the map unit for composition and behavior characteristics.

TABLE 13.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1 Bastrop	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
2 Bastrop	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
3 Burleson	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
4*:					
Collinsville	Severe: depth to rock.	Severe: seepage, depth to rock, slope.	Severe: seepage, depth to rock.	Severe: seepage, depth to rock.	Poor: thin layer, area reclaim.
Bates	Severe: depth to rock.	Moderate: depth to rock, slope.	Severe: depth to rock.	Moderate: depth to rock.	Fair: thin layer.
5 Counts	Severe: wetness, percs slowly.	Severe: wetness.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey.
6 Dougherty	Slight	Severe: seepage.	Severe: seepage.	Slight	Fair: too sandy.
7, 8 Durant	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, thin layer.
9 Eufaula	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Fair: too sandy.
10 Ferris	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
11 Ferris	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Slight	Poor: too clayey.
12*:					
Ferris	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey.
Tarrant	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Moderate: slope.	Poor: area reclaim, too clayey.
13 Frioton	Severe: percs slowly, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Fair: too clayey, hard to pack.
14 Gracemont	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: floods, seepage, wetness.	Severe: wetness, floods, seepage.	Poor: wetness.
15, 16 Heiden	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
17, 18, 19 Konawa	Slight	Severe: seepage.	Severe: seepage.	Slight	Good.

See footnote at end of table.

TABLE 13.--SANITARY FACILITIES--Continued

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
20, 21, 22, 23------ Konsil	Moderate: percs slowly.	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
24------------------ Konsil	Moderate: percs slowly, slope.	Moderate: seepage, slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
25------------------ Madill	Severe: floods.	Severe: seepage, floods.	Severe: seepage, floods.	Severe: floods, seepage.	Good.
26------------------ Purves	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight-----------	Poor: area reclaim, too clayey.
27------------------ Tarrant	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Moderate: slope.	Poor: area reclaim, too clayey.
28------------------ Teller	Moderate: percs slowly.	Moderate: seepage.	Severe: seepage.	Slight-----------	Good.
29------------------ Wilson	Severe: percs slowly, wetness.	Slight-----------	Severe: too clayey, wetness.	Severe: wetness.	Poor: thin layer, wetness.

* See description of the map unit for composition and behavior characteristics.

TABLE 14.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
1, 2 Bastrop	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Good.
3 Burleson	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
4*:				
Collinsville	Poor: thin layer, area reclaim.	Unsuited: excess fines, thin layer.	Unsuited: excess fines, thin layer.	Fair: thin layer, area reclaim.
Bates	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim.
5 Counts	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
6 Dougherty	Good	Poor: excess fines.	Unsuited: excess fines.	Fair: too sandy.
7 Durant	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
8 Durant	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey.
9 Eufaula	Fair: low strength.	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy.
10, 11 Ferris	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
12*:				
Ferris	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Tarrant	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: area reclaim, too clayey, large stones.
13 Frioton	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
14 Gracemont	Fair: wetness, low strength.	Poor: excess fines.	Unsuited: excess fines.	Poor: wetness.
15, 16 Heiden	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
17, 18, 19 Konawa	Fair: low strength.	Poor: excess fines, thin layer.	Poor: excess fines, thin layer.	Fair: too sandy.

See footnote at end of table.

TABLE 14.--CONSTRUCTION MATERIALS--Continued

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
20, 21, 22, 23: Konsil	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
24: Konsil	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
25: Madill	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Good.
26: Purves	Poor: shrink-swell, thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
27: Tarrant	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: area reclaim, too clayey, large stones.
28: Teller	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
29: Wilson	Poor: shrink-swell, low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer, wetness.

* See description of the map unit for composition and behavior characteristics.

TABLE 15.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Map symbol and soil name	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
1, 2: Bastrop	Moderate: seepage.	Slight	Severe: no water.	Not needed	Soil blowing	Erodes easily.
3: Burleson	Slight	Moderate: hard to pack.	Severe: no water.	Not needed	Percs slowly	Percs slowly.
4*:						
Collinsville	Severe: seepage, depth to rock.	Severe: thin layer, piping.	Severe: no water.	Not needed	Depth to rock, slope.	Rooting depth, depth to rock.
Bates	Moderate: depth to rock, seepage.	Severe: piping.	Severe: no water.	Not needed	Depth to rock, soil blowing.	Depth to rock.
5: Counts	Slight	Moderate: hard to pack, wetness.	Severe: slow refill.	Percs slowly, wetness.	Percs slowly, wetness, erodes easily.	Percs slowly, wetness, erodes easily.
6: Dougherty	Severe: seepage.	Severe: seepage.	Severe: no water.	Not needed	Soil blowing, too sandy.	Favorable.
7, 8: Durant	Slight	Moderate: hard to pack.	Severe: no water.	Not needed	Percs slowly, erodes easily.	Percs slowly, erodes easily.
9: Eufaula	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Not needed	Too sandy, soil blowing, slope.	Slope, droughty.
10, 11: Ferris	Slight	Moderate: hard to pack.	Severe: no water.	Not needed	Percs slowly, slope.	Percs slowly, slope.
12*:						
Ferris	Slight	Moderate: hard to pack.	Severe: no water.	Not needed	Percs slowly, slope.	Percs slowly, slope.
Tarrant	Severe: depth to rock.	Severe: thin layer, large stones.	Severe: no water.	Not needed	Large stones, depth to rock.	Rooting depth, large stones, slope.
13: Frioton	Slight	Moderate: hard to pack.	Severe: deep to water.	Not needed	Favorable	Favorable.
14: Gracemont	Severe: seepage.	Severe: piping, wetness.	Slight	Floods	Not needed	Wetness.
15, 16: Heiden	Slight	Moderate: hard to pack.	Severe: no water.	Not needed	Percs slowly	Percs slowly.
17, 18, 19: Konawa	Severe: seepage.	Severe: piping.	Severe: no water.	Not needed	Soil blowing	Favorable.
20, 21, 22, 23: Konsil	Moderate: seepage.	Slight	Severe: no water.	Not needed	Soil blowing	Favorable.
24: Konsil	Moderate: seepage.	Slight	Severe: no water.	Not needed	Soil blowing, slope.	Slope.
25: Madill	Severe: seepage.	Moderate: seepage.	Severe: no water.	Not needed	Favorable	Favorable.
26: Purves	Severe: depth to rock.	Severe: thin layer.	Severe: no water.	Not needed	Depth to rock	Rooting depth.

See footnote at end of table.

TABLE 15.--WATER MANAGEMENT--Continued

Map symbol and soil name	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
27. Tarrant	Severe: depth to rock.	Severe: thin layer, large stones.	Severe: no water.	Not needed	Large stones, depth to rock.	Rooting depth, large stones, slope.
28. Teller	Severe: seepage.	Severe: piping.	Severe: no water.	Not needed	Favorable	Favorable.
29. Wilson	Slight	Severe: wetness.	Severe: no water.	Percs slowly, wetness.	Percs slowly, wetness, erodes easily.	Percs slowly, wetness, erodes easily.

* See description of the map unit for composition and behavior characteristics.

TABLE 16.--ENGINEERING INDEX PROPERTIES

[Absence of an entry indicates that data were not estimated]

Map symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
1, 2---------------- Bastrop	0-10	Fine sandy loam	ML, SM, CL-ML, SM-SC	A-4	0	95-100	80-100	80-100	36-70	18-25	2-7
	10-80	Sandy clay loam, clay loam, loam.	CL, SC	A-6	0	95-100	80-100	80-100	40-70	26-40	11-22
3------------------ Burleson	0-40	Clay------------	CH, MH	A-7-6	0-2	83-100	80-100	80-100	80-95	51-90	27-55
	40-74	Clay, silty clay	CH, MH	A-7-6	0-1	95-100	80-100	75-98	70-95	51-90	30-55
4*:											
Collinsville------	0-4	Fine sandy loam	SM, SC, ML, CL	A-4	0-3	80-100	60-100	60-95	36-75	<30	NP-10
	4-14	Fine sandy loam, loam, extremely stony fine sandy loam.	SM, SC, ML, CL	A-4	3-40	80-100	60-100	60-95	36-75	<30	NP-10
	14-22	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bates-------------	0-14	Fine sandy loam	ML, SM	A-4	0	100	100	90-100	40-55	<30	NP-5
	14-26	Loam, clay loam, sandy clay loam.	ML, CL	A-4, A-6	0	100	100	90-100	50-85	25-40	3-15
	26-38	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
5------------------ Counts	0-12	Loam------------	CL, CL-ML	A-4	0	100	98-100	96-100	65-97	20-30	4-10
	12-70	Clay, silty clay loam, clay loam.	CL, CH	A-7, A-6	0	98-100	98-100	96-100	90-98	37-65	15-35
6------------------ Dougherty	0-28	Loamy fine sand	SM	A-2	0	100	98-100	90-100	15-35	---	NP
	28-40	Fine sandy loam, sandy clay loam.	ML, SM, CL, SC	A-4, A-6	0	100	98-100	90-100	36-65	<37	NP-15
	40-54	Fine sandy loam, sandy clay loam.	SM, ML, CL, SC	A-4, A-6	0	100	98-100	90-100	36-65	<37	NP-15
	54-72	Loamy fine sand, fine sandy loam.	SM	A-2	0	100	98-100	90-100	15-35	---	NP
7------------------ Durant	0-10	Loam------------	CL	A-4, A-6	0	100	100	96-100	65-97	28-40	8-17
	10-14	Clay loam, silty clay loam, clay.	CL, CH	A-6, A-7	0	100	100	96-100	80-98	37-70	15-39
	14-66	Clay------------	CL, CH	A-7	0	100	100	96-100	90-95	45-70	21-39
8------------------ Durant	0-10	Clay loam-------	CL	A-4, A-6	0	100	100	96-100	65-97	28-40	8-17
	10-14	Clay loam, silty clay loam, clay.	CL, CH	A-6, A-7	0	100	100	96-100	80-98	37-70	15-39
	14-66	Clay------------	CL, CH	A-7	0	100	100	96-100	90-95	45-70	21-39
9------------------ Eufaula	0-80	Loamy fine sand	SM, SP-SM	A-2, A-3	0	100	98-100	82-100	5-35	---	NP
10, 11------------- Ferris	0-64	Clay------------	CH	A-7-6	0	95-100	95-100	75-100	75-98	51-70	35-50
12*:											
Ferris------------	0-60	Clay------------	CH	A-7-6	0	95-100	95-100	75-100	75-98	51-70	35-50

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
12*:											
Tarrant	0-11	Cobbly clay	CH, GC	A-7-6	33-77	55-100	51-100	51-95	45-95	55-76	31-49
	11-22	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
13 Frioton	0-74	Silty clay loam	CL, CH	A-6, A-7	0-2	65-100	65-100	60-100	55-95	35-52	20-34
14 Gracemont	0-16	Fine sandy loam	ML, CL-ML, SM, SM-SC	A-4	0	100	98-100	94-100	36-60	<26	NP-7
	16-44	Fine sandy loam, loam.	ML, CL-ML, SM, SM-SC	A-4	0	100	98-100	94-100	36-90	22-29	2-7
	44-66	Loam, clay loam, fine sandy loam.	ML, CL, SM, SC	A-4, A-6	0	100	98-100	94-100	36-90	22-40	2-18
15 Heiden	0-20	Clay	CH	A-7-6	0	95-100	90-100	80-100	75-99	54-80	35-55
	20-65	Clay, silty clay	CH	A-7-6	0	90-100	90-100	75-100	70-99	52-80	35-55
16 Heiden	0-8	Stony clay	CH	A-7-6	5-20	75-98	70-98	60-95	55-95	55-80	35-55
	8-80	Clay, silty clay	CH	A-7-6	0	90-100	90-100	75-100	70-99	52-80	35-60
17, 18, 19 Konawa	0-12	Fine sandy loam	CL, ML, SM, SM-SC	A-4	0	98-100	98-100	90-100	40-60	<26	NP-7
	12-44	Sandy clay loam, fine sandy loam.	SC, CL	A-4, A-6	0	98-100	98-100	85-100	40-60	26-40	8-18
	44-80	Fine sandy loam, sandy clay loam, loamy fine sand.	SM, SC, CL, ML	A-4, A-6, A-2	0	98-100	98-100	85-100	15-60	<34	NP-14
20, 21, 22, 23, 24 Konsil	0-14	Fine sandy loam	CL, ML, SC, SM	A-4	0	90-100	90-100	85-98	36-55	<28	NP-10
	14-70	Sandy clay loam, loam, fine sandy loam.	CL, SC	A-6	0	90-100	90-100	85-99	40-60	28-40	11-20
25 Madill	0-4	Fine sandy loam	SM, SC, ML, CL	A-4	0	100	98-100	94-100	36-85	<30	NP-10
	4-30	Fine sandy loam, loam.	SM, SC, ML, CL	A-4	0	100	98-100	94-100	36-85	<30	NP-10
	30-68	Fine sandy loam, loam, loamy fine sand.	SM, SC, ML, CL	A-2, A-4	0	100	98-100	90-100	15-85	<30	NP-10
26 Purves	0-10	Clay	CH	A-7-6	0-5	90-100	80-100	80-95	70-95	51-65	30-40
	10-16	Gravelly clay, very gravelly clay, gravelly clay loam.	CH, SC, GC	A-7-6	0-35	60-100	60-100	55-95	45-90	51-65	30-40
	16-24	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
27 Tarrant	0-11	Cobbly clay	CH, GC	A-7-6	33-77	55-100	51-100	51-95	45-95	55-76	31-49
	11-22	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
28------------------ Teller	0-24	Fine sandy loam	SM, SC, ML, CL	A-4	0	100	100	94-100	36-85	<30	NP-10
	24-58	Sandy clay loam, clay loam.	SC, CL	A-6, A-4	0	100	100	90-100	45-85	24-40	7-18
	58-80	Fine sandy loam, very fine sandy loam, loam.	SM, SC, ML, CL	A-4, A-6	0	100	100	94-100	45-85	20-34	3-13
29------------------ Wilson	0-6	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	85-100	80-100	60-96	24-36	7-18
	6-36	Silty clay, clay, clay loam.	CL, CH	A-7-6, A-6	0	90-100	80-100	80-100	65-96	38-55	21-35
	36-70	Silty clay, clay	CL, CH	A-7-6, A-6	0	95-100	90-100	85-100	70-96	38-65	24-48

* See description of the map unit for composition and behavior characteristics.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[Entries under "Erosion factors--T" apply to the entire profile. Absence of an entry indicates that data were not available or were not estimated]

Map symbol and soil name	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T
	In	In/hr	In/in	pH			
1, 2------------ Bastrop	0-10	2.0-6.0	0.11-0.17	5.6-7.3	Low------------	0.37	5
	10-80	0.6-2.0	0.15-0.19	5.6-8.4	Low------------	0.32	
3--------------- Burleson	0-40	<0.06	0.12-0.18	5.6-8.4	High-----------	0.32	5
	40-74	<0.06	0.12-0.18	7.4-8.4	High-----------	0.32	
4*:							
Collinsville----	0-4	2.0-6.0	0.12-0.16	5.1-6.5	Low------------	0.32	2
	4-14	2.0-6.0	0.09-0.13	5.1-6.5	Low------------	0.20	
	14-22	---	---	---	---------------	----	
Bates-----------	0-14	0.6-2.0	0.15-0.17	5.1-6.5	Low------------	0.20	4
	14-26	0.6-2.0	0.15-0.19	5.1-6.5	Low------------	0.28	
	26-38	---	---	---	---------------	----	
5--------------- Counts	0-12	0.6-2.0	0.15-0.24	4.5-6.0	Low------------	0.49	5
	12-70	<0.06	0.12-0.22	4.5-8.4	High-----------	0.43	
6--------------- Dougherty	0-28	2.0-6.0	0.07-0.11	5.1-6.5	Low------------	0.20	5
	28-40	0.6-2.0	0.11-0.17	5.1-6.5	Low------------	0.32	
	40-54	0.6-2.0	0.11-0.17	5.1-7.3	Low------------	0.32	
	54-72	2.0-6.0	0.07-0.11	5.1-7.3	Low------------	0.24	
7, 8------------ Durant	0-10	0.6-2.0	0.15-0.24	5.6-6.5	Low------------	0.49	5
	10-14	<0.06	0.12-0.22	5.1-6.5	Moderate-------	0.43	
	14-66	<0.06	0.12-0.18	5.6-8.4	High-----------	0.37	
9--------------- Eufaula	0-80	6.0-20.0	0.05-0.11	5.1-7.3	Low------------	0.17	5
10, 11---------- Ferris	0-64	<0.06	0.15-0.18	7.9-8.4	Very high------	0.32	4
12*:							
Ferris----------	0-60	<0.06	0.15-0.18	7.9-8.4	Very high------	0.32	4
Tarrant---------	0-11	0.2-0.6	0.10-0.17	7.9-8.4	Moderate-------	0.20	1
	11-22	---	---	---	---------------	----	
13-------------- Frioton	0-74	0.2-0.6	0.15-0.22	7.4-8.4	High-----------	0.32	5
14-------------- Gracemont	0-16	0.6-6.0	0.11-0.15	6.6-8.4	Low------------	0.20	5
	16-44	0.6-6.0	0.11-0.20	7.9-8.4	Low------------	0.32	
	44-66	0.6-6.0	0.11-0.20	7.9-8.4	Low------------	0.32	
15-------------- Heiden	0-20	<0.06	0.15-0.20	7.9-8.4	Very high------	0.32	5
	20-65	<0.06	0.12-0.20	7.9-8.4	Very high------	0.32	
16-------------- Heiden	0-8	<0.06	0.10-0.18	7.9-8.4	Very high------	0.28	5
	8-80	<0.06	0.12-0.20	7.9-8.4	Very high------	0.32	
17, 18, 19------- Konawa	0-12	2.0-6.0	0.11-0.15	5.6-6.5	Low------------	0.24	5
	12-44	0.6-2.0	0.12-0.16	5.1-6.0	Low------------	0.32	
	44-80	2.0-6.0	0.11-0.15	5.1-7.3	Low------------	0.24	
20, 21, 22, 23, 24-------------- Konsil	0-14	2.0-6.0	0.11-0.15	6.1-7.8	Low------------	0.24	5
	14-70	0.6-2.0	0.12-0.19	5.1-6.5	Moderate-------	0.32	
25-------------- Madill	0-4	2.0-6.0	0.11-0.16	5.6-7.3	Low------------	0.32	5
	4-30	2.0-6.0	0.11-0.16	5.6-7.3	Low------------	0.32	
	30-68	2.0-6.0	0.07-0.16	5.6-8.4	Low------------	0.32	

See footnote at end of table.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Map symbol and soil name	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors	
						K	T
	In	In/hr	In/in	pH			
26----------------	0-10	0.2-0.6	0.12-0.18	7.9-8.4	High------------	0.32	1
Purves	10-16	0.2-0.6	0.08-0.18	7.9-8.4	High------------	0.32	
	16-24	---	---	---	----------------	----	
27----------------	0-11	0.2-0.6	0.10-0.17	7.9-8.4	Moderate--------	0.20	1
Tarrant	11-22	---	---	---	----------------	----	
28----------------	0-24	2.0-6.0	0.12-0.16	5.6-6.5	Low-------------	0.37	5
Teller	24-58	0.6-2.0	0.14-0.18	5.6-6.5	Low-------------	0.32	
	58-80	2.0-6.0	0.13-0.17	5.6-7.3	Low-------------	0.32	
29----------------	0-6	0.2-0.6	0.15-0.20	5.6-7.3	Low-------------	0.43	5
Wilson	6-36	<0.06	0.14-0.20	5.6-8.4	High------------	0.37	
	36-70	<0.06	0.12-0.15	6.6-8.4	High------------	0.37	

* See description of the map unit for composition and behavior characteristics.

TABLE 18.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the text explain terms such as "brief," "apparent," and "perched." Absence of an entry indicates that the feature is not a concern]

Map symbol and soil name	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
1, 2-------------- Bastrop	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low.
3----------------- Burleson	D	None---------	---	---	>6.0	---	---	>60	---	High------	Low.
4*:											
Collinsville-----	C	None---------	---	---	>6.0	---	---	4-20	Hard	Low-------	Moderate.
Bates------------	B	None---------	---	---	>6.0	---	---	20-40	Rip-pable	Low-------	Moderate.
5----------------- Counts	C	None---------	---	---	1.0-2.0	Perched	Nov-Apr	>60	---	High------	Moderate.
6----------------- Dougherty	A	None---------	---	---	>6.0	---	---	>60	---	Low-------	Moderate.
7, 8-------------- Durant	D	None---------	---	---	>6.0	---	---	>60	---	High------	Moderate.
9----------------- Eufaula	A	None---------	---	---	>6.0	---	---	>60	---	Low-------	Moderate.
10, 11------------ Ferris	D	None---------	---	---	>6.0	---	---	>60	---	High------	Low.
12*:											
Ferris-----------	D	None---------	---	---	>6.0	---	---	>60	---	High------	Low.
Tarrant----------	D	None---------	---	---	>6.0	---	---	6-20	Hard	High------	Low.
13---------------- Frioton	B	Occasional	Very brief	Feb-Jul	>6.0	---	---	>60	---	High------	Low.
14---------------- Gracemont	B	Frequent----	Very brief to brief.	Mar-Aug	0.5-3.0	Apparent	Nov-May	>60	---	Moderate	Low.
15, 16------------ Heiden	D	None---------	---	---	>6.0	---	---	>60	---	High------	Low.
17, 18, 19-------- Konawa	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate.
20, 21, 22, 23, 24---------------- Konsil	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Moderate.
25---------------- Madill	B	Occasional	Very brief	Feb-Jul	>6.0	---	---	>60	---	Low-------	Moderate.
26---------------- Purves	D	None---------	---	---	>6.0	---	---	8-20	Hard	High------	Low.
27---------------- Tarrant	D	None---------	---	---	>6.0	---	---	6-20	Hard	High------	Low.
28---------------- Teller	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Moderate.
29---------------- Wilson	D	None---------	---	---	0-1.0	Perched	Nov-Mar	>60	---	High------	High.

* See description of the map unit for composition and behavior characteristics.

TABLE 19.--PHYSICAL ANALYSES OF SELECTED SOILS

Soil series and sample number	Depth	Horizon	Particle size distribution: Very coarse and coarse sand (2.0-0.50 mm)	Medium sand (0.50-0.25 mm)	Fine sand (0.25-0.10 mm)	Very fine sand (0.10-0.05 mm)	Total sand (2.0-0.05 mm)	Silt (0.05-0.002 mm)	Clay (<0.002 mm)
	In		Pct	Pct	Pct	Pct	Pct	Pct	Pct
Burleson:									
76-OK-48-2-1	0-6	Ap	0.3	2.0	1.8	4.8	8.9	46.0	45.0
76-OK-48-2-2	6-14	A12	0.3	0.7	1.7	3.5	6.2	42.5	51.3
76-OK-48-2-3	14-58	AC	2.1	1.0	1.3	2.8	7.2	43.2	49.5
76-OK-48-2-4	58-78	C	0.8	0.7	1.7	2.9	6.1	54.7	39.2
Dougherty:									
76-OK-48-3-1	0-6	A1	0.4	17.0	41.2	11.0	69.6	22.9	7.6
76-OK-48-3-2	6-30	A2	0.5	21.1	46.7	11.1	79.4	14.3	6.3
76-OK-48-3-3	30-42	B21t	0.5	18.2	37.2	9.5	65.4	15.8	18.8
76-OK-48-3-4	42-67	B22t	0.8	20.4	41.1	10.7	73.0	12.0	15.0
76-OK-48-3-5	67-82	B3	1.1	27.9	45.1	8.5	82.6	6.2	11.3
Konsil:									
76-OK-48-8-1	0-11	Ap	2.2	10.5	31.2	22.2	66.1	24.4	9.4
76-OK-48-8-2	11-30	B21t	2.5	8.6	23.3	16.6	51.0	23.2	25.7
76-OK-48-8-3	30-42	B22t	4.2	10.8	22.9	18.3	56.2	16.8	27.0
76-OK-48-8-4	42-62	B23t	3.4	9.0	25.4	20.0	57.8	20.7	21.4
76-OK-48-8-5	62-78	B3	0.8	6.9	25.1	15.0	47.8	29.0	23.2

TABLE 20.--CHEMICAL ANALYSES OF SELECTED SOILS

Soil series and sample number	Depth	Horizon	Extractable bases (Milliequivalents per 100 grams of soil): Ca	Mg	K	Na	Cation exchange capacity	Base saturation	Reaction 1:1 soil:water	Organic matter	Total phosphorus
	In							Pct	pH	Pct	Ppm
Burleson:											
76-OK-48-2-1	0-6	Ap	39.86	1.91	1.47	0.19	68.5	63.4	6.8	1.68	398.9
76-OK-48-2-2	6-14	A12	40.07	4.45	0.51	0.21	73.1	61.9	7.0	3.77	260.0
76-OK-48-2-3	14-58	AC	64.87	3.60	0.44	0.26	65.8	100.0	7.8	1.70	286.8
76-OK-48-2-4	58-78	C	59.36	0.85	0.34	0.38	49.3	100.0	7.8	0.58	260.0
Dougherty:											
76-OK-48-3-1	0-6	A1	4.07	0.51	0.58	0.07	5.1	100.0	6.8	1.24	242.1
76-OK-48-3-2	6-30	A2	0.89	0.08	0.11	0.07	1.3	85.6	6.9	0.22	91.3
76-OK-48-3-3	30-42	B21t	2.29	2.42	0.11	0.07	10.2	47.9	5.0	0.20	129.0
76-OK-48-3-4	42-67	B22t	1.27	1.53	0.10	0.07	7.8	37.9	4.8	0.17	101.2
76-OK-48-3-5	67-82	B3	0.38	1.48	0.08	0.07	4.5	44.4	4.9	0.17	79.4
Konsil:											
76-OK-48-8-1	0-11	Ap	0.85	0.85	0.09	0.06	3.2	57.6	5.2	0.77	96.0
76-OK-48-8-2	11-30	B21t	6.57	3.60	0.22	0.07	18.3	57.3	5.5	0.62	110.0
76-OK-48-8-3	30-42	B22t	9.12	4.66	0.14	0.09	20.6	68.0	5.7	0.48	106.0
76-OK-48-8-4	42-62	B23t	5.94	3.82	0.16	0.09	16.8	59.5	5.1	0.40	110.0
76-OK-48-8-5	62-78	B3	5.51	2.97	0.16	0.09	15.7	55.8	5.2	0.36	110.0

TABLE 21.--ENGINEERING INDEX TEST DATA

[Dashes indicate data were not available. NP means nonplastic]

Soil name, report number, horizon, and depth in inches	Classification: AASHTO	Classification: Unified	Grain size distribution: Percentage passing sieve: No. 4	No. 10	No. 40	No. 200	Percentage smaller than--: .02 mm	.005 mm	.002 mm	Liquid limit	Plasticity index	Moisture density: Max. dry density	Optimum moisture	Shrinkage: Limit	Linear	Ratio
										Pct		Lb/ft3	Pct	Pct	Pct	Pct
Burleson clay:[1] (S76OK-095-001)																
A1------ 0 to 40	A-7-6(43)	CH	100	100	100	96	--	54	48	65	38	--	--	8.0	0.0	2.1
AC1----- 40 to 60	A-7-6(41)	CH	100	100	99	95	--	56	50	63	38	--	--	6.0	0.0	2.2
AC2----- 60 to 72	A-7-6(24)	CL	100	100	99	95	--	51	38	44	24	--	--	9.0	0.0	2.1
Dougherty loamy fine sand:[2] (S76OK-095-002)																
A2------ 6 to 30	A-2-4(00)	SM	100	100	99	25	--	3	1	--	NP	--	--	--	0.0	--
B21t---- 30 to 42	A-4 (00)	SM-SC	100	100	97	48	--	20	16	22	7	--	--	14.0	0.0	1.8
B3------ 67 to 82	A-2-4(00)	SM	100	100	98	23	--	11	7	--	NP	--	--	0.0	0.0	0.0
Durant loam:[3] (S76OK-095-005)																
A1------ 0 to 11	A-6 (09)	CL	100	100	98	82	--	24	18	34	11	--	--	17.0	0.0	1.7
B21t---- 18 to 41	A-7-6(36)	CH	100	100	99	87	--	48	43	59	39	--	--	10.0	0.0	2.0
B3------ 66 to 82	A-7-6(22)	CL	100	100	100	85	--	48	40	45	26	--	--	11.0	0.0	2.0
Ferris clay:[4] (S76OK-095-006)																
A1------ 0 to 7	A-7-6(22)	ML-MH	100	100	98	91	--	47	31	50	21	--	--	12.0	0.0	1.9
AC2----- 23 to 57	A-6 (20)	CL	100	100	99	96	--	54	39	40	20	--	--	11.0	0.0	2.0
Frioton silty clay loam:[5] (S76OK-095-004)																
A11----- 0 to 24	A-7-6(15)	CL	100	100	100	78	--	32	26	41	20	--	--	12.0	0.0	1.9
A14----- 50 to 63	A-6 (05)	CL	100	100	97	55	--	24	20	29	15	--	--	12.0	0.0	1.9
Konsil fine sandy loam:[6] (S76OK-095-007)																
Ap------ 0 to 11	A-4 (00)	SM	100	100	97	43	--	3	1	--	NP	--	--	--	0.0	--
B21t---- 11 to 30	A-6 (07)	CL	100	100	96	57	--	25	20	33	17	--	--	14.0	0.0	1.8
B3------ 62 to 78	A-6 (06)	CL	100	100	99	58	--	24	20	30	15	--	--	16.0	0.0	1.7
Konawa fine sandy loam:[7] (S76OK-095-003)																
Ap------ 0 to 12	A-4 (00)	SM	100	100	98	47	--	6	4	--	NP	--	--	--	0.0	--
B21t---- 12 to 30	A-4 (00)	CL-ML	100	100	98	56	--	16	15	21	5	--	--	14.0	0.0	1.8
B31----- 62 to 73	A-4 (00)	SM	100	100	99	40	--	7	6	--	NP	--	--	0.0	0.0	0.0

[1]Burleson clay: 2,550 feet north and 600 feet east of SW1/4 sec. 28, T. 6 S., R. 5 E.
[2]Dougherty loamy fine sand: 2,640 feet south and 400 feet east of NW1/4 sec. 12, T. 8 S., R. 5 E.
[3]Durant loam: 2,590 feet north and 300 feet east of SW1/4 sec. 34, T. 5 S., R. 6 E.
[4]Ferris clay: 1,540 feet south and 800 feet west of NE1/4 sec. 16, T. 6 S., R. 6 E.
[5]Frioton silty clay loam: 2,020 feet north and 2,000 feet east of NW corner sec. 36, T. 5 S., R. 5 E.
[6]Konsil fine sandy loam: 100 feet south and 100 feet west of NE1/4 sec. 12 T. 5 S., R. 4 E.
[7]Konawa fine sandy loam: 1,320 feet west and 800 feet north of SE1/4 sec. 15, T. 8 S., R. 5 E.

TABLE 22.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Bastrop	Fine-loamy, mixed, thermic Udic Paleustalfs
*Bates	Fine-loamy, siliceous, thermic Typic Argiudolls
Burleson	Fine, montmorillonitic, thermic Udic Pellusterts
*Collinsville	Loamy, siliceous, thermic Lithic Hapludolls
*Counts	Fine, mixed, thermic Albaquic Paleudalfs
Dougherty	Loamy, mixed, thermic Arenic Haplustalfs
Durant	Fine, montmorillonitic, thermic Vertic Argiustolls
Eufaula	Sandy, siliceous, thermic Psammentic Paleustalfs
Ferris	Fine, montmorillonitic, thermic Udorthentic Chromusterts
Frioton	Fine, mixed, thermic Cumulic Hapludolls
Gracemont	Coarse-loamy, mixed (calcareous), thermic Aquic Udifluvents
Heiden	Fine, montmorillonitic, thermic Udic Chromusterts
Konawa	Fine-loamy, mixed, thermic Ultic Haplustalfs
Konsil	Fine-loamy, siliceous, thermic Ultic Paleustalfs
Madill	Coarse-loamy, mixed, nonacid, thermic Typic Udifluvents
Purves	Clayey, montmorillonitic, thermic Lithic Calciustolls
*Tarrant	Clayey-skeletal, montmorillonitic, thermic Lithic Calciustolls
Teller	Fine-loamy, mixed, thermic Udic Argiustolls
Wilson	Fine, montmorillonitic, thermic Vertic Ochraqualfs

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