



United States
Department of
Agriculture

Soil
Conservation
Service

In Cooperation with
Texas
Agricultural
Experiment
Station

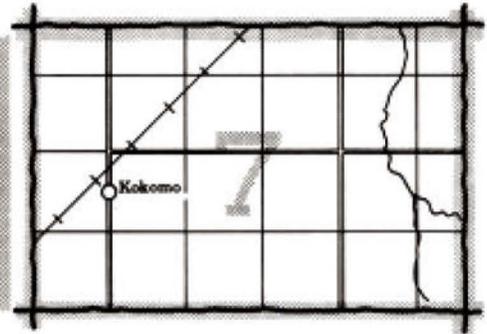
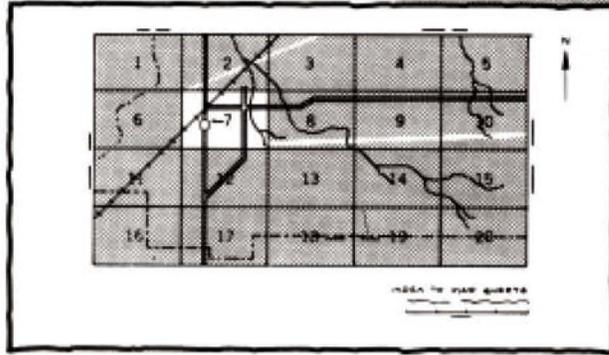
Soil Survey of Comal and Hays Counties Texas

Part 1



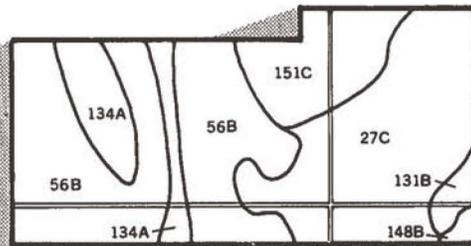
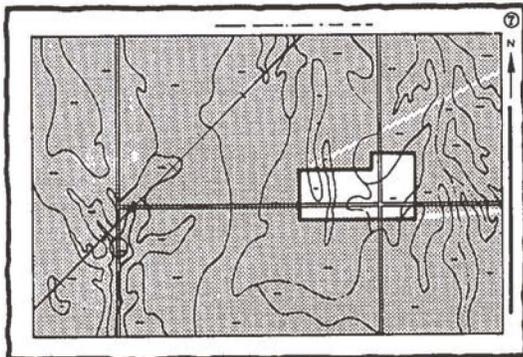
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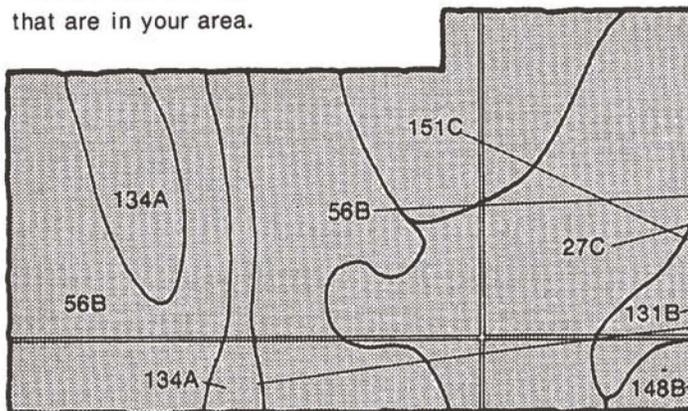


2. Note the number of the map sheet and turn to that sheet.

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



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

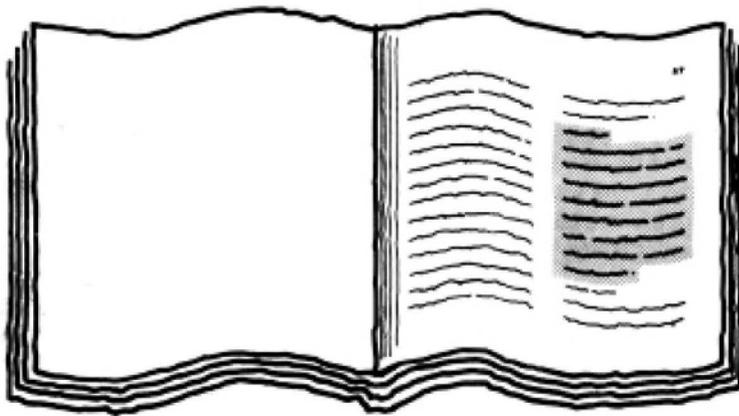


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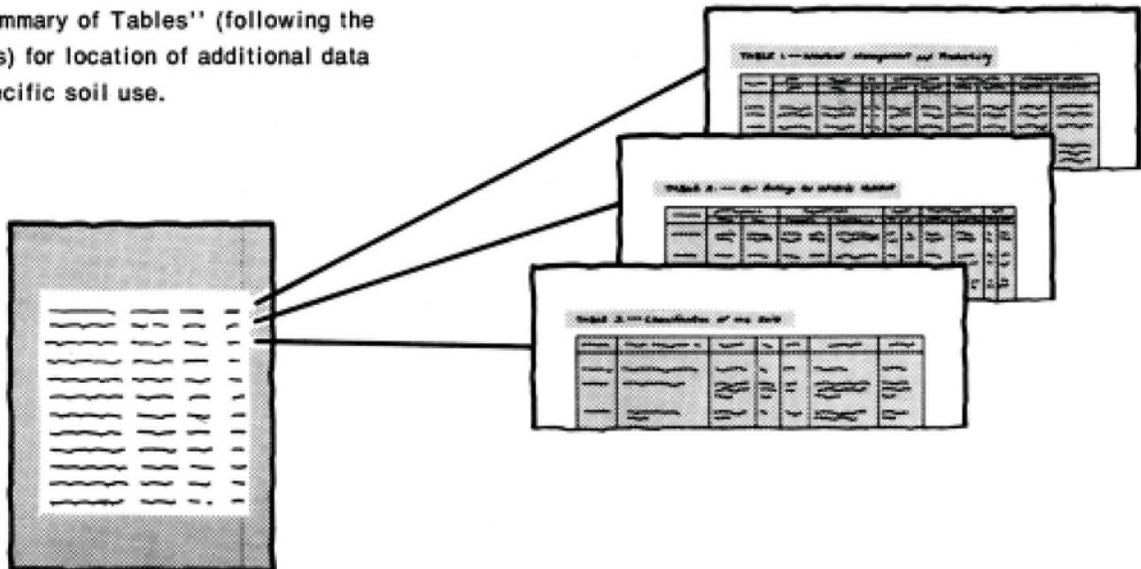
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THIS SOIL SURVEY

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.

A detailed illustration of a table with multiple columns and rows, representing the 'Index to Soil Map Units'. The table is organized into sections with bolded headers, and each row contains text and numbers, likely representing map unit names and their corresponding page numbers.

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



Consult "Contents" for parts of the publication that will meet your specific needs.

7. 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 1975-80. Soil names and descriptions were approved in 1981. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1981. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Comal-Hays-Guadalupe Soil and Water Conservation District and the Hays-Caldwell-Travis Soil and Water 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: An area of Rumble-Comfort association, undulating. The soil is Rumble very cherty clay loam. It produces medium yields of range forage.

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foreword

This soil survey contains information that can be used in land-planning programs in Comal and Hays Counties. 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.

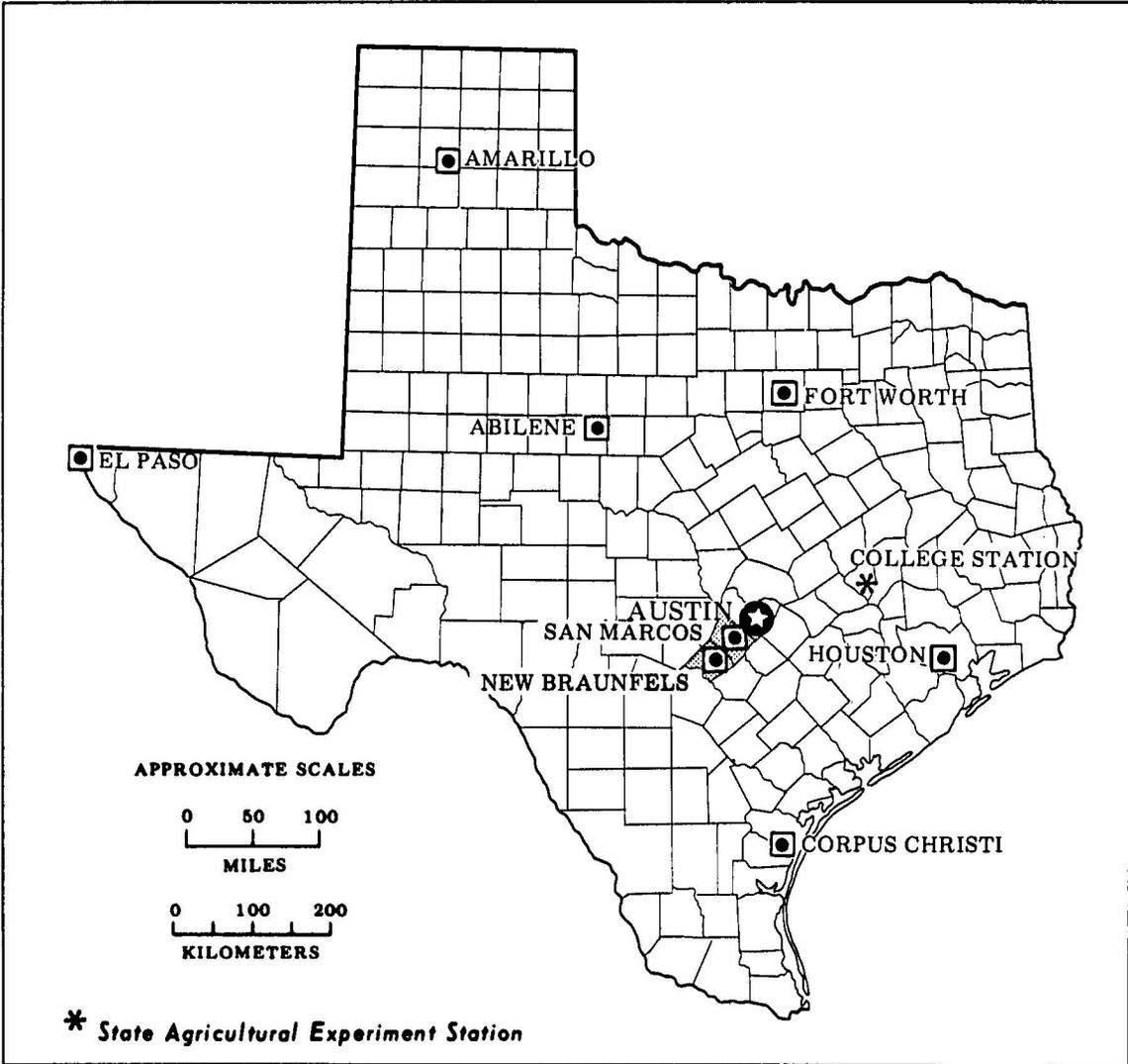
This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use 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.



George C. Marks
State Conservationist
Soil Conservation Service



Location of Comal and Hays Counties in Texas.

soil survey of Comal and Hays Counties Texas

By Charles D. Batte, Soil Conservation Service

Fieldwork by Charles D. Batte, Rosendo Trevino III, James Divin, and Eddie D. Bearden,
Soil Conservation Service

Audrey C. Lowther and Robert N. Ramsey, Soil Conservation Service,
assisted in field mapping

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

COMAL AND HAYS COUNTIES are in south-central Texas. The two counties have a total area of 791,680 acres, or 1,237 square miles. Comal County has an area of 362,880 acres and Hays County, 428,800 acres. The survey area is bordered by Travis County on the north, Caldwell and Guadalupe Counties on the east, Bexar County on the south, and Kendall and Blanco Counties on the west.

In 1970, according to the U.S. Census, the population of Comal County was 24,195, and that of Hays County was 27,642. In 1980, the population of Comal County was 36,446. New Braunfels, the county seat, had a population of 17,859 in 1970 and a population of 22,402 in 1980. In 1980, the population of Hays County was 40,594. San Marcos, the county seat, had a population of 18,860 in 1970 and a population of 23,420 in 1980.

The Balcones Escarpment extends through the eastern part of both counties, separating the Edwards Plateau Land Resource Area and the Blackland Prairie Land Resource Area (fig. 1). Soils of the Edwards Plateau, locally known as the "Hill Country," are mostly shallow stony clays and gravelly clay loams. Soils of the Blackland Prairie are mainly deep clays. Elevation ranges from about 600 to 1,600 feet.

Land use in the survey area has undergone significant change since 1960. Some of the land once used for agriculture has been converted to urban uses. This

conversion is due mainly to the expansion of the nearby urban areas of San Antonio and Austin. The growth of the smaller urban areas around New Braunfels and San Marcos and of retirement communities near Canyon Lake and Wimberley also has contributed to this change in land use.

Another significant change in land use has been the conversion of cropland, much of it marginal, to use as pasture. Since 1960 there has been a net loss of cropland and rangeland and a gain in urban land and land in pasture.

general nature of the survey area

This section provides information of general interest about Comal and Hays Counties. It discusses briefly history, climate, natural resources, and agriculture.

history

The area that is now Comal and Hays Counties was once occupied by nomadic Indians. Spanish explorers visited the area in the late 1600's and in 1691 blazed the Camino Real, or King's Highway. The road passed through the eastern part of the area that is now Comal and Hays Counties. It connected the Spanish missions in

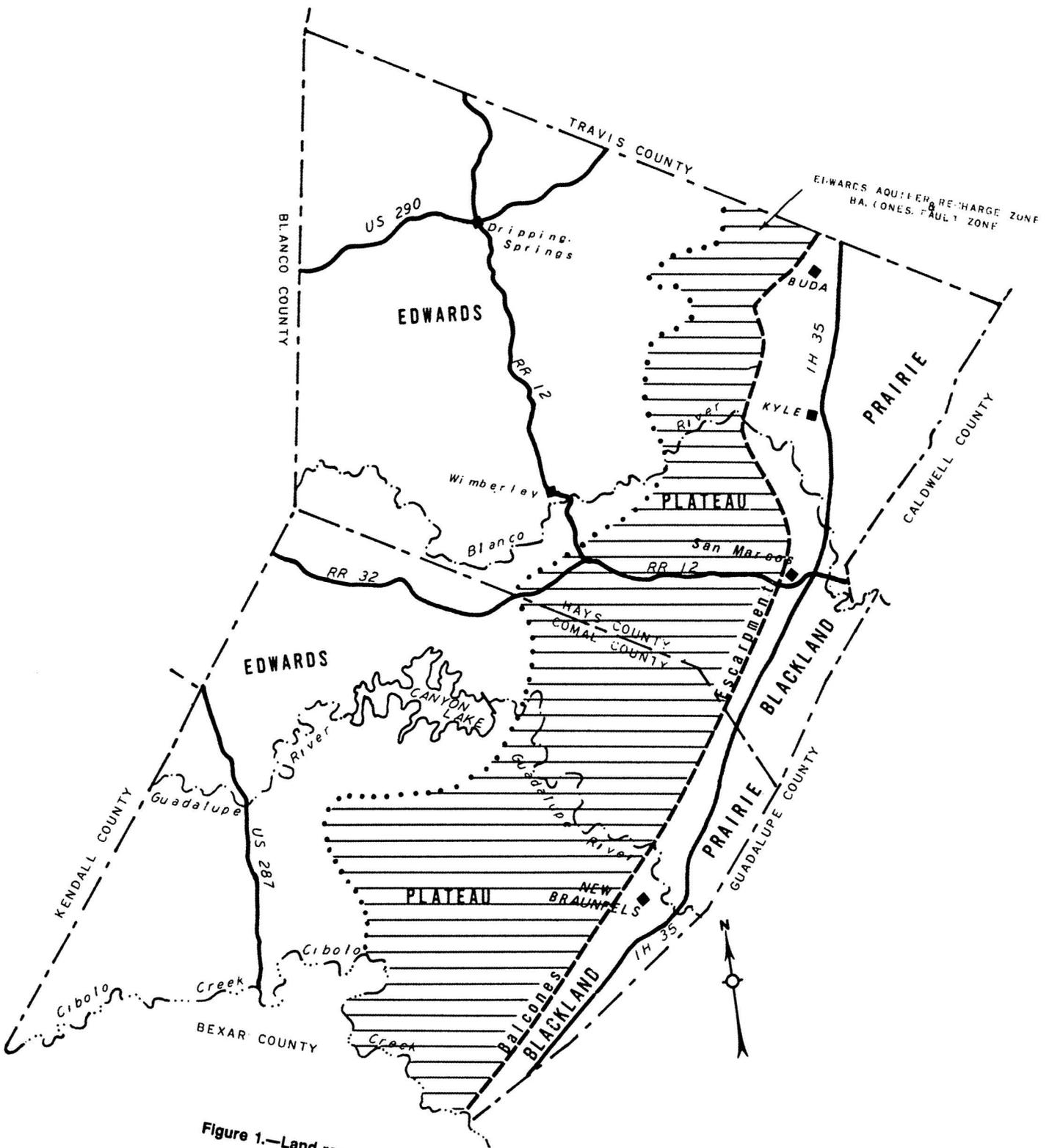


Figure 1.—Land resource areas in Comal and Hays Counties.

eastern Texas with settlements in Mexico. Spanish missions were built near San Marcos Springs and Comal Springs around the middle of the 1700's.

Comal County was organized in 1846 from Bexar, Gonzales, and Travis Counties. It was named for the Comal River.

Hays County was organized in 1848 from Travis County. It was named for John Coffee Hays, a famous Texas Ranger.

natural resources

Soil is the most important resource in Comal and Hays Counties. It provides the base for a wide range of agricultural enterprises, including the production of livestock forage and of feed and fiber crops.

The soils in the Blackland Prairie Land Resource Area are well suited to improved pasture grasses. Many of these soils are well suited to field crops. Coastal bermudagrass, medio bluestem, King Ranch bluestem, and kleingrass are some of the most widely grown pasture grasses. Grain sorghum, cotton, corn, wheat, and oats are the most common crops. Some of the soils in this area are suitable for irrigation.

The soils in the Edwards Plateau Land Resource Area generally are best suited to use as rangeland. If proper management is practiced, most of these soils can provide good yields of high-quality forage for livestock.

Water is an important resource found in abundance in Comal and Hays Counties. The Edwards Aquifer (see figure 1) provides a steady supply of water of good quality for agricultural, municipal, industrial, and home use (3, 4). Part of the recharge zone for the aquifer is within the survey area. Two large springs and many small ones rise from the aquifer. Comal Springs in New Braunfels has an average flow of about 184 million gallons per day and is the source of the Comal River. San Marcos Springs in the city of San Marcos has an average flow of about 107 million gallons per day and is the source of the San Marcos River. These two rivers, as well as the Guadalupe and Blanco Rivers and Canyon Lake in Comal County, provide a multitude of recreation opportunities.

Wildlife, including deer, is abundant in the survey area. Several ranches have been stocked with exotic game animals.

Other natural resources include limestone, gravel, and caliche, which are excavated from open pit mines and are used mainly in road construction, as building material, and in the manufacture of cement.

agriculture

The part of the survey area in the Edwards Plateau, or "Hill Country," is used mainly as rangeland, whereas the part in the Blackland Prairie is used mainly as cropland and pasture.

Ranches in the "Hill Country" are mostly beef cattle operations. Raising sheep and goats was a major enterprise at one time, but few are raised at present. There are small scattered areas of cropland. Oats and forage sorghums are the main crops. Hay is grown as a cash crop and for supplemental cattle feed during the winter.

In the Blackland Prairie, growing cultivated crops was once the primary agricultural enterprise. However, erosion on the more sloping soils, for example, map units AgC3, AgD3, AuC3, CaC3, DeC3, FeF4, HeC3, and HeD3, in the Altoga, Austin, Castephen, Denton, Ferris, and Heiden series, has caused a decrease in productivity. Most of these soils are now used as pasture or have been reestablished to native range. Raising beef cattle is the main livestock operation, although there are also a few dairy herds in the area. On the better soils, the main crops are grain sorghum, cotton, corn, oats, and wheat.

climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Summers in Comal and Hays Counties are hot, and winters are fairly warm. Cold spells are of short duration, and snowfall is rare. Rainfall usually is heaviest late in spring and early in fall. In the fall, rain often is associated with a dissipating tropical storm. The total annual precipitation usually is adequate for range vegetation. Because of the high rate of evapotranspiration, however, it often is not adequate for optimum growth of cotton, small grains, and sorghum.

Table 1 gives data on temperature and precipitation for the survey area as recorded at New Braunfels in the period 1951 to 1978. 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 52 degrees F, and the average daily minimum temperature is 40 degrees. The lowest temperature on record, which occurred at New Braunfels on February 2, 1951, is 8 degrees. In summer the average temperature is 84 degrees, and the average daily maximum temperature is 96 degrees. The highest recorded temperature, which occurred on July 19, 1951, is 110 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, 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.

The total annual precipitation is about 33 inches. Of this, 19 inches, or 57 percent, usually falls in April through September, which includes the growing season

for most crops. In 2 years out of 10, the rainfall in April through September is less than 14 inches. The heaviest 1-day rainfall during the period of record was 6.65 inches at New Braunfels on October 4, 1959. Unofficial records indicate that 16 inches of rain fell in a 4-hour period about 5 miles northwest of New Braunfels on May 11, 1972. Thunderstorms occur on about 40 days each year, and most occur in spring.

Snowfall is rare. In 90 percent of the winters, there is no measurable snowfall. In 10 percent, the snowfall, usually of short duration, is more than 2 inches. The heaviest 1-day snowfall on record was more than 3 inches.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the southeast. Average windspeed is highest, 10 miles per hour, in spring.

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 units" and "Detailed soil map units."

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.

A small part of Hays County was included in the Soil Survey of the San Marcos Area, which was published in 1906 (5). This soil survey of Hays County and Comal County gives additional information about the soils in the area and contains maps that show the soils in greater detail than those in the earlier survey.

general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units 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 map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

soil descriptions

1. Brackett-Comfort-Real

Shallow, undulating to steep soils over limestone or strongly cemented chalk; on uplands of Edwards Plateau

This map unit is made up dominantly of well drained soils that have slopes of 1 to 30 percent (fig. 2). The soils are on hills, ridges, and valleys. They are underlain by alternating layers of chalk, marl, and cemented to indurated limestone. The limestone is more resistant to weathering and erosion than the marl. Consequently, limestone ledges give the hill slopes a benched or stepped appearance. This map unit accounts for about 49 percent of the survey area.

Brackett soils make up about 23 percent of the unit; Comfort soils make up 17 percent; Real soils make up 9 percent; and Bolar, Denton, Doss, Eckrant, Krum, Lewisville, Orif, Purves, Sunev, and Tarpley soils and Rock outcrop make up 51 percent.

The Brackett soils are undulating to steep. They are on hill slopes. Typically, the surface layer is grayish brown gravelly clay loam about 6 inches thick. The subsoil is light gray gravelly clay loam about 8 inches thick. The underlying material is weakly cemented limestone that has thin strata of calcareous shaly clay.

The Comfort soils are undulating. They are on ridge summits and short hill slopes near indurated limestone outcrops. Typically, the surface layer is dark brown

extremely stony clay about 6 inches thick. The subsoil is dark reddish brown extremely stony clay about 7 inches thick. The underlying material is indurated, fractured limestone.

The Real soils are undulating to steep. They are on hill slopes. Typically, these soils are dark grayish brown to a depth of about 14 inches. The upper part is gravelly loam, the middle part is very gravelly loam, and the lower part is extremely stony loam. The underlying material is strongly cemented platy chalk.

The other soils in this map unit are the shallow, clayey Doss, Purves, and Tarpley soils on broad ridge summits and hillside benches; the shallow, strongly sloping to steep, stony and clayey Eckrant soils on hill slopes; the moderately deep, clayey Denton soils; the moderately deep, loamy Bolar soils; the deep, clayey Krum soils; the deep, loamy Sunev soils on foot slopes and toe slopes in valleys; the deep Lewisville soils on stream terraces; and the deep Orif soils on narrow flood plains.

The soils in this map unit are used mainly as rangeland. In a few areas they are used as pastureland and hayland. Many areas offer scenic views and are being converted to urban uses.

Forage yields on rangeland generally are medium because of the shallow rooting depth, the medium to rapid runoff, and the very low available water capacity.

The soils in this unit are not suited to use as cropland or pasture. They are suited to use as habitat for wildlife. They provide food and cover for deer, turkey, and quail.

Shallowness to rock, slope, and stoniness are limitations for urban and recreational uses.

2. Comfort-Rumple-Eckrant

Very shallow to moderately deep, undulating to steep and hilly soils over indurated limestone; on uplands of Edwards Plateau

This map unit is made up dominantly of well drained soils that have slopes of 1 to 30 percent (fig. 3). The soils are on broad divides widely intersected by small drainageways. Sinks as much as 500 feet across are scattered over the landscape. There are areas of hilly and steep soils near the larger streams. This map unit accounts for about 31 percent of the survey area.

Comfort soils make up about 36 percent of the unit; Rumple soils make up 26 percent; Eckrant soils make up 8 percent; and Anhalt, Denton, Krum, Orif, Purves, Real,

Sunev, and Tarpley soils and Rock outcrop make up 30 percent.

The Comfort soils are undulating. They are on ridge summits and short hill slopes. Typically, the surface layer is dark brown extremely stony clay about 6 inches thick. The subsoil is dark reddish brown extremely stony clay about 7 inches thick. The underlying material is indurated, fractured limestone.

The Rumble soils are undulating. They are on broad interstream divides and short hill slopes. Typically, the surface layer is dark reddish brown very cherty clay loam about 10 inches thick. The subsoil is about 18 inches thick. To a depth of 14 inches it is dark reddish brown very cherty clay, and to a depth of 28 inches it is dark reddish brown extremely stony clay. The underlying material is indurated, fractured limestone.

The Eckrant soils are strongly sloping to steep. They are on side slopes of high ridges. Typically, the surface layer is very dark gray extremely stony clay about 10 inches thick. It is moderately alkaline. The underlying material is indurated, fractured limestone.

The other soils in this map unit are the shallow, clayey Tarpley and Purves soils on hillside benches and toe slopes; the shallow, loamy Real soils on low ridges intermingled with chalk outcrops; the moderately deep, clayey Anhalt and Denton soils; the deep, clayey Krum and Sunev soils on toe slopes in wide U-shaped valleys; and the deep Orif soils on narrow flood plains.

In most areas the soils in this map unit are used as rangeland. In a few areas they are used as pastureland and hayland. Many areas offer scenic views and are being converted to urban uses.

Forage yields on rangeland generally are medium.

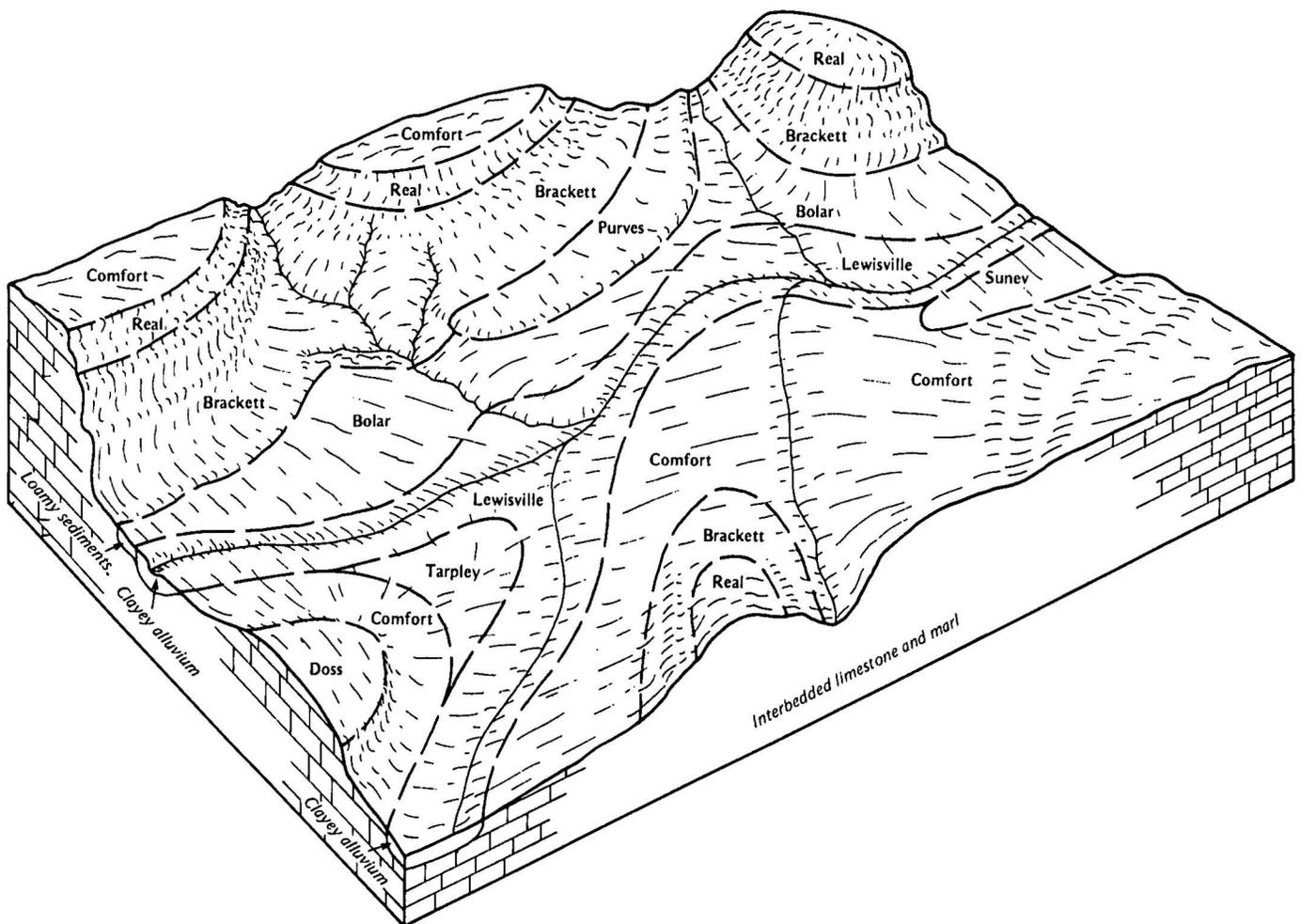


Figure 2.—Pattern of soils in the Brackett-Comfort-Real general soil map unit.

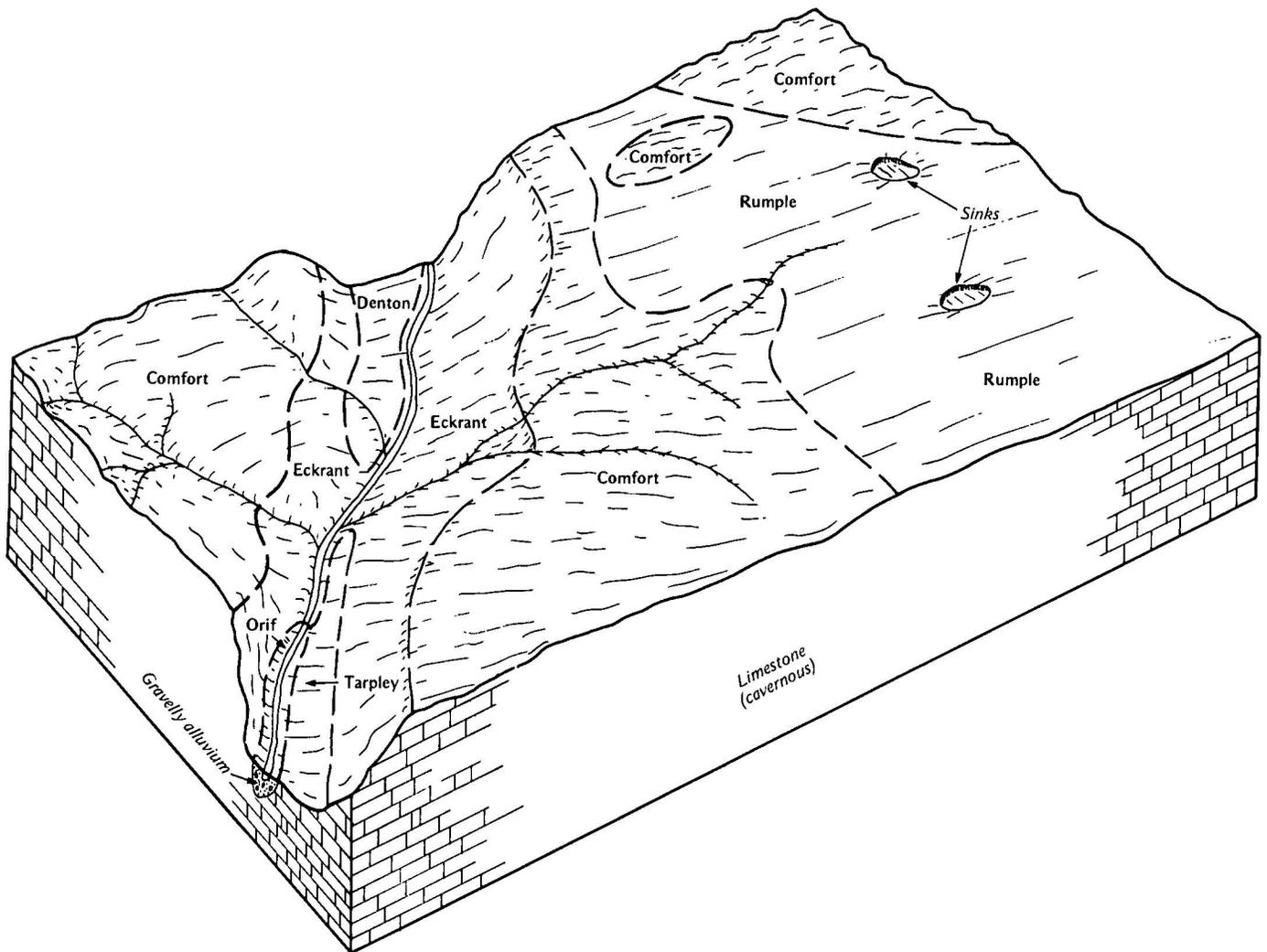


Figure 3.—Pattern of soils in the Comfort-Rumple-Eckrant general soil map unit.

The soils are not suited to crops or pasture, except in a few small areas where the soils are deeper. The shallow to very shallow rooting zone, the very low available water capacity, stoniness, and slope are limitations.

The soils provide habitat for deer, turkey, and quail.

Shallowness to rock, slope, and stoniness are limitations for urban and recreation uses.

3. Heiden-Houston Black

Deep, gently sloping to sloping soils over clay and shale; on uplands of Blackland Prairie

This map unit is made up dominantly of well drained and moderately well drained soils that have slopes of 1

to 8 percent (fig. 4). This map unit accounts for about 9 percent of the survey area.

Heiden soils make up about 42 percent of the map unit; Houston Black soils make up about 38 percent; and Altoga, Branyon, Ferris, and Tinn soils make up 20 percent.

The Heiden soils are gently sloping to sloping. They are mainly on the more eroded parts of the landscape. Typically, the surface layer is dark grayish brown clay about 13 inches thick. The layer below that, to a depth of 58 inches, is grayish brown clay. The underlying material is grayish brown shaly clay.

The Houston Black soils are gently sloping to sloping. They are on ridge summits and on long, smooth ridge slopes. Typically, the soil material is very dark gray clay

to a depth of about 50 inches. To a depth of 77 inches, it is grayish brown and gray clay. The underlying material is yellow marly clay.

The other soils in this map unit are the deep, clayey, highly calcareous Altoga soils on uplands; the deep, clayey Ferris soils on old eroded hill slopes; the deep, clayey Branyon soils on old stream terraces; and the deep, clayey Tinn soils on flood plains.

The soils in this map unit are used mainly for crops and pasture. Most areas of the more sloping soils on hillsides have been converted from cropland to pasture.

The soils are well suited to moderately well suited to row crops, including cotton and grain sorghum. The suitability depends on the slope and the hazard of erosion. The eroded and sloping Heiden soils are poorly suited to use as cropland. Erosion control is needed in most cropped areas.

The soils in this map unit are moderately well suited to well suited to use as pasture.

If the soils are used as rangeland, forage yields are high.

The soils provide suitable habitat for openland wildlife, including rabbit and small birds.

There are limitations to use of the soils for urban and recreation uses. The limitations, which are difficult to overcome, include the high shrink-swell potential, corrosivity to uncoated steel, clayey texture, very slow permeability, and low strength, which affects roads and streets.

4. Lewisville-Gruene-Krum

Deep, shallow, and very shallow, nearly level to gently sloping soils over loamy, clayey, and gravelly sediments; on stream terraces and valley fills of Blackland Prairie and Edwards Plateau

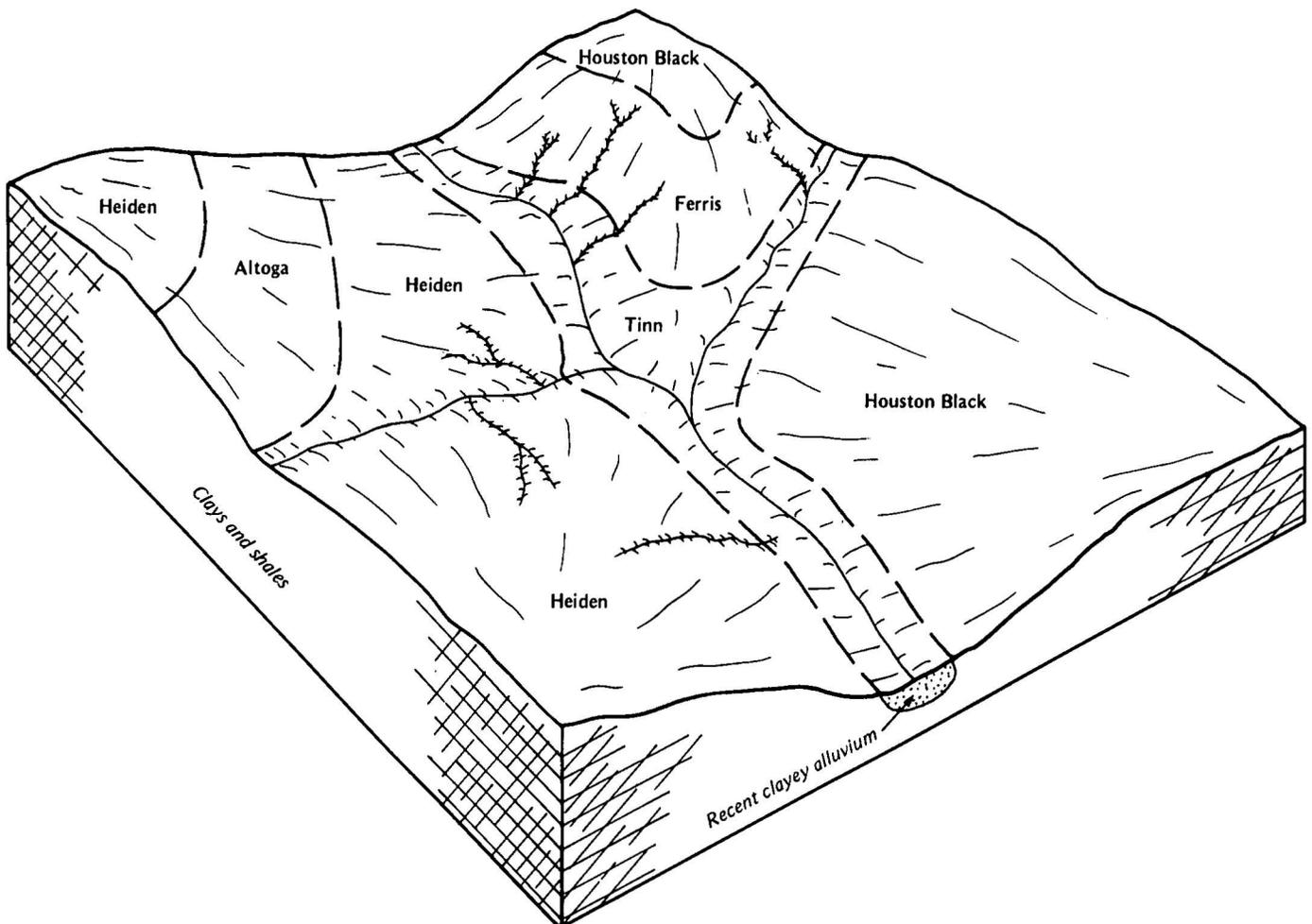


Figure 4.—Pattern of soils in the Heiden-Houston Black general soil map unit.

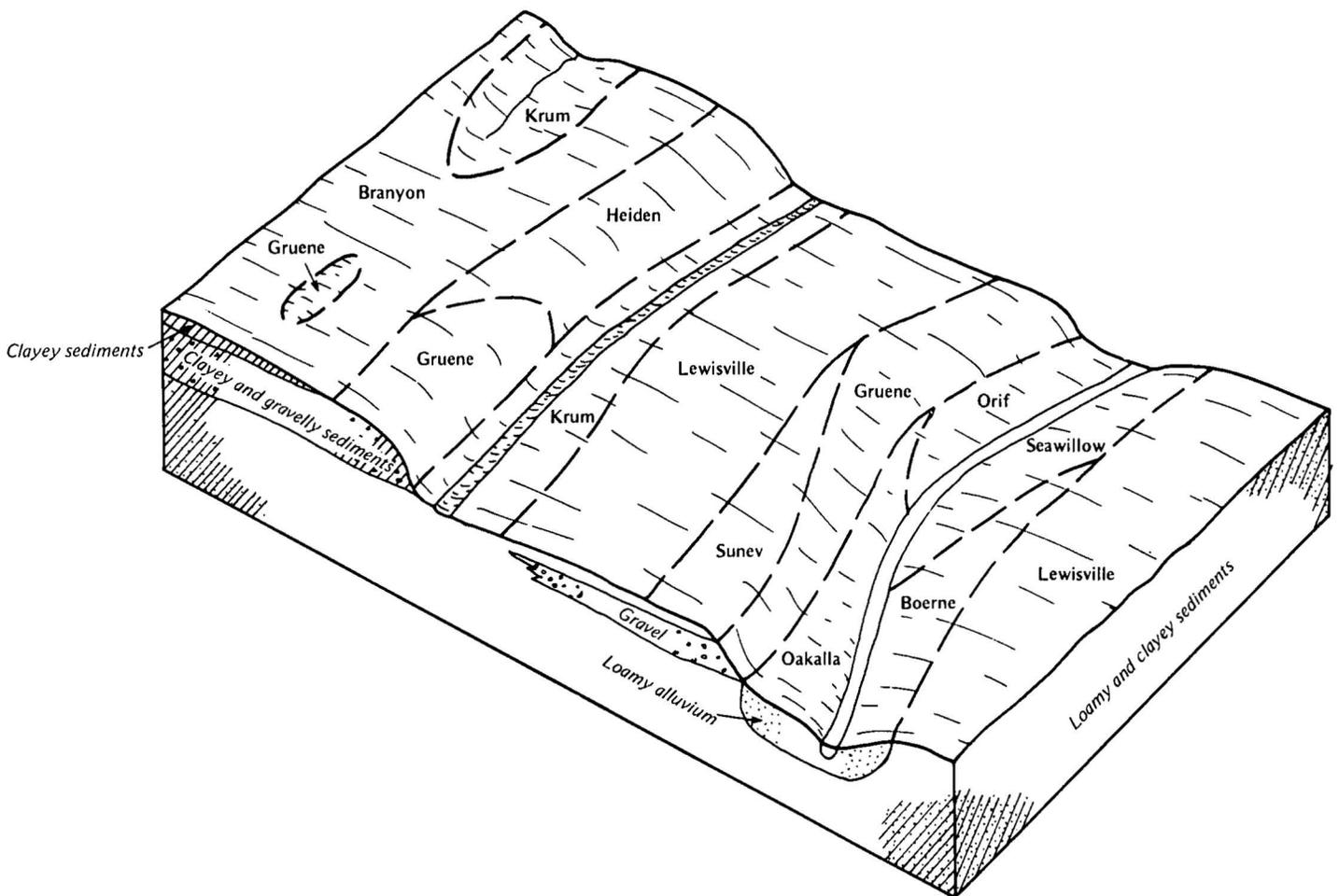


Figure 5.—Pattern of soils in the Lewisville-Gruene-Krum and Branyon-Krum general soil map units.

This map unit is made up dominantly of well drained soils that have slopes of 0 to 5 percent (fig. 5). The soils are on low terraces along rivers and large creeks. This map unit accounts for about 4 percent of the survey area.

Lewisville soils make up about 27 percent of the map unit; Gruene soils make up 14 percent; Krum soils make up 13 percent; and Boerne, Branyon, Oakalla, Orif, Seawillow, and Sunev soils and Pits make up 46 percent.

The Lewisville soils are nearly level to gently sloping. They are in plane to slightly convex areas that are slightly higher on the landscape than the areas of the Krum soils and lower than those of the Gruene soils. Lewisville soils are moderately permeable. Typically, the surface layer is dark grayish brown silty clay about 17 inches thick. The subsoil to a depth of 36 inches is brown silty clay, and to a depth of 54 inches it is

yellowish brown silty clay. The underlying material is brown silty clay.

The Gruene soils are gently sloping. They are in convex areas that are slightly higher than the areas of Lewisville and Krum soils. Typically, the surface layer is very dark grayish brown clay about 13 inches thick. The layer below that is strongly cemented caliche. It extends to a depth of 22 inches. The underlying material is stratified very gravelly sand and very gravelly loam.

The Krum soils are nearly level to gently sloping. They are in slightly concave areas that are slightly lower in elevation than the areas of Lewisville and Gruene soils. Some of these areas are old stream channels that have been filled. Krum soils are moderately slowly permeable. Typically, the surface layer is dark gray clay about 16 inches thick. The subsoil extends to a depth of 58 inches. It is grayish brown clay. The underlying material is brown clay.

The other soils in this unit are the deep, loamy Boerne, Seawillow, and Sunev soils in convex to plane areas on the lowest stream terraces; the deep, clayey Branyon soils in slightly concave areas; and the deep, loamy Oakalla soils and the deep, sandy and gravelly Orif soils on flood plains.

The soils in this map unit are used mainly for crops and pasture. Lewisville and Krum soils are well suited to these uses. Gruene soils are poorly suited because they are shallow to caliche. Irrigation is used in a few areas.

In a few areas the soils are used as rangeland. Forage yields are high on the Lewisville and Krum soils and medium on the Gruene soils.

The soils provide habitat for openland wildlife, including rabbit and small birds. Deer, turkey, and quail inhabit areas where they find cover and food.

There are limitations to use of the soils for urban development. The limitations, which are difficult to overcome, are clayey texture, shrink-swell potential, and low soil strength, which affects roads and streets. The soils are moderately well suited to recreation uses. Clayey texture is the most severe limitation.

5. Branyon-Krum

Deep, nearly level to gently sloping soils over clayey sediments; on ancient stream terraces and valley fills of Blackland Prairie

This map unit is made up dominantly of moderately well drained and well drained soils that have slopes of 0 to 5 percent (fig. 5). The soils are on ancient, high terraces along rivers and large creeks. The areas are broad and smooth and are widely dissected by small drainageways. This map unit accounts for about 3 percent of the survey area.

Branyon soils make up about 64 percent of the map unit, Krum soils make up 19 percent, and Heiden, Gruene, and Tinn soils make up 17 percent.

The Branyon soils are nearly level to gently sloping. They are mainly in broad, smooth areas. Typically, the soil material is dark gray clay to a depth of about 44 inches. To a depth of 60 inches it is grayish brown clay. The underlying material to a depth of 80 inches is very pale brown and pale yellow clay.

The Krum soils are nearly level to gently sloping. They are mainly in broad, smooth areas. Typically, the surface layer is dark gray clay about 14 inches thick. The subsoil extends to a depth of 58 inches. It is grayish brown clay. The underlying material is brown clay.

The other soils in this unit are the deep, clayey Heiden soils on hill slopes, the deep, clayey Tinn soils on narrow flood plains of small streams, and the shallow, clayey Gruene soils on convex uplands.

The soils in this map unit are used mainly as cropland. In a few areas they are used for improved pasture. The soils are well suited to crops and pasture. They are suitable for irrigation.

If the soils in this map unit are used as rangeland, forage yields are high.

The soils provide habitat for openland wildlife, including rabbit and small birds.

There are limitations to use of the soils for urban and recreation uses. The limitations, which are difficult to overcome, are clayey texture, shrink-swell potential, very slow permeability, and low strength, which affects roads and streets.

6. Krum-Medlin-Eckrant

Deep, very shallow, and shallow, undulating to steep and hilly soils over clay, shaly clay, and limestone; on stream terraces, valley fills, and uplands of Edwards Plateau

This map unit is made up dominantly of well drained soils that have slopes of 1 to 30 percent (fig. 6). The soils are on low hills and U-shaped valleys. This map unit accounts for about 2 percent of the survey area.

Krum soils make up about 30 percent of the map unit; Medlin soils make up 15 percent; Eckrant soils make up about 15 percent; and Bolar, Denton, Doss, Purves, Rumble, and Tarpley soils make up 40 percent.

The Krum soils are gently sloping. They are on foot slopes and toe slopes in U-shaped valleys. Typically, the surface layer is dark gray clay about 16 inches thick. The subsoil to a depth of 58 inches is grayish brown clay. The underlying material to a depth of 66 inches is brown clay.

The Medlin soils are undulating to hilly. They are on the middle and lower hill slopes. Typically, the surface layer is grayish brown stony clay 6 inches thick. The layer below that, to a depth of 11 inches, is grayish brown clay, and to a depth of 50 inches it is light yellowish brown clay. The underlying material is light gray shaly clay.

The Eckrant soils are undulating to hilly. They are on the upper part of hill slopes. Typically, the soil material is very dark gray extremely stony clay about 10 inches thick. The underlying material is indurated, fractured limestone.

The other soils in this map unit are the shallow, clayey Doss, Purves, and Tarpley soils on hillside benches and toe slopes in valleys; the moderately deep, clayey Denton and Bolar soils on foot slopes and toe slopes; and the moderately deep, clayey Rumble soils on the summit of ridges.

Krum soils are used mainly for crops and pasture. The principal crops are oats and forage sorghums. These soils are well suited to crops and pasture. Yields are high if good management is practiced.

The Medlin and Eckrant soils are used mainly as rangeland. Yields of range forage are medium. These soils are not suited to crops or pasture mainly because of the shallow rooting zone, slope, the very low available water capacity, and stoniness.

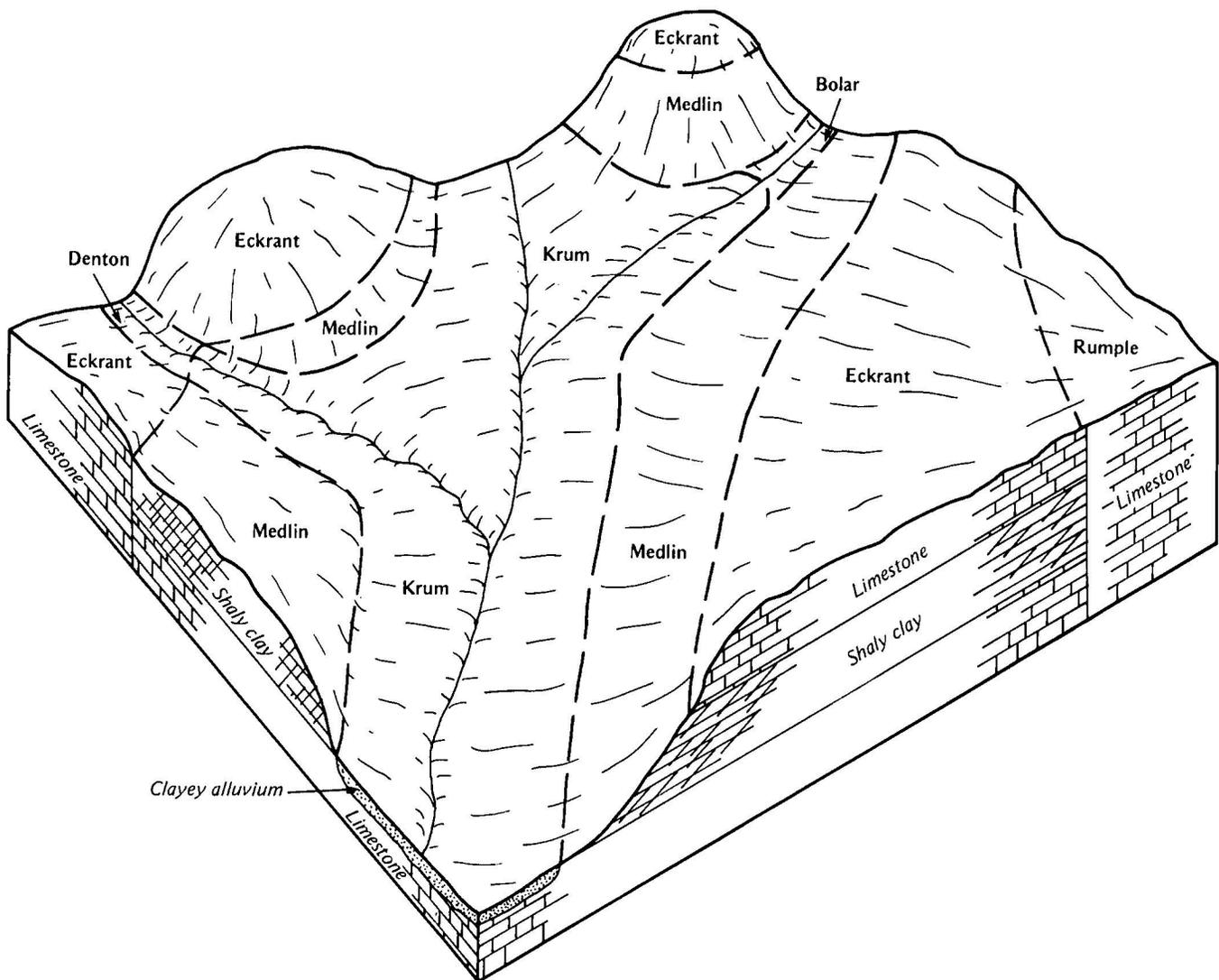


Figure 6.—Pattern of soils in the Krum-Medlin-Eckrant general soil map unit.

The soils in this map unit provide habitat for deer, turkey, dove, and quail.

There are limitations to use of the soils for urban and recreation uses. The limitations, which are difficult to overcome, are shallowness to rock, slope, stoniness, shrink-swell potential, and clayey texture.

7. Austin-Castephen-Houston Black

Shallow to deep, gently sloping to sloping soils over chalk or marly clay; on uplands of Blackland Prairie

This map unit is made up dominantly of well drained and moderately well drained soils that have slopes of 1 to 8 percent. It accounts for about 1 percent of the survey area.

Austin soils make up about 21 percent of the unit; Castephen soils make up 20 percent; Houston Black soils make up 18 percent; and Heiden, Real, and Tinn soils make up 41 percent.

Austin soils are gently sloping. Typically, the surface layer is dark grayish brown silty clay about 11 inches thick. The subsoil, to a depth of 24 inches, is brown and pale brown silty clay. The underlying material is white, weakly cemented platy chalk.

Castephen soils are gently sloping. Typically, the surface layer to a depth of 8 inches is dark grayish brown clay loam, and to a depth of 16 inches it is dark brown clay loam. The underlying material is white, weakly cemented, platy chalk.

Houston Black soils are gently sloping. They are in plane to slightly concave areas near small drainageways. The positions are lower on the landscape than those of Austin and Castephen soils. Typically, the soil material is very dark gray clay to a depth of about 50 inches. To a depth of 77 inches, it is grayish brown clay. The underlying material is yellow marly clay.

The other soils in this map unit are the deep, clayey Heiden soils on convex uplands; the deep, clayey Tinn soils on flood plains of small creeks; and the shallow, loamy Real soils on ridges and hill slopes.

The soils in this map unit are used mainly as rangeland and pastureland. In a few areas they are used for row crops and hay.

Most of the soils are well suited to pasture. Forage yields are high.

The Austin and Houston Black soils are well suited to crops, and the Castephen soils are poorly suited because of a shallow rooting zone.

The soils in this map unit provide habitat for openland wildlife, including rabbit and small birds.

The Austin and Houston Black soils have several limitations for urban and recreation uses, including high shrink-swell potential, very slow permeability, clayey texture, and low strength, which affects roads and streets. These limitations are difficult to overcome. On the Castephen soils, shallowness to rock and the clayey texture are limitations for urban and recreation uses.

detailed soil map units

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 and gives the principal hazards and limitations to be considered in planning for specific uses.

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, Heiden clay, 1 to 3 percent slopes, is one of several phases in the Heiden series.

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

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. Austin-Castephen complex, 1 to 3 percent slopes, is an example.

A *soil association* is made up of two or more geographically associated soils that are shown as one unit on the maps. Because of present or anticipated soil uses in the survey area, it was not considered practical or necessary to map the soils separately. The pattern and relative proportion of the soils are somewhat similar. Rumble-Comfort association, undulating, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in a mapped area are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Oakalla soils, frequently flooded, is an undifferentiated group in this survey area.

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.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown 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.

Some of the boundaries on the soil maps of Comal and Hays Counties do not match those on the soil maps of adjacent counties, and some of the soil names and descriptions do not fully agree. The differences are a result of improvements in the classification of soils, particularly modification or refinements in soil series concepts. Also, there may be differences in the intensity of mapping or in the extent of the soils within the survey area.

soil descriptions

AgC3—Altoga silty clay, 2 to 5 percent slopes, eroded. This is a deep, gently sloping soil on convex, smooth slopes of low hills. The areas are irregular in shape and range from 5 to 150 acres in size. Sheet and rill erosion have removed 25 to 50 percent of the surface layer. Small gullies less than 3 feet deep and generally

500 to 1,000 feet apart are scattered throughout the areas.

Typically, the surface layer is grayish brown, moderately alkaline silty clay about 7 inches thick. The upper part of the subsoil extends to a depth of 13 inches. It is light brownish gray, moderately alkaline silty clay. The lower part of the subsoil extends to a depth of 36 inches. It is light gray, moderately alkaline silty clay that has a few soft masses and rounded concretions of calcium carbonate. It is about 55 percent calcium carbonate (lime). The next layer, to a depth of 60 inches, is white, moderately alkaline silty clay.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is high. The rooting zone is deep. Water erosion is a moderate hazard. Fertility has been reduced because of erosion.

Included with this soil in mapping are small areas of Heiden and Ferris soils and areas of less sloping Altoga soils that are not eroded or are only slightly eroded. The included soils make up less than 15 percent of a mapped area.

This soil was once used mainly for row crops. However, it is now used mainly for pasture or hay. Grain sorghum, forage sorghums, and small grains are the main crops. King Ranch bluestem and Coastal bermudagrass are the main pasture grasses.

This soil is moderately well suited to use as cropland. Medium yields can be obtained under good management. Fertilization and proper residue management improve tilth and fertility and help prevent erosion. Contour farming and terraces are needed to control runoff. In some places, grassed waterways are needed to carry off excess water from terraces. Lime-induced chlorosis is a problem on this soil, especially for sorghum crops.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This Altoga soil is well suited to use as pastureland. Improved bermudagrass, kleingrass, medio bluestem, and King Ranch bluestem grow well on this soil. Good management includes proper stocking, controlled grazing, and brush management. Gullies need shaping, smoothing, and revegetating.

This soil provides habitat for quail, dove, rabbit, small birds, and other openland wildlife.

Clayey texture, shrink-swell potential, corrosivity to uncoated steel, and low strength, which affects roads and streets, are limitations for urban uses. Slope is the main limitation for recreation uses.

This soil is in capability subclass IIIe and in the Clay Loam range site.

AgD3—Altoga silty clay, 5 to 8 percent slopes, eroded. This is a deep, sloping soil on convex, smooth hill slopes. The areas are irregular in shape and range from 5 to 450 acres in size. Sheet and rill erosion have

removed 25 to 50 percent of the surface layer. Gullies less than 3 feet deep and generally 500 to 800 feet apart are scattered throughout the areas.

Typically, the surface layer is grayish brown, moderately alkaline silty clay about 12 inches thick. The upper part of the subsoil extends to a depth of 27 inches. It is light yellowish brown, moderately alkaline silty clay. The lower part of the subsoil extends to a depth of 42 inches. It is pale yellow, moderately alkaline silty clay that has a few soft masses of calcium carbonate. It is about 55 percent calcium carbonate (lime). The underlying layer, to a depth of 60 inches, is pale yellow, moderately alkaline shaly clay.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is high. The rooting zone is deep. Water erosion is a severe hazard. Fertility has been reduced because of erosion.

Included with this soil in mapping are small areas of Heiden and Ferris soils and a soil similar to this Altoga soil that has a dark gray surface layer. The included soils make up less than 15 percent of a mapped area.

In many areas, this soil was once used for row crops. In most areas it is now used for pasture or hay. Forage sorghums are the main crops. King Ranch bluestem and Coastal bermudagrass are the main pasture grasses. In a few areas this soil is used as rangeland.

This soil is not suited to use as cropland. Fertility is low, and continuous vegetative cover is needed to adequately protect the soil from erosion.

This soil is well suited to use as pastureland. Improved bermudagrass, kleingrass, medio bluestem, and King Ranch bluestem grow well. Good management includes proper stocking and controlled grazing. Gullies need shaping, smoothing, and revegetating.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides habitat for quail, dove, rabbit, small birds, and other openland wildlife.

For urban uses, the main limitations are the clayey texture, shrink-swell potential, low strength affecting roads and streets, corrosivity to uncoated steel, and slope. These limitations can be overcome through good design and careful installation. Slope is the main limitation for recreation uses.

This soil is in capability subclass VIe and in the Clay Loam range site.

AnA—Anhalt clay, 0 to 1 percent slopes. This is a moderately deep, nearly level soil on plane to slightly concave slopes on uplands. It is generally near streams. The areas are irregular in shape and range from 10 to 250 acres in size.

Typically, the surface layer is dark brown, mildly alkaline clay about 18 inches thick. The layer below that extends to a depth of 28 inches and is dark reddish

brown, mildly alkaline clay. Below that, there is fractured, hard limestone.

This soil is well drained. In most areas it is not flooded. However, in a few areas adjacent to stream channels it is subject to rare flooding for brief periods. Surface runoff is slow. The available water capacity is low. Permeability is very slow. Water enters rapidly when the soil is dry and cracked and very slowly when the soil is wet. The rooting zone is moderately deep. However, the high content of clay tends to impede root penetration. If the soil is cultivated, good tilth is difficult to maintain because the clay causes the soil to be sticky when wet and very hard and cloddy when dry. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Tarpley and Denton soils, a few small areas of soils similar to the Anhalt soil except that they are deeper than 40 inches to bedrock, and a few areas of another soil that is similar to this Anhalt soil except that it is dark gray throughout. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. Small grains and forage sorghums are the main crops. In some areas this soil is used as rangeland or for improved pasture.

This soil is moderately well suited to use as cropland. Very slow permeability and the low available water capacity are the main limitations. These conditions can be improved, and good tilth and fertility can be maintained if proper residue management is practiced.

This Anhalt soil is well suited to use as improved pasture. Improved bermudagrass, kleingrass, and medio bluestem grow well. This soil produces high yields of native range grasses in favorable years. Good management includes proper stocking, controlled grazing, and brush management.

This soil provides good habitat for quail, dove, rabbit, small birds, and other openland wildlife.

For urban uses, the clayey texture, high shrink-swell potential, and depth to rock are severe limitations that can be difficult to overcome and can require expensive construction measures. The very slow permeability and clayey texture are limitations for recreation uses.

This soil is in capability subclass IIs and in the Deep Redland range site.

AnB—Anhalt clay, 1 to 3 percent slopes. This is a moderately deep, gently sloping soil on slightly concave foot slopes on uplands. It is generally near streams. The areas are irregular in shape and range from 10 to 150 acres in size.

Typically, the surface layer is dark reddish gray, neutral clay about 23 inches thick. The subsoil extends to a depth of 32 inches and is dark reddish brown, neutral clay. Below the subsoil there is fractured, indurated limestone.

This soil is well drained. Surface runoff is medium. Permeability is very slow. Water enters rapidly when the

soil is dry and cracked and very slowly when the soil is wet. The available water capacity is low. The rooting zone is moderately deep. However, the clay tends to impede root penetration. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Tarpley and Denton soils. Also included are a few small areas of soils that are similar to this Anhalt soil except that one is deeper than 40 inches to bedrock and the other is dark gray throughout. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. Small grains and forage sorghums are the main crops. In some areas this soil is used as rangeland or for improved pasture.

This soil is moderately well suited to use as cropland. The very slow permeability and the low available water capacity are the main limitations. These conditions can be improved, however, and good tilth and fertility can be maintained if proper residue management is practiced. Contour farming and terraces generally are needed to help control erosion.

This Anhalt soil is well suited to improved pasture. Improved bermudagrass, kleingrass, and medio bluestem grow well. Good management includes proper stocking, controlled grazing, and brush management.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides good habitat for quail, dove, rabbit, small birds, and other openland wildlife.

For urban uses, the clayey texture, high shrink-swell potential, and depth to rock are severe limitations that can be difficult to overcome and can require expensive construction measures. The very slow permeability, clayey texture, and slope, in some places, are limitations for recreation uses.

This soil is in capability subclass IIIe and in the Deep Redland range site.

AuB—Austin-Castephen complex, 1 to 3 percent slopes. This complex consists of the moderately deep, clayey Austin soil and the shallow, loamy Castephen soil. These soils are gently sloping and are on uplands in the Blackland Prairie Land Resource Area. Slopes are convex. The areas are irregular in shape and range from 10 to 300 acres in size.

Austin silty clay makes up 40 to 85 percent of the complex, but on the average it makes up 60 percent. Castephen silty clay loam makes up 10 to 45 percent, but the average is 30 percent. Other soils make up less than 5 percent to 30 percent, but the average is 10 percent. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Austin soil is dark grayish brown silty clay about 11 inches thick. The subsoil to a depth of 18 inches is brown silty clay, and to a depth of 24 inches it is pale brown silty clay loam and

has common concretions of calcium carbonate. The underlying material is chalk bedrock. The soil is moderately alkaline and calcareous throughout.

The Austin soil is well drained. Surface runoff is medium. Permeability is moderately slow, and the available water capacity is medium. The rooting zone is moderately deep. Water erosion is a moderate hazard.

Typically, the surface layer of the Castephen soil is dark grayish brown silty clay loam about 15 inches thick. It is about 20 percent chalk pebbles. The layer below the surface layer extends to a depth of 18 inches. It is brown silty clay loam and about 50 percent chalk fragments. The underlying material is chalk bedrock. The soil is moderately alkaline and calcareous throughout.

The Castephen soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is very low. The rooting zone is shallow. Water erosion is a moderate hazard.

Included in mapping are small areas of Real and Houston Black soils. They make up less than 30 percent of a mapped area.

The soils in this complex are used as cropland, pastureland, and rangeland. They are moderately well suited to use as cropland. Small grains, including wheat, oats, and forage sorghums, are the main crops. The shallow rooting zone and the very low available water capacity of the Castephen soil are the main limitations to plant growth. Some plants are susceptible to lime-induced chlorosis, which is caused by the high content of lime in these soils.

The soils are well suited to use as pasture. They produce medium to high yields of improved pasture grasses if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management.

The Austin soil produces high yields of range forage, and the Castephen soil produces medium yields.

These soils provide habitat for openland wildlife, including quail, dove, rabbit, and birds. In most areas, cover is not available for deer and turkey.

There are limitations to use of the soils for urban development, including corrosivity to uncoated steel, low soil strength, which affects roads and streets, and the shallowness of the Castephen soil. The limitations can be partly overcome through good design and careful installation. Clayey texture, shallowness to rock, and, in places, slope are limitations to recreation uses.

These soils are in capability subclass IIIe. The Austin soil is in the Clay Loam range site, and the Castephen soil is in the Chalky Ridge range site.

AuC3—Austin-Castephen complex, 2 to 5 percent slopes, eroded. This complex consists of moderately deep, clayey Austin soil and shallow, loamy Castephen soil. These soils are gently sloping and are on uplands in the Blackland Prairie Land Resource Area. Slopes are convex. The areas are irregular in shape and range from

10 to 50 acres in size. There are gullies throughout the areas. Most gullies are less than 2 feet deep and 3 to 5 feet wide. They are 200 to 600 feet apart. Sheet erosion has removed 25 to 50 percent of the surface layer in most areas between the gullies.

Austin silty clay makes up 45 to 75 percent of the complex, but on the average it makes up 60 percent. Castephen silty clay loam makes up 15 to 55 percent, but the average is 30 percent. Real, Heiden, and other soils make up less than 5 percent to 25 percent, but the average is 10 percent. The areas of these soils are so intricately mixed or so small that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Austin soil is dark grayish brown silty clay about 10 inches thick. The subsoil to a depth of 14 inches is grayish brown silty clay; to a depth of 23 inches it is pale brown silty clay; and to a depth of 28 inches it is very pale brown silty clay. There are many chalk pebbles in the lower part of the subsoil. The underlying material is chalk bedrock. The soil is moderately alkaline and calcareous throughout.

The Austin soil is well drained. Surface runoff is medium. Permeability is moderately slow, and the available water capacity is low. The rooting zone is moderately deep. Water erosion is a moderate hazard.

Typically, the surface layer of the Castephen soil is dark grayish brown silty clay loam about 9 inches thick. The layer below that, to a depth of 18 inches, is grayish brown silty clay loam; it has many chalk pebbles in the lower part. The underlying material is chalk bedrock. The soil is moderately alkaline and calcareous throughout.

The Castephen soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is very low. The rooting zone is shallow. Water erosion is a moderate hazard.

These soils are used mainly as rangeland. In a few areas they are used as cropland. Oats, wheat, and forage sorghums are the main crops.

The soils are poorly suited to use as cropland. The shallow rooting zone and the very low available water capacity of the Castephen soil are the main limitations. Low fertility, resulting from erosion, is also a limitation. Some plants are susceptible to lime-induced chlorosis, which is caused by the high content of lime in these soils. Crop residue left on the surface, cover crops, and terraces help control erosion.

These soils are well suited to use as pasture. They produce medium to high yields of improved pasture grasses. Good management includes proper stocking and controlled grazing.

The Austin soil produces high yields of range forage, and the Castephen soil produces medium yields.

These soils provide habitat for openland wildlife, including quail, dove, rabbit, and birds. In most areas, cover is not available for deer and turkey.

There are limitations to use of the soils for urban development, including corrosivity to uncoated steel, low soil strength, which affects roads and streets, and the shallowness of the Castephen soil. The limitations can be partly overcome through good design and careful installation. Clayey texture, shallowness to rock, and slope are limitations to recreation uses.

These soils are in capability subclass IVe. The Austin soil is in the Clay Loam range site, and the Castephen soil is in the Chalky Ridge range site.

BoB—Boerne fine sandy loam, 1 to 3 percent slopes. This is a deep, gently sloping soil on convex slopes of low stream terraces near rivers and large creeks. Most areas are long and narrow. Some are oblong. The areas range from 5 to 40 acres in size.

Typically, the surface layer is grayish brown, moderately alkaline fine sandy loam about 17 inches thick. The subsoil extends to a depth of 41 inches and is pale brown and very pale brown, moderately alkaline fine sandy loam. It is about 50 percent calcium carbonate (lime). The underlying material to a depth of 65 inches is very pale brown, moderately alkaline fine sandy loam.

This soil is well drained. Surface runoff is slow. Permeability is moderately rapid, and the available water capacity is medium. The rooting zone is deep. Water erosion is a slight to moderate hazard. This soil is flooded only rarely.

Included with this soil in mapping are small areas of Sunev silty clay loam and Seawillow soils. Also included are areas of soils that are similar to Boerne soils. One of the similar soils has a dark colored surface layer, and the other is more than 35 percent gravel in the subsoil. The included soils make up less than 10 percent of a mapped area.

This soil is used mainly for pasture. In a few areas it is used as cropland or rangeland.

The soil is moderately well suited to use as pasture. Moderate yields can be expected if good management is practiced. Improved bermudagrass and improved bluestem are the main grasses. These grasses respond well to fertilizer.

If this soil is used as rangeland, it produces medium yields of forage if good management is practiced.

Boerne soil is moderately well suited to cultivated crops. Moderate yields can be expected if good management is practiced. The main crops are small grains and forage sorghum. The medium available water capacity and the susceptibility of some plants to lime-induced iron chlorosis caused by an excessive amount of calcium carbonate are limitations. Fertilization and proper residue management increase the content of organic matter, maintain the level of fertility, and help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Contour farming and terraces are needed in most areas to

control erosion. Grassed waterways safely remove runoff from the terraces.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Adequate cover is not available for deer and turkey.

Seepage and corrosivity to uncoated steel are limitations for urban uses. These limitations can be overcome through good design and careful installation. Flooding, although rare, is a limitation that must be considered in planning permanent installations. The possibility of flooding is a limitation for camp areas. In some places, slope is a limitation for playgrounds.

This soil is in capability subclass IIe and in the Loamy Bottomland range site.

BrB—Bolar clay loam, 1 to 3 percent slopes. This is a moderately deep, gently sloping soil on concave valley slopes and foot slopes of hills on uplands in the Edwards Plateau Land Resource Area. The areas of this soil are mostly long and narrow and range from 5 to 350 acres in size.

Typically, the surface layer is dark grayish brown and dark brown clay loam about 14 inches thick. The subsoil extends to a depth of 28 inches. It is brown clay loam; it is about 50 percent calcium carbonate (lime). Indurated limestone interbedded with marl is at a depth of 28 inches. This soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is low. The rooting zone is moderately deep. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Krum, Denton, Doss, and Sunev soils. Also included are small areas of eroded Bolar soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In some areas it is used for crops and pasture. This soil is well suited to use as pasture. Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. The limitations include the moderately deep rooting zone and the low available water capacity. Good management includes proper stocking and controlled grazing.

This soil produces high yields of range forage if good management is practiced.

This soil is moderately well suited to use as cropland. Low to medium yields can be expected if good management is practiced. The main crops are oats and forage sorghums. The limitations are the low available water capacity, the moderate hazard of erosion, and the susceptibility of some plants to lime-induced chlorosis, which is caused by an excessive amount of calcium carbonate. Fertilizer and proper residue management increase organic matter, maintain the level of fertility, and help prevent erosion. Minimum tillage helps conserve moisture, prevent runoff, reduce compaction,

and conserve energy. Contour farming and terraces are needed to control erosion. Grassed waterways safely remove runoff from terraces.

This Bolar soil provides fair habitat for wildlife. In some areas, cover is not available for deer, turkey, and quail.

The moderate depth to rock, corrosivity to uncoated steel, and the shrink-swell potential are limitations for urban uses. The limitations can be partly overcome through good design and careful installation. Slope, in some places, is a limitation for playgrounds.

This soil is in capability subclass IIe and in the Clay Loam range site.

BtD—Brackett-Rock outcrop-Comfort complex, undulating. This complex consists of shallow, loamy and clayey soils and Rock outcrop on uplands in the Edwards Plateau Land Resource Area. Slopes are convex and range from 1 to 8 percent. The mapped areas consist of either a single low hill in oval areas or a series of low hills in irregularly shaped areas. Many areas have a benched appearance along the hill slopes because of the horizontal bands of Rock outcrop. The Brackett and Comfort soils are between the bands of Rock outcrop. The mapped areas range from 25 to 3,000 acres in size.

The Brackett soil makes up 30 to 60 percent of the complex, but on the average it makes up 50 percent. Rock outcrop makes up 10 to 45 percent, but the average is 20 percent. The Comfort soil and similar soils make up 10 to 20 percent, but the average is 15 percent. Purves soils in benched areas and Bolar and Doss soils in narrow valleys make up as much as 15 percent of a mapped area. The soils and Rock outcrop are in areas so small or so intricately mixed that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Brackett soil is grayish brown gravelly clay loam about 6 inches thick. The subsoil extends to a depth of 17 inches. It is very pale brown and pale yellow gravelly clay loam. The underlying material is weakly cemented limestone interbedded with thin layers of indurated limestone. The soil is moderately alkaline and calcareous throughout.

Typically, the areas of Rock outcrop consist of exposures of limestone bedrock. There is some soil material in the narrow fractures in the rock. In some areas, however, the rock is flat and is covered by soil material as much as 3 inches thick.

Typically, the surface layer of the Comfort soil is dark brown extremely stony clay about 4 inches thick. The subsoil extends to a depth of 11 inches. It is dark reddish brown extremely stony clay. The underlying material is indurated fractured limestone. The soil is moderately alkaline and noncalcareous throughout.

The soils in this complex are well drained. Surface runoff is medium to rapid. Permeability is moderately slow in the Brackett soil and slow in the Comfort soil. The available water capacity is very low. The rooting

zone is shallow. Water erosion is a severe hazard. Seeps are common along the slopes after heavy rainfall.

The soils are used as rangeland and as habitat for wildlife. Rangeland forage production is limited because of the very low available water capacity and the shallow rooting zone. Medium yields of native range grasses can be expected if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management. Juniper readily invades if the grasses are overgrazed.

These soils provide fair habitat for rangeland wildlife. They provide adequate cover and food for deer, turkey, and quail.

The soils are not suited to use as pastureland or cropland. The medium to rapid runoff, the very low available water capacity, the shallow rooting zone, and the outcrops of rock are severe limitations.

The limitations to use of the soils for urban and recreation uses are severe and generally are difficult to overcome. The limitations are shallowness to rock, low soil strength, which affects roads and streets, corrosivity to uncoated steel, outcrops of rock, and slope.

Brackett and Comfort soils are in capability subclass VI_s. The Brackett soil is in the Adobe range site, and the Comfort soil is in the Low Stony Hills range site. Rock outcrop is not assigned to a capability subclass or a range site.

BtG—Brackett-Rock outcrop-Real complex, steep. This complex consists of shallow, loamy soils and Rock outcrop on uplands in the Edwards Plateau Land Resource Area. Slopes are convex and range from 8 to 30 percent. Escarpments and high rounded hills and ridges and their side slopes are characteristic of the areas (fig. 7). Slopes have a benched appearance because of the horizontal layers of Rock outcrop. The Real and Brackett soils are between the areas of Rock outcrop. The mapped areas range from 50 to 6,000 acres in size.

The Brackett soil makes up 20 to 55 percent of the complex, but on the average it makes up 35 percent. Rock outcrop makes up 10 to 46 percent, but the average is 25 percent. The Real soil makes up 10 to 30 percent, but the average is 20 percent. Eckrant soils on hilltops and Bolar and Sunev soils in narrow valleys make up 10 to 30 percent, but the average is 20 percent. The soils and Rock outcrop are in areas so small or so intricately mixed that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Brackett soil is grayish brown gravelly clay loam about 6 inches thick. The subsoil extends to a depth of 14 inches. It is light gray gravelly clay loam. The underlying material is weakly cemented limestone interbedded with thin strata of pale yellow and very pale brown shaly clay. The soil is moderately alkaline and calcareous throughout.



Figure 7.—An area of Brackett-Rock outcrop-Real complex, steep. The soils in this complex are used mainly as rangeland.

Typically, Rock outcrop is barren of soil except in narrow fractures in the rock. In some areas the rock is flat and has as much as 3 inches of soil material on the surface.

Typically, the surface layer of the Real soil is very dark grayish brown gravelly clay loam about 12 inches thick. The upper part is about 20 percent, by volume, weakly cemented limestone gravel, and the lower part is about 60 percent. The underlying material is weakly cemented limestone.

The soils in this complex are well drained. Surface runoff is rapid. Permeability is moderately slow in the Brackett soil and slow in the Real soil. The available water capacity is very low. The rooting zone is shallow.

Water erosion is a severe hazard. Seeps are common along the slopes after periods of heavy rainfall.

The soils are used as rangeland and as habitat for wildlife. Range forage production is severely limited because of the steep slopes, rapid runoff, the very low available water capacity, the shallow rooting zone, and the rock outcrops. Yields of native range grasses are low, even in favorable years and if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management. Juniper readily invades if the grasses are overgrazed.

These soils are not suited to pasture or crops. The steep slopes, shallow rooting zone, the very low available water capacity, rapid runoff, and the rock outcrops are severe limitations.

The soils provide cover and food for deer, turkey, and quail. Mature juniper provides nesting material for the golden-cheeked warbler, a rare species native to the survey area.

The limitations to use of the soils for urban and recreation uses are steep slopes, shallowness to rock, low strength, which affects roads and streets, corrosivity to uncoated steel, and the outcrops of rock. The limitations are difficult to overcome and can require expensive engineering procedures. In most areas, however, the view is scenic, increasing the desirability of the areas as sites for houses.

Brackett and Real soils are in capability subclass VII_s and in the Steep Adobe range site. Rock outcrop is not assigned to a capability subclass or a range site.

ByA—Branyon clay, 0 to 1 percent slopes. This is a deep, nearly level soil on ancient high stream terraces in the Blackland Prairie Land Resource Area. Most areas are irregular in shape and range from 10 to 800 acres in size.

Typically, this soil has an upper layer of dark gray clay about 44 inches thick. Below that, to a depth of 60 inches, there is grayish brown clay with dark gray streaks, which are cracks that have filled with material from the upper layer. The underlying material, from 60 to 80 inches, is mottled very pale brown and pale yellow clay. The soil is moderately alkaline and calcareous throughout.

This soil is moderately well drained. Surface runoff is slow. Permeability is very slow. When the soil is very dry, cracks form that are 0.5 to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when the soil is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a slight hazard. The clayey texture of this soil makes it difficult to work. Some areas are flat and remain wet later in the spring, which can delay farming operations.

Included with this soil in mapping are small areas of Houston Black, Lewisville, and Krum soils. Also included are areas of soils that are similar to the Branyon soil. One of these has a gravelly surface layer and a very gravelly subsoil. The other similar soil is noncalcareous throughout. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In some areas it is used for pasture and hay.

This soil is well suited to use as cropland. Grain sorghum, cotton, wheat, corn, and oats are the main crops. High yields can be expected if good management is practiced. Fertilizer and proper residue management increase organic matter, improve tilth, and maintain the level of fertility. Minimum tillage reduces compaction and conserves energy.

This soil is well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass grow well on this soil. These grasses respond well to fertilizer. Good pasture management includes proper stocking, controlled grazing, and weed and brush management.

If this soil is used as rangeland, it can produce high yields of forage if good management is practiced.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Most areas do not provide sufficient food and cover for deer and turkey.

There are limitations to use of the soil for urban development, including clayey texture, shrink-swell potential, the very slow permeability, corrosivity to uncoated steel, and low soil strength, which affects roads and streets. The limitations can be partly overcome through good design and careful installation. Cave-in is a hazard in deep excavations. Clayey texture and the very slow permeability are limitations to recreation uses.

This soil is in capability subclass II_w and in the Blackland range site.

ByB—Branyon clay, 1 to 3 percent slopes. This is a deep, gently sloping soil on ancient high stream terraces in the Blackland Prairie Land Resource Area. Most areas are irregular in shape and range from 10 to 300 acres in size.

Typically, the upper layer is dark gray clay about 48 inches thick. The layer below that, to a depth of 82 inches, is grayish brown clay. The underlying material to a depth of 94 inches is clay that has yellowish, brownish, and grayish mottles. The soil is moderately alkaline and calcareous throughout.

This soil is moderately well drained. Surface runoff is medium. Permeability is very slow. When the soil is very dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a moderate hazard. The clayey texture of this soil makes it difficult to work.

Included with this soil in mapping are small areas of Houston Black, Lewisville, and Krum soils. Also included are areas of a similar soil that has a gravelly surface layer and very gravelly subsoil and another similar soil that is noncalcareous throughout. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In some areas it is used for pasture and hay.

This soil is well suited to use as cropland. Grain sorghum, cotton, corn, wheat, and oats are the main crops. High yields can be expected if good management is practiced. Fertilizer and proper residue management increase organic matter, improve tilth, maintain the level

of fertility, and help prevent erosion. Minimum tillage helps reduce compaction, prevent runoff, and conserve energy. Terraces and contour farming are needed to prevent erosion.

This soil is well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. Good pastureland management includes proper stocking, controlled grazing, and weed and brush management.

If this soil is used as rangeland, it can produce high yields of forage if good management is practiced.

This soil provides habitat for openland wildlife, including rabbits and small birds. Adequate cover for deer and turkey is not available in most places.

There are limitations to use of the soil for urban development, including clayey texture, shrink-swell potential, the very slow permeability, corrosivity to uncoated steel, and low soil strength, which affects roads and streets. The limitations can be partly overcome through good design and careful installation. Cave-in is a hazard in deep excavations. Clayey texture and the very slow permeability are limitations to recreation uses.

This soil is in capability subclass IIe and in the Blackland range site.

CaC3—Castephen clay loam, 3 to 5 percent slopes, eroded. This is a shallow, gently sloping soil on convex, smooth slopes on low hills and ridges in the Blackland Prairie Land Resource Area. The areas of this soil are irregular in shape and range from 8 to 85 acres in size. In most areas there are a few shallow gullies that are less than 3 feet deep and generally 500 to 1,000 feet apart.

Typically, the surface layer is dark grayish brown and brown, moderately alkaline clay loam about 16 inches thick. There are many chalk fragments less than 3 inches across in the lower part. White, platy chalk bedrock is at a depth of 16 inches.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is very low. The rooting zone is shallow. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Austin and Real soils and small areas of a soil that is similar to this Castephen soil except that it has a light colored surface layer. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. Forage yields are medium if good management is practiced.

This soil is moderately well suited to use as pastureland. The shallow rooting zone and the very low water holding capacity are the main limitations. Good management includes proper stocking, controlled grazing, and brush management.

This soil is poorly suited to use as cropland. Low yields can be expected, even if good management is practiced. The very low available water capacity, the shallow rooting zone, the moderate hazard of erosion, and the susceptibility of some plants to lime-induced chlorosis are limitations.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. In most areas, cover for deer and turkey is not available.

The limitations to use of the soil for urban development are shallowness to rock and corrosivity to uncoated steel. The limitations can be partly overcome through good design and careful installation. Shallowness to rock and slope are limitations to recreation uses.

This soil is in capability subclass IVe and in the Chalky Ridge range site.

CrD—Comfort-Rock outcrop complex, undulating. This complex consists of shallow, clayey soils and Rock outcrop on side slopes and on hilltops and ridgetops on uplands in the Edwards Plateau Land Resource Area. Slopes are convex. The areas are irregular in shape and range from 25 to 1,000 acres in size.

Comfort extremely stony clay makes up 49 to more than 95 percent of the complex, but on the average it makes up 70 percent. Rock outcrop and areas of soil less than 4 inches deep make up 5 to 36 percent, but the average is 15 percent. Rumble, Purves, Eckrant, and Real soils make up less than 5 to 30 percent, but the average is 15 percent. The areas of Rock outcrop are long, narrow horizontal bands on hill slopes and along small drains. The Comfort soil is between the bands of Rock outcrop. The soils and Rock outcrop are in areas so small or so intricately mixed that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Comfort soil is dark brown extremely stony clay about 6 inches thick. Cobbles and stones as much as 4 feet across cover about 45 percent of the surface. The subsoil extends to a depth of 13 inches. It is dark reddish brown extremely stony clay. The underlying material is indurated fractured limestone. The soil is mildly alkaline and noncalcareous throughout.

The Comfort soil is well drained. Surface runoff is slow to medium. Permeability is slow, and the available water capacity is very low. The rooting zone is shallow. Water erosion is a slight hazard.

Typically, Rock outcrop is dolomitic limestone that is barren of soil except in narrow fractures in the rock. In some areas the rock is flat and has as much as 3 inches of soil material on the surface.

The soils in this complex are used as rangeland and as habitat for wildlife.

Production of range forage is low because of the restricted rooting depth, the very low available water capacity, and the cobbles and stones on the surface.

Texas persimmon and blueberry juniper invade if the range is overgrazed.

The soils are not suited to cultivated crops or pasture. The areas of Rock outcrop, cobbles and stones on the surface and in the soil, the limited rooting depth, and the very low available water capacity are severe limitations.

The soils are suited to use as wildlife habitat. They provide adequate food and cover for deer, turkey, and quail.

The stony surface layer, shallowness to bedrock, and corrosivity to uncoated steel are severe limitations to use of the soils for recreation purposes.

The Comfort soil is in capability subclass VIIc and in the Low Stony Hills range site. Rock outcrop is not assigned to a capability subclass or range site.

DeB—Denton silty clay, 1 to 3 percent slopes. This is a moderately deep, gently sloping soil on valley slopes on uplands in the Edwards Plateau Land Resource Area. Slopes are slightly convex to concave. The areas are long and narrow in shape and range from 5 to 400 acres in size.

Typically, the surface layer is dark grayish brown silty clay about 14 inches thick. The layer below that extends to a depth of 25 inches and is dark brown silty clay. The subsoil extends to a depth of 33 inches. It is light yellowish brown silty clay. The underlying material to a depth of 36 inches is light brown and reddish yellow silty clay. It is underlain by fractured limestone interbedded with calcareous clayey marl. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is slow. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is medium. The rooting zone is moderately deep. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Purves, Anhalt, Bolar, Sunev, and Krum soils. Also included are areas of a soil that is similar to this Denton soil except that it is underlain by hard, indurated limestone. The included soils make up less than 15 percent of a mapped area.

This soil is used as rangeland, pastureland, and cropland.

This soil is well suited to use as cropland. Medium to high yields can be expected if good management is practiced. Small grains and forage sorghums are the main crops. Good tilth and fertility can be maintained by using proper residue management, fertilization, and crop rotation. Minimum tillage helps prevent runoff, conserve moisture, reduce compaction, and conserve energy. Terraces and contour farming help prevent water erosion. Grassed waterways safely remove runoff from terraces.

This Denton soil is well suited to use as pastureland. Improved bermudagrass, improved bluestem, and kleingrass are adapted to this soil. Good management

includes proper stocking, controlled grazing, and brush management.

This soil produces high yields of range forage if good management is practiced.

This soil provides good habitat for openland wildlife. In some areas, cover for deer and turkey is not available.

For urban and recreational uses, clayey texture, high shrink-swell potential, low strength, which affects roads and streets, depth to rock, and corrosivity to uncoated steel are limitations that can be partly overcome through good design and careful installation.

This soil is in capability subclass IIe and in the Clay Loam range site.

DeC3—Denton silty clay, 1 to 5 percent slopes, eroded. This is a moderately deep, gently sloping soil on valley slopes on uplands in the Edwards Plateau Land Resource Area. Slopes are slightly convex to concave. The areas are long and narrow and range from 5 to 87 acres in size. Gullies are 1 to 3 feet deep and 200 to 500 feet apart.

Typically, the surface layer extends to a depth of 28 inches. It is dark grayish brown silty clay in the upper part and dark brown silty clay in the lower part. The subsoil extends to a depth of 31 inches and is grayish brown silty clay. The underlying material is fractured limestone interbedded with calcareous clayey marl.

This soil is well drained. Surface runoff is rapid. Permeability is slow. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is medium. The rooting zone is moderately deep. The fertility level has been lowered by erosion. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Purves, Anhalt, Bolar, Sunev, and Krum soils. The included soils make up less than 15 percent of a mapped area.

This soil was once used mainly as cropland. However, in most areas it is now used as pastureland. In some areas small grains and hay sorghums are still grown.

This soil is moderately well suited to use as cropland. The eroded condition of this soil resulting in low fertility is the main limitation. Proper residue management is needed to help prevent further erosion and improve tilth and fertility. Terracing and contour farming are also needed. Eroding gullies can be stabilized by shaping, smoothing, and revegetating.

This soil is well suited to use as pastureland. Improved bermudagrass, improved bluestem, and kleingrass are adapted to this soil. Good management includes proper stocking, controlled grazing, and brush management.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides good habitat for openland wildlife. Cover in some areas may not be adequate for deer and turkey.

For urban and recreational uses, clayey texture, high shrink-swell potential, depth to rock, low strength affecting roads and streets, and corrosivity to uncoated steel are limitations which can be partly overcome through good design.

This soil is in capability subclass IIIe and in the Clay Loam range site.

DoC—Doss silty clay, 1 to 5 percent slopes. This is a shallow, gently sloping soil on convex slopes of low hills and ridges on uplands in the Edwards Plateau Land Resource Area. The areas of this soil are generally irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is dark grayish brown silty clay about 9 inches thick. The subsoil extends to a depth of 18 inches and is yellowish brown clay loam. About 50 percent of the subsoil is calcium carbonate (lime). The underlying material to a depth of 24 inches is weakly cemented limestone and marl. The soil is generally moderately alkaline and calcareous throughout; however, in a few areas the surface layer is noncalcareous.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow, and the available water capacity is low. The rooting zone is shallow. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Bolar, Brackett, Eckrant, and Purves soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland and cropland. In a few areas it is used for improved pasture.

This soil is well suited to use as pasture. Improved bluestems and kleingrass grow well. These grasses respond well to fertilizer. The shallow rooting zone and the low available water capacity are limitations. Good management includes proper stocking, controlled grazing, and brush management.

Yields of range forage are medium if good management is practiced.

This soil is moderately well suited to use as cropland. Moderate yields can be expected if good management is practiced. The main crops are oats and forage sorghums. The low available water capacity, the shallow rooting zone, the hazard of erosion, and lime-induced chlorosis caused by excess calcium carbonate are limitations. Fertilizer and proper residue management increase organic matter, maintain the level of fertility, and help prevent erosion. Contour farming and terraces are needed to control erosion. Grassed waterways safely remove runoff from terraces.

This soil provides fair habitat for openland wildlife, including quail, dove, rabbit, and small birds. In some areas, cover for deer and turkey is not available.

For urban uses, shallowness to rock, moderately slow permeability, low strength affecting roads and streets, and corrosivity to uncoated underground steel pipelines are limitations that can be partly overcome through good

design and careful installation. For recreation uses, slope and depth to rock are the main limitations.

This soil is in capability subclass IIIe and in the Shallow range site.

ErG—Eckrant-Rock outcrop complex, steep. This complex consists of shallow, clayey soils and Rock outcrop on uplands in the Edwards Plateau Land Resource Area. Slopes are convex and range from 8 to 30 percent. The mapped areas consist of long, narrow slopes on high hills and ridges and along escarpments. The areas range from 50 to 2,000 acres in size.

The Eckrant soil makes up 50 to 80 percent of the complex, but on the average it makes up 70 percent. Rock outcrop makes up 9 to 30 percent, but the average is 20 percent. Brackett, Real, Rumble, and Purves soils make up less than 5 to 30 percent, but the average is 10 percent. The soils and Rock outcrop are in areas so small or so intricately mixed that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Eckrant soil is very dark gray extremely stony clay about 10 inches thick. It is about 35 percent, by volume, cobbles and stones in the upper part and about 75 percent, by volume, stones in the lower part. The underlying layer is indurated fractured limestone. The soil is moderately alkaline and noncalcareous throughout.

Typically, Rock outcrop consists of barren exposures of indurated limestone. In a few areas as much as 4 inches of clayey soil material overlies the bedrock, and dark colored clay is in cracks and fractures.

The Eckrant soil is well drained. Surface runoff is rapid. Permeability is moderately slow, and the available water capacity is very low. The rooting zone is shallow. Water erosion is a severe hazard.

The soils are used as rangeland and as habitat for wildlife. They are not suited to use as cropland or pastureland.

Forage yields on rangeland are low because of the very low available water capacity, the shallow rooting zone, rapid runoff, the rock outcrops, and the large number of stones in the soil. Wild persimmon and Ashe juniper invade the range if it is overgrazed.

The soils provide a fair amount of food and shelter for deer and turkey.

Stoniness, shallowness to rock, slope, and corrosivity to uncoated steel are severe limitations to use of the soils for urban development.

The Eckrant soil is in capability subclass VIIc and in the Steep Rocky range site. Rock outcrop is not assigned to a capability subclass or a range site.

ErF4—Ferris clay, 5 to 20 percent slopes, severely eroded. This is a deep, sloping to moderately steep soil on uplands. Slopes are convex. The areas are irregular in shape and range from about 10 to 400 acres in size. Gullies are scattered throughout the areas. They are 2 to

8 feet deep, 4 to 10 feet wide, and 50 to 300 feet apart. In most areas, sheet and rill erosion have removed 25 to 75 percent of the surface soil between the gullies.

Typically, the surface layer is grayish brown clay about 12 inches thick. The layer below that extends to a depth of 24 inches and is grayish brown clay mottled with light yellowish brown and pale olive. The layer below that extends to a depth of 35 inches and is mottled light gray and light yellowish brown clay. The underlying material to a depth of 60 inches is mottled pale olive, pale yellow, gray, and light yellowish brown shaly clay and shale. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is rapid. Permeability is very slow. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a severe hazard.

Included with this soil in mapping are small areas of Heiden, Altoga, and Houston Black soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In some areas it was once used as cropland; however, erosion has made it no longer suitable for use as cropland.

This soil is poorly suited to use as pastureland because of difficulty in establishing and maintaining an adequate grass cover.

On rangeland, native grasses produce high yields in favorable years if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management.

The control of erosion is critical on this soil. Gullies need to be stabilized by shaping, smoothing, and revegetating. Establishing a cover of improved bermudagrass helps prevent further erosion.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. It is poorly suited to use as habitat for deer and turkey because of a lack of cover and an adequate supply of food.

For urban uses, clayey texture, high shrink-swell potential, very slow permeability, rapid runoff, low strength affecting roads and streets, and corrosivity to underground steel pipelines are limitations. For recreational uses, slope and very slow permeability are the main limitations.

This soil is in capability subclass VIe and in the Eroded Blackland range site.

GrC—Gruene clay, 1 to 5 percent slopes. This is a shallow to very shallow soil on stream terraces. Slopes are convex. The areas are long and narrow in shape and range from 5 to 650 acres in size.

Typically, the surface layer is very dark grayish brown clay about 13 inches thick. The underlying material to a depth of 22 inches is strongly cemented, massive caliche containing embedded gravel. The underlying material to a depth of about 80 inches is very gravelly

loam. The soil is mildly alkaline and noncalcareous above the cemented layer.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow in the surface layer and very slow in the cemented layer. The available water capacity is very low. The rooting zone is very shallow to shallow. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Lewisville, Krum, and Seawillow soils. Also included are areas of a soil that is similar to this Gruene soil except that it has a gravelly layer in the lower part that is not cemented and another similar soil that has a surface layer of gravelly clay loam. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In some areas it is cultivated. Small grains and forage sorghums are the main crops.

On rangeland, forage yields of native range plants are medium if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management.

This soil is poorly suited to use as cropland and pastureland. The very low available water capacity and shallow to very shallow rooting zone are limitations.

This soil provides adequate food and cover for deer, turkey, and quail.

For urban uses, shallowness to the cemented layer and corrosivity to uncoated steel are severe limitations that are difficult to overcome. For recreation areas, slope and depth to rock are the main limitations. This soil is a source of sand and gravel for construction purposes.

This soil is in capability subclass IVs and in the Shallow range site.

HeB—Heiden clay, 1 to 3 percent slopes. This is a deep, gently sloping soil mainly on upland ridges in the Blackland Prairie Land Resource Area. Slopes are convex. The areas are long and narrow in shape and range from 8 to 300 acres in size.

Typically, the surface layer is dark grayish brown clay about 16 inches thick. The layer below that extends to a depth of 63 inches and is grayish brown clay that has light yellowish brown and olive mottles. The underlying layer to a depth of 72 inches is mottled grayish brown, pale yellow, and olive yellow shaly clay. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is very slow. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a moderate hazard.

Included with this soil in mapping and making up less than 15 percent of a mapped area are small areas of Houston Black and Altoga soils.

This soil is used mainly as cropland. In some areas it is used for improved pasture.



Figure 8.—Grain sorghum is a major crop on Heiden clay, 1 to 3 percent slopes.

This soil is well suited to use as cropland (fig. 8). Grain sorghum, cotton, and small grains are the main crops. Fertilization and proper residue management increase organic matter, maintain the level of fertility, and help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Terraces and contour farming are needed to prevent erosion.

This soil is well suited to use as pastureland. It produces high forage yields of improved pasture grasses in favorable years. Good management includes proper stocking, controlled grazing, and brush management.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. It does not provide adequate food and cover for deer and turkey.

For urban uses, clayey texture, shrink-swell potential, low strength affecting roads and streets, corrosivity to uncoated steel, and very slow permeability are limitations which can be partly overcome through good design and

careful installation. For recreational uses, very slow permeability and slope, in some places, are limitations.

This soil is in capability subclass Ite and in the Blackland range site.

HeC3—Heiden clay, 3 to 5 percent slopes, eroded.

This is a deep, gently sloping soil on convex side slopes on low hills and ridges on uplands in the Blackland Prairie Land Resource Area. The areas of this soil are long and narrow or irregular in shape and range from 10 to 150 acres in size. Shallow gullies 1 to 4 feet deep and 200 to 500 feet apart are few to common in all mapped areas.

Typically, the surface layer is dark grayish brown clay about 13 inches thick. The layer below that extends to a depth of 58 inches and is grayish brown clay. The underlying material to a depth of 80 inches is pale yellow shaly clay that has brownish yellow and olive yellow mottles. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is very slow. When the soil is dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. The fertility level has been reduced because of erosion. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Altoga, Houston Black, Ferris, and Tinn soils. Tinn soils are on narrow flood plains of small creeks. Also included are a few areas of Heiden soils that are only slightly eroded. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as pastureland. In some areas it is used as rangeland and cropland.

This soil is well suited to improved pasture grasses and native range plants. Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. Good pastureland and rangeland management includes proper stocking, controlled grazing, and brush management. Gullies need to be stabilized by shaping, smoothing, and revegetating.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil is well suited to use as cropland. Medium yields can be expected if good management is practiced. The main crops are oats, wheat, grain sorghum, and forage sorghums. The hazard of erosion, very slow permeability, poor tilth, and low fertility, especially near gullies, are limitations. Fertilization and proper residue management increase organic matter, maintain the level of fertility, and help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Contour farming and terraces are needed to control erosion. Grassed waterways safely remove runoff from terraces.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Deer and turkey are few because of lack of cover and an adequate food source.

For urban uses, clayey texture, shrink-swell potential, very slow permeability, low strength affecting roads and streets, and corrosivity to uncoated steel are limitations which can be partly overcome through good design and careful installation. Very slow permeability, clayey texture, and slope are limitations for recreation uses.

This soil is in capability subclass IIIe and in the Blackland range site.

HeD3—Heiden clay, 5 to 8 percent slopes, eroded. This is a deep, sloping soil on the steeper side slopes of hills and ridges in the Blackland Prairie Land Resource Area. The slopes are convex. Areas are mostly long and narrow in shape. They range from 5 to 150 acres in size.

There are few to common gullies, 2 to 5 feet deep and 100 to 500 feet apart, in all mapped areas.

Typically, the upper layer is dark grayish brown clay about 28 inches thick. The layer below that extends to a depth of 57 inches and is grayish brown clay. The underlying material to a depth of 84 inches is light olive gray and pale olive shale. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is rapid. Permeability is very slow. When the soil is very dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. The fertility level has been reduced because of erosion. Water erosion is a severe hazard.

Included with this soil in mapping are small areas of Ferris and Altoga soils. The included soils make up less than 10 percent of a mapped area.

This soil is used mainly as rangeland. In a few areas it is used as cropland.

This soil is moderately well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. Good pastureland and rangeland management includes proper stocking, controlled grazing, and brush management. Gullies need to be stabilized by shaping, smoothing, and revegetating.

On rangeland this soil produces high yields of forage if good management is practiced.

This soil is poorly suited to use as cropland. Low to medium yields can be expected if good management is practiced. Low fertility, poor tilth, rapid runoff, and the severe hazard of further erosion are limitations. The measures needed in cropped areas to adequately protect the soil from further erosion are costly. Protective measures include stabilization of existing gullies and installation of an extensive terrace system that includes grassed waterways and well designed outlets.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Deer and turkey are few because of lack of cover and an adequate food source.

For urban uses, clayey texture, shrink-swell potential, low strength affecting roads and streets, and corrosivity to uncoated steel are limitations. Slippage is a potential problem when the soil is wet because of the slope and low strength. These limitations can be partly overcome through good design and careful installation. For recreation areas, clayey texture, very slow permeability, and slope are limitations.

This soil is in capability subclass IVe and in the Blackland range site.

HgD—Heiden gravelly clay, 3 to 8 percent slopes. This is a deep, gently sloping to sloping soil on the side

slopes of hills and ridges in the Blackland Prairie Land Resource Area. Slopes are convex. Areas are mostly long and narrow in shape and range from 10 to 170 acres in size.

Typically, the surface layer is 25 inches thick. The upper part is dark gray gravelly clay, and the lower part is dark grayish brown gravelly clay. The subsoil extends to a depth of 48 inches and is olive clay that has mottles of dark grayish brown and streaks of dark gray. The underlying material to a depth of 80 inches is pale yellow clay. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is rapid. Permeability is very slow. When the soil is dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a severe hazard. The gravelly surface layer and the clayey texture make this soil difficult to work.

Included with this soil in mapping are small areas of Houston Black soils, small areas of Heiden clay, and a few areas where the soil is eroded in spots. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as pastureland and cropland.

This soil is well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. Good pastureland and rangeland management includes proper stocking, controlled grazing, and brush management.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil is moderately well suited to use as cropland. Grain sorghum, forage sorghum, oats, and wheat are the main crops. Medium yields can be expected if good management is practiced. Rapid runoff, very slow permeability, the hazard of erosion, and surface gravel are limitations. Fertilization and proper residue management increase organic matter, improve tilth, maintain the level of fertility, and help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Terraces and contour farming are needed to control erosion. Grassed waterways safely remove runoff from terraces.

This soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Deer and turkey are few because of a lack of cover and an adequate food source.

For urban uses, clayey texture, shrink-swell potential, very slow permeability, low strength, which affects roads and streets, and corrosivity to uncoated steel are limitations which can be partly overcome through good design and careful installation. For recreational uses, the

clayey texture, slope, very slow permeability, and gravelly surface layer are limitations.

This soil is in capability subclass IVe and in the Blackland range site.

HoB—Houston Black clay, 1 to 3 percent slopes.

This is a deep, gently sloping soil on narrow ridgetops and long smooth foot slopes on uplands in the Blackland Prairie Land Resource Area. Slopes are mostly convex. The mapped areas are irregular in shape and range from 25 to 2,000 acres in size.

Typically, the soil to a depth of about 50 inches is very dark gray clay. To a depth of 77 inches it is grayish brown clay. The underlying material is yellowish shaly clay. The soil is moderately alkaline and calcareous throughout.

This soil is moderately well drained. Surface runoff is medium. Permeability is very slow. When the soil is dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep (fig. 9). Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Heiden soils, Altoga soils on uplands, and Tinn soils on the flood plains of small creeks. Also included are small areas of gravelly Houston Black soils and a few eroded spots. Very small areas of saline soils are also included. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly for cultivated crops. In some areas it is used as pastureland.

This soil is well suited to nonirrigated crops. Cotton, grain sorghum, and small grains are the main crops. High yields can be expected if good management is practiced. Fertilization and proper residue management increase organic matter, improve tilth, maintain the level of fertility, and help prevent erosion. Rotating cotton with other crops helps to prevent cotton root rot, which is prevalent in these soils.

This soil is well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass are adapted. These grasses respond well to fertilizer. Good pastureland management includes proper stocking, controlled grazing, and weed control.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

Houston Black soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Deer and turkey are few because of a lack of cover and an adequate food source.

For urban uses, clayey texture, very slow permeability, high shrink-swell potential, low strength affecting roads and streets, and corrosivity to uncoated steel are severe limitations that are difficult to overcome. Very slow



Figure 9.—Cracks that are several feet deep form in this soil when it is dry. The soil is Houston Black clay, 1 to 3 percent slopes.

permeability, clayey texture, and slope, in some places, are limitations for recreation uses.

This soil is in capability subclass IIe and in the Blackland range site.

HvB—Houston Black gravelly clay, 1 to 3 percent slopes. This is a deep, gently sloping soil on upland ridgetops and long smooth side slopes in the Blackland Prairie Land Resource Area. Slopes are mostly convex. The areas are irregular in shape and range from about 5 to 650 acres in size.

Typically, this soil is very dark gray gravelly clay to a depth of about 36 inches and dark gray clay to a depth of 54 inches. The soil is moderately alkaline and calcareous throughout. Smooth cherty gravel covers about 40 percent of the surface.

This soil is moderately well drained. Surface runoff is medium. Permeability is very slow. When the soil is very dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a moderate hazard. Gravel in the surface layer and the clayey texture make this soil difficult to work.

Included with this soil in mapping are small areas of Heiden and Tinn soils. Also included are small areas where the soil is eroded and areas of Houston Black soils that have slopes of 3 to 5 percent. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly for cultivated crops and as pastureland. Cotton, grain sorghum, and small grains are the main crops.

This soil is well suited to nonirrigated crops. High yields can be expected if good management is practiced. Fertilization and proper residue management increase organic matter, improve tilth, maintain the level of fertility, and help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Contour farming and terraces are needed to prevent erosion. Grassed waterways safely remove runoff from terraces.

This soil is well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. Good pastureland management includes proper stocking, controlled grazing, and weed control.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This Houston Black soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Deer and turkey are few because of a lack of cover and an adequate food source.

The clayey texture, very slow permeability, high shrink-swell potential, low strength, which affects roads and streets, and corrosivity to uncoated steel are severe limitations to use of the soil for urban development. The limitations are difficult to overcome. The very slow permeability, clayey texture, gravel, and slope are limitations to recreation uses.

This soil is in capability subclass IIe and in the Blackland range site.

HvD—Houston Black gravelly clay, 3 to 8 percent slopes. This is a deep, sloping soil on convex side slopes of ridges in the Blackland Prairie Land Resource Area. The mapped areas are generally long and narrow or irregular in shape and range from 10 to 250 acres in size.

Typically, the upper layer is black gravelly clay about 36 inches thick. Below that, to a depth of 48 inches there is dark gray clay. The underlying layer to a depth

of 60 inches is shaly clay. About 20 percent of the surface is covered with smooth cherty gravel.

This soil is moderately well drained. Surface runoff is medium to rapid. Permeability is very slow. When the soil is dry, cracks form that are 0.5 inch to 3 inches wide and several feet deep. Water enters rapidly when the soil is dry and cracked and very slowly when it is moist. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a severe hazard. The gravel on the surface and the clayey texture make this soil difficult to till at most moisture levels.

Included with this soil in mapping are small areas of Heiden and Tinn soils. Tinn soils are on flood plains of small creeks. Also included are small areas of nongravelly Houston Black soil and a few areas of eroded soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as pastureland and rangeland. In a few areas it is cultivated.

This soil is moderately well suited to nonirrigated crops. The gravel on the surface, rapid runoff, and very slow permeability are the main limitations. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Terraces and contour farming are needed to control erosion.

This soil is well suited to improved pasture grasses. Improved bermudagrass, improved bluestem, and kleingrass are adapted. These grasses respond well to fertilizer. Good pastureland and rangeland management includes proper stocking, controlled grazing, and brush management.

This soil produces high yields of range forage if good management is practiced.

The soil provides habitat for openland wildlife, including quail, dove, rabbit, and small birds. Deer and turkey are few because of the lack of cover and an adequate food source.

For urban uses, the clay content, very slow permeability, high shrink-swell potential, low strength affecting roads and streets, and corrosivity to uncoated steel are limitations that are difficult to overcome. The clay content, very slow permeability, and slope are limitations for recreational uses.

This soil is in capability subclass IIIe and in the Blackland range site.

KrA—Krum clay, 0 to 1 percent slopes. This is a deep, nearly level soil on stream terraces and valley fills. Slopes are plane or slightly concave. The areas are mostly long and narrow or oblong in shape and range from 10 to 360 acres in size.

Typically, the surface layer is dark brown clay about 19 inches thick. The subsoil to a depth of 49 inches is brown clay, and to a depth of 69 inches it is yellowish brown clay. The underlying material to a depth of 80

inches is yellowish brown clay. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is slow. Permeability is moderately slow. Cracks form when the soil is very dry. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is medium. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Bolar, Branyon, Denton, Lewisville, and Sunev soils at a slightly higher elevation than this Krum soil. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In some small areas it is used as pastureland and rangeland.

This soil is well suited to use as cropland. Grain sorghum, wheat, oats, and corn are the main crops. High yields can be expected if good management is practiced. Good tillage and fertility can be maintained if proper residue management, fertilization, and crop rotation are used. Minimum tillage reduces compaction and conserves energy.

This soil is well suited to use as pastureland. Improved bermudagrass, improved bluestem, and kleingrass are adapted to this soil. Good management includes proper stocking, controlled grazing, and brush management.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

Krum soil provides good habitat for openland wildlife. In some areas, cover for deer and turkey is not available.

For urban uses, the clay content, moderately slow permeability, shrink-swell potential, and corrosivity to uncoated steel are limitations which can be partly overcome through good design and careful installation. Clayey texture and moderately slow permeability are limitations for recreational uses.

This soil is in capability subclass IIe and in the Clay Loam range site.

KrB—Krum clay, 1 to 3 percent slopes. This is a deep, gently sloping soil on stream terraces and valley fills. Slopes are plane or concave. Areas are long and narrow or oblong in shape and range from 10 to 400 acres in size.

Typically, the surface layer is dark gray clay about 16 inches thick. The subsoil to a depth of 58 inches is grayish brown clay, and to a depth of 66 inches it is brown clay. The underlying material to a depth of 80 inches is pale brown clay. The soil is moderately alkaline and calcareous throughout.

The soil is well drained. Surface runoff is medium. Permeability is moderately slow. Cracks form when the soil is dry. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Bolar, Denton, Lewisville, Branyon, and Sunev soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In some areas it is used as pastureland and rangeland. The soil is well suited to these uses.

Grain sorghum, wheat, oats, and corn are the main crops. High yields can be expected if good management is practiced. Good tilth and fertility can be maintained if proper residue management, fertilization, and crop rotation are used. Contour farming and terraces are needed to help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy.

Improved bermudagrasses, improved bluestems, and kleingrass are adapted pasture grasses. This soil produces high yields of improved pasture grass forage. Good management includes proper stocking and controlled grazing.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This Krum soil provides good habitat for openland wildlife. In some areas, cover for deer and turkey is not available.

For urban uses, the clay content, shrink-swell potential, moderately slow permeability, and corrosivity to uncoated steel are limitations which can be partly overcome through good design and careful installation. For recreational uses, moderately slow permeability, clayey texture, and slope are limitations.

This soil is in capability subclass IIe and in the Clay Loam range site.

KrC—Krum clay, 3 to 5 percent slopes. This is a deep, gently sloping soil on stream terraces and valley fills. Slopes are mostly concave. The mapped areas are long and narrow and range from 5 to 75 acres.

Typically, the surface layer is dark grayish brown clay about 22 inches thick. The subsoil to a depth of 31 inches is dark brown clay, and to a depth of 44 inches it is brown clay. The subsoil to a depth of 54 inches is light yellowish brown clay. The underlying material is brownish yellow clay. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow. Cracks form when the soil is dry. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is medium. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a severe hazard.

Included with this soil in mapping are small areas of Denton, Lewisville, and Medlin soils. The included soils make up less than 15 percent of a mapped area.

This soil is used as cropland, pastureland, and rangeland.

This soil is moderately well suited to use as cropland. Grain sorghum, wheat, oats, and corn are the main crops. Medium yields can be expected if good management is practiced. Good tilth and fertility can be maintained if proper residue management, fertilization, and crop rotation are used. Contour farming and terraces are needed to help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy.

This Krum soil is well suited to use as pastureland. Improved bermudagrasses, improved bluestems, and kleingrass grow well. Good management includes proper stocking, controlled grazing, and brush management.

This soil produces high yields of range forage if good management is practiced.

Krum soil provides habitat for openland wildlife. In some areas, cover for deer and turkey is not available.

For urban uses, the clayey texture, shrink-swell potential, moderately slow permeability, and corrosivity to uncoated steel are limitations which can be partly overcome through good design and careful installation. For recreational uses, clayey texture, moderately slow permeability, and slope are limitations.

This soil is in capability subclass IIIe and in the Clay Loam range site.

LeA—Lewisville silty clay, 0 to 1 percent slopes.

This is a deep, nearly level soil on plane to slightly convex slopes on stream terraces. The areas are irregular in shape and range from 5 to 400 acres in size.

Typically, the surface layer is dark grayish brown, silty clay about 17 inches thick. The subsoil to a depth of 36 inches is brown silty clay, and to a depth of 54 inches it is yellowish brown silty clay. The underlying material to a depth of 61 inches is brown silty clay. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is slow. Permeability is moderate. The available water capacity is high. The rooting zone is deep. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Krum, Branyon, Gruene, and Sunev soils. Also included are small areas of gently sloping Lewisville soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In a few areas it is irrigated. Grain sorghum, cotton, and small grains are the main crops. In some areas this soil is used for improved pasture and as rangeland.

This soil is well suited to use as irrigated and nonirrigated cropland. High yields can be obtained if good management is practiced. Fertilization and proper residue management help maintain good tilth and fertility.

This Lewisville soil is well suited to improved pasture. Improved bermudagrass, kleingrass, and medio bluestem are adapted. Good management includes proper stocking and controlled grazing.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides good habitat for openland wildlife, although cover is not adequate in some areas.

For urban uses, the clayey texture, shrink-swell potential, moderate permeability, low strength affecting roads and streets, and corrosivity to uncoated steel are limitations. The clayey texture is a limitation for recreation uses.

This soil is in capability class I and in the Clay Loam range site.

LeB—Lewisville silty clay, 1 to 3 percent slopes.

This is a deep, gently sloping soil on stream terraces. Slopes are convex. Areas are irregular in shape and range from 5 to 200 acres in size.

Typically, the surface layer is dark grayish brown silty clay about 15 inches thick. The subsoil to a depth of 33 inches is light brown silty clay, and to a depth of 63 inches it is reddish yellow silty clay. The soil is moderately alkaline and calcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is moderate. The available water capacity is high. The rooting zone is deep. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Krum, Sunev, Seawillow, and Gruene soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In a few areas it is used as pastureland. In some areas it is used for improved pasture.

This soil is well suited to use as irrigated and nonirrigated cropland. Grain sorghum, cotton, and small grains are the main crops. High yields can be obtained if good management is practiced. Fertilization and proper residue management maintain good tilth and fertility and help prevent erosion. Contour farming and terracing are needed to prevent erosion.

This Lewisville soil is well suited to improved pasture. Improved bermudagrass, kleingrass, and medio bluestem grow well. Good management includes proper stocking and controlled grazing.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides good habitat for openland wildlife, although cover is inadequate in some areas.

For urban uses, the clayey texture, shrink-swell potential, moderate permeability, low strength affecting roads and streets, and corrosivity to uncoated steel are limitations. For recreational uses, clayey texture and slope are the limitations.

This soil is in capability subclass IIe and in the Clay Loam range site.

MEC—Medlin-Eckrant association, undulating. This association consists of very shallow to shallow and deep soils on uplands in the Edwards Plateau Land Resource

Area. The Medlin soil is on slightly concave slopes, and the Eckrant soil is on convex slopes. Slopes range from 1 to 8 percent. The mapped areas are irregular in shape and range from 25 to 500 acres in size.

The Medlin soil makes up 30 to 65 percent of the mapped areas, and the Eckrant soil makes up 20 to 60 percent. A typical area is 50 percent Medlin soil and 30 percent Eckrant soil. The Medlin soil is on the lower side slopes of low hills and ridges. The Eckrant soil is on the upper side slopes and on the crest of hills and ridges. Krum soils on toe slopes below the Medlin soil, Comfort soils on the crest of ridges, and narrow ledges of limestone bedrock on the upper side slopes make up about 20 percent of the mapped areas. The Medlin soil is eroded in about 15 percent of the areas. The composition of this association is more variable than that of other map units in the survey area. Mapping has been controlled well enough, however, for the anticipated use of the soils.

Typically, the surface layer of the Medlin soil is grayish brown clay about 9 inches thick. The subsoil, to a depth of 24 inches, is olive clay and, to a depth of 38 inches, mottled pale olive and pale yellow clay. The underlying material to a depth of 80 inches is mottled olive, pale yellow, and brownish yellow shale. The soil is moderately alkaline and calcareous throughout.

The Medlin soil is well drained. Surface runoff is rapid. Permeability is very slow. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a severe hazard.

Typically, the surface layer of the Eckrant soil is dark brown extremely stony clay about 17 inches thick. The underlying material is fractured limestone bedrock. The soil is moderately alkaline and noncalcareous throughout.

The Eckrant soil is well drained. Surface runoff is rapid. Permeability is moderately slow. The available water capacity is very low. The rooting zone is very shallow to shallow. Water erosion is a slight hazard.

The Eckrant soil is not suited to use as cropland or pastureland. Stones on the surface, limited rooting depth, and very low available water capacity are limitations. The Medlin soil is poorly suited to use as cropland and pastureland because of the hazard of erosion and very slow permeability. Yields are low in most years.

The Medlin and Eckrant soils are used as rangeland. High forage yields can be expected on the Medlin soil and medium yields on the Eckrant soil if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management. Wild persimmon and Ashe juniper tend to invade these soils if the range is overgrazed. In addition, mesquite will encroach on areas of the Medlin soil.

The Medlin soil is well suited to farm ponds and is used extensively for this purpose.

The Medlin and Eckrant soils provide habitat for deer, turkey, dove, and quail.

For urban uses, the slope, stoniness, the shallowness of the Eckrant soil, the moderately slow and very slow permeability, shrink-swell potential, low strength affecting roads and streets, and corrosivity to uncoated steel are severe limitations that can be difficult and costly to overcome. For recreational uses, slope, shallowness to rock, very slow permeability, and stoniness are limitations.

The Medlin soil is in capability subclass VIe, and the Eckrant soil is in capability subclass VIIs. The Medlin soil is in the Blackland range site, and the Eckrant soil is in the Low Stony Hills range site.

MED—Medlin-Eckrant association, hilly. This association consists of very shallow to shallow and deep soils on uplands in the Edwards Plateau Land Resource Area (fig. 10). The Medlin soil is on slightly concave slopes, and the Eckrant soil is on convex slopes. There are narrow limestone ledges at the top of some slopes. The slopes range from 8 to 30 percent. The areas are long and narrow and range from 25 to 350 acres in size.

The Medlin and Eckrant soils each make up 20 to 80 percent of a mapped area. Together, on the average, they make up about 95 percent of a mapped area. A typical area is 50 percent Medlin soil and 45 percent Eckrant soil. The Medlin soil is on lower side slopes, and the Eckrant soil is on the upper side slopes and on the crest of narrow ridges. Krum soils on toe slopes below the Medlin soil and rock outcrops on the upper side slopes make up less than 20 percent of the mapped areas. The Medlin soil is eroded in about 15 percent of the areas. The composition of this association is more variable than that of other map units in the survey area. Mapping has been controlled well enough, however, for the anticipated use of the soils.

Typically, the Medlin soil has a grayish brown surface layer about 11 inches thick that is stony clay in the upper part and clay in the lower part. The subsoil, from 11 to 50 inches, is light yellowish brown clay that has yellowish brown and olive yellow mottles. The underlying material to a depth of 80 inches is light gray shaly clay that has yellow and olive yellow mottles. The soil is moderately alkaline and calcareous throughout.

The Medlin soil is well drained. Surface runoff is rapid. Permeability is very slow. Water enters rapidly when the soil is dry and cracked and very slowly when it is wet. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. Water erosion is a severe hazard.

Typically, the surface layer of the Eckrant soil is very dark gray extremely stony clay about 16 inches thick. The underlying material is fractured limestone bedrock.

The soil is moderately alkaline and noncalcareous throughout.

The Eckrant soil is well drained. Surface runoff is rapid. Permeability is moderately slow. The available water capacity is very low. The rooting zone is very shallow to shallow. Water erosion is a severe hazard.

These soils are used as rangeland. High forage yields can be expected on the Medlin soil and medium yields on the Eckrant soil if good management is practiced. Good management includes proper stocking, controlled grazing, and brush management. Mesquite invades the Medlin soil, and Texas persimmon and Ashe juniper invade both the Eckrant and Medlin soils if the range is overgrazed.

The Medlin soil provides good sites for farm ponds and is used extensively for this purpose.

The Eckrant soil is not suited to use as cropland or pastureland. Slopes, stoniness, limited rooting depth, and very low available water capacity are severe limitations.

The Medlin and Eckrant soils provide habitat for deer, turkey, dove, and quail.

For urban and recreational purposes, the slope, stoniness, the shallowness of the Eckrant soil, the very slow permeability of the Medlin soil, shrink-swell potential, low strength affecting roads and streets, and corrosivity to uncoated steel are severe limitations that can be difficult and costly to overcome.

These soils are in capability subclass VIIs. The Medlin soil is in the Blackland range site, and the Eckrant soil is in the Steep Rocky range site.

Oa—Oakalla silty clay loam, rarely flooded. This is a deep, nearly level soil on plane, smooth slopes on flood plains. Slopes are less than 1 percent. The areas are irregular in shape and range from about 10 to 700 acres in size.

Typically, the upper layer is grayish brown silty clay loam about 31 inches thick. The subsoil to a depth of 42 inches is brown silty clay loam, and to a depth of 62 inches it is yellowish brown silty clay loam. The underlying material is light yellowish brown silty clay loam. The soil is moderately alkaline and calcareous and about 40 percent calcium carbonate throughout.

This soil is well drained. Flooding is unlikely, although it can occur under abnormal weather conditions. Surface runoff is slow. Permeability is moderate, and the available water capacity is high. The rooting zone is deep. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Lewisville, Boerne, Seawillow, and Sunev soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In some areas it is used as pastureland and rangeland. It is well suited to these uses.

The main crops are wheat, oats, grain sorghum, and forage sorghums. Medium to high yields can be

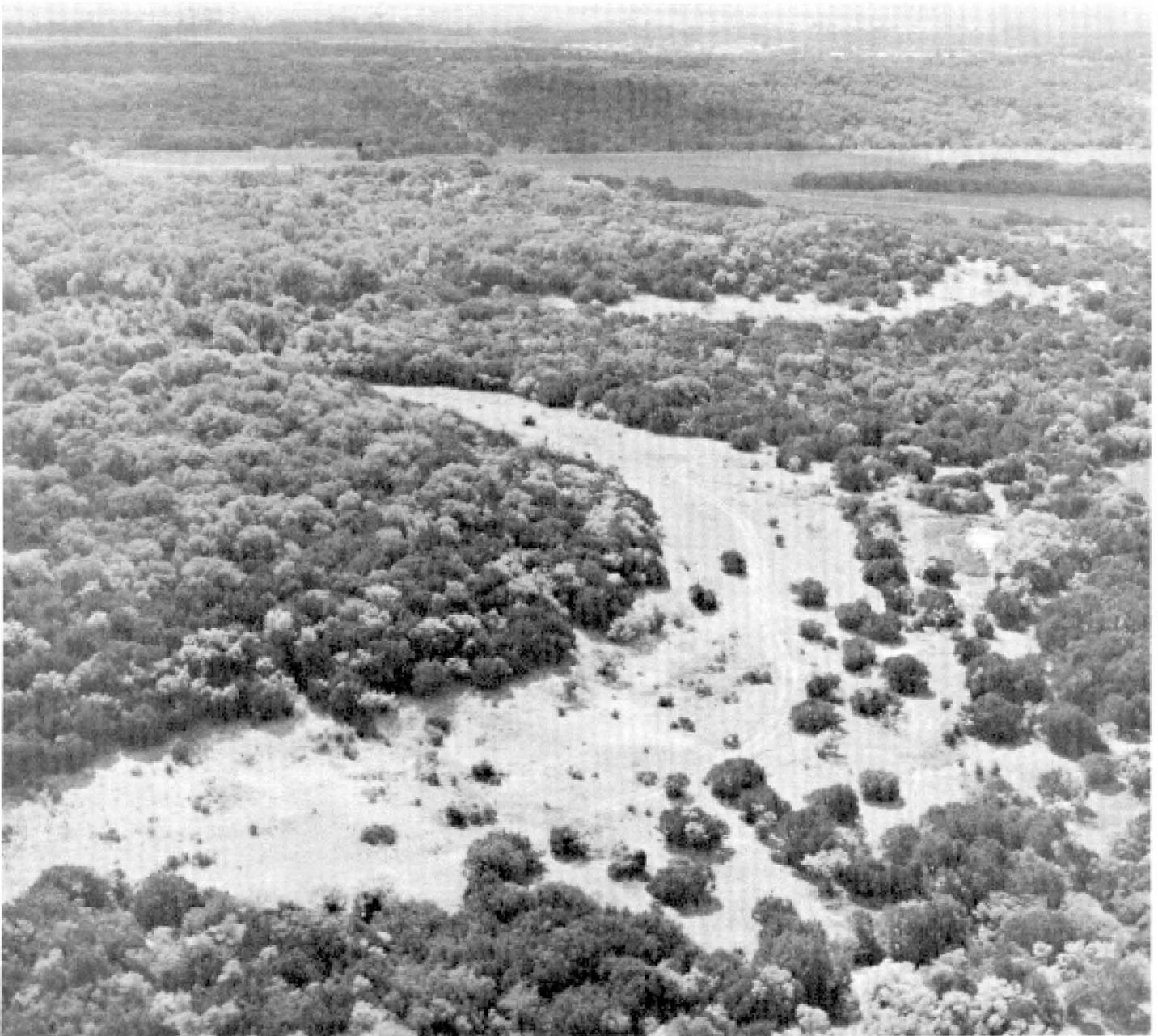


Figure 10.—An aerial view of Medlin-Eckrant association, hilly. Medlin stony clay is in the open areas, and Eckrant extremely stony clay is in the wooded areas.

expected if good management is practiced. Good till and fertility can be maintained if proper residue management, fertilization, and crop rotation are used. Minimum tillage helps prevent runoff, conserve moisture, reduce compaction, and conserve energy.

High forage yields can be expected from improved pasture grasses if good management is practiced.

Improved bermudagrass, improved bluestem, and kleingrass grow well. These grasses respond well to fertilizer. Good pastureland and rangeland management includes proper stocking, controlled grazing, and brush management.

This soil produces high yields of range forage if good management is practiced.

This Oakalla soil provides good habitat for wildlife. Food and cover, however, are not adequate in areas that are cultivated.

This soil is not suited to urban uses because of the hazard of flooding. Excess lime is a limitation for landscape plants. Low strength, which affects roads and streets, and corrosivity to uncoated steel are other limitations. This soil is suited to some recreation uses, but flooding is a hazard.

This soil is in capability class I and in the Loamy Bottomland range site.

Ok—Oakalla soils, frequently flooded. These are deep, nearly level soils on plane, smooth to slightly undulating flood plains. Areas are long and narrow in shape and range from 5 to 200 acres in size. The surface texture of these soils is loam, clay loam, silty clay, or silty clay loam and does not vary in a uniform or regular pattern.

Typically, the upper layer to a depth of 40 inches is dark grayish brown clay loam. The subsoil to a depth of 49 inches is light yellowish brown clay loam. The underlying material to a depth of 80 inches is very pale brown clay loam. These soils are moderately alkaline and calcareous throughout. They are about 60 percent calcium carbonate (lime) throughout.

These soils are well drained. They are flooded more than once every 2 years for very brief periods. Surface runoff is slow. Permeability is moderate, and the available water capacity is high. The rooting zone is deep. Water erosion is a slight hazard.

Included with these soils in mapping are small areas of a soil that is similar to the Oakalla soils except that it is more silty throughout. Also included are areas of a soil that has gravelly layers in the subsoil and in the underlying material. The included soils make up less than 15 percent of a mapped area.

Oakalla soils are not suited to use as cropland because of the hazard of flooding.

These soils are used as pastureland and rangeland. They are well suited to these uses. High yields can be expected from native range plants and improved pasture grasses if good management is practiced. Common bermudagrass and improved bermudagrass are well adapted. These grasses respond well to fertilizer. Good pastureland and rangeland management includes proper stocking, controlled grazing, and brush management.

Oakalla soils provide fair habitat for wildlife. They produce adequate food and cover for deer, turkey, dove, quail, and many other nongame animals.

These soils are not suited to urban uses mainly because flooding is a hazard. Low strength affecting roads and streets and corrosivity to uncoated steel are limitations that are difficult and costly to overcome.

If these soils are protected from flooding they provide good sites for recreation (fig. 11).

These soils are in capability subclass Vw and in the Loamy Bottomland range site.

Or—Orif soils, frequently flooded. These are deep, nearly level soils on flood plains of large creeks and rivers. Slopes are convex and on the average are less than 1 percent. They are adjacent to the stream channel. The areas are long and narrow and range from 10 to 350 acres in size. The surface texture is gravelly loam, gravelly sandy loam, gravelly loamy sand, or a very gravelly counterpart. The texture does not vary in a regular pattern.

Typically, the surface layer is grayish brown, moderately alkaline gravelly loamy sand about 20 inches thick. The underlying layer to a depth of 60 inches is very gravelly loamy sand stratified with very gravelly sand, very gravelly sandy loam, and loam.

These soils are well drained. Flooding occurs several times in most years and is of very brief duration. Floodwaters are swift and destructive. Surface runoff is slow. Permeability is rapid. The available water capacity is low. The rooting zone is deep. Water erosion is a severe hazard.

Included with these soils in mapping are small areas of Oakalla soils on low ridges and areas of a soil that is similar to Orif soils except that it has a dark grayish brown gravelly loam surface layer. The included soils make up less than 15 percent of a mapped area.

These soils are used as rangeland and as a source of sand and gravel for road and building construction. They are not suited to use as pastureland or cropland because of flooding, the high content of gravel, and low available water capacity.

Orif soils produce medium yields of native range grass forage. The low available water capacity and low natural fertility limit the amount of forage produced in favorable years.

These soils provide fair habitat for the wildlife commonly found along creeks and rivers.

These soils are not suited to most urban and recreational uses because of the hazard of flooding.

Orif soils are in capability subclass VIs and in the Loamy Bottomland range site.

PdB—Pedernales fine sandy loam, 1 to 5 percent slopes. This is a deep, gently sloping soil on uplands on high, thin terraces along the Pedernales River. Slopes are convex. The areas are long and narrow in shape and range from 100 to 200 acres in size.

Typically, the surface layer is reddish brown, neutral fine sandy loam about 12 inches thick. The subsoil to a depth of 16 inches is reddish brown, neutral sandy clay, and to a depth of 40 inches it is mottled red and dark red, slightly acid sandy clay. The underlying material is light reddish brown sandy clay loam interbedded with weakly cemented limestone.



Figure 11.—This area of Oakalla soils, frequently flooded, is protected from flooding and thus can be used for some kinds of recreation.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow, and the available water capacity is high. The rooting zone is deep. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of a soil that has a loamy fine sand surface layer and areas of a soil that is less than 35 inches deep to limestone. Also included are some small areas of Pedernales gravelly fine sandy loam. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In some small areas it is cultivated. In some areas it is being subdivided into small tracts for urban uses.

This soil is moderately well suited to use as cropland and it is well suited to use as pastureland. In most areas it is planted to oats for grazing. Forage yields on rangeland are high if good management is practiced.

Good management includes proper stocking, controlled grazing, and brush management.

Pedernales soil provides good habitat for deer, turkey, quail, and several species of nongame birds and small animals.

For urban uses, the moderately slow permeability, low strength, which affects roads and streets, and the clayey subsoil are limitations. The moderately slow permeability and slope are the main limitations for recreation uses.

This soil is in capability subclass IIIe and in the Tight Sandy Loam range site.

Pt—Pits. Pits are excavations from which rock, gravel, caliche, or clay has been removed. They range in size from 5 to 550 acres and in depth from about 10 to 100 feet. Pits smaller than 5 acres are identified by a spot symbol on the soil maps.

The surface material is residual rock, gravel, caliche, or clay that has been disturbed in excavation. The material ranges in thickness from a few inches to several feet where it is in piles.

The largest and deepest pits are rock quarries from which limestone has been excavated for use as commercial lime. Rock from other quarries has been used for road construction. The limestone that is taken from the newer pits is used in making cement. These pits are mainly in areas of the Comfort, Rumble, Eckrant, Austin, and Castephen soils.

Gravel pits are generally near large creeks and rivers. Large areas of Gruene soils and smaller areas of Lewisville, Krum, Oakalla, and Seawillow soils have been excavated for the underlying gravel. The gravel is used as construction material. Some of the pits have standing water most of the time.

Caliche pits are in the western half of the survey area in areas of interbedded marl and weakly cemented limestone. Most are small and shallow. The caliche is used mainly as the base material for paved roads or as the surface for caliche roads. These pits are mainly in areas of the Brackett, Real, and Doss soils.

Clay has been excavated from several pits near Interstate 35. The clay was used as fill material in constructing the highway. Most of these pits now hold water. They are in areas of the Branyon soils.

A few of the smaller pits near urban areas are being reclaimed by back-filling with material from nearby pits that are currently being excavated. A few of the larger pits can be reclaimed by spreading topsoil and seeding with a variety of drought-resistant range grasses.

Pits are not suited to use as cropland, pastureland, or rangeland or for recreation or urban uses. Slope, the roughness of the terrain, and coarse fragments, including gravel, cobbles, and stones, are the main limitations.

Some small animals, particularly rock squirrel, live in abandoned rock quarries.

Pits are not assigned to a capability subclass or a range site.

PuC—Purves clay, 1 to 5 percent slopes. This is a shallow, gently sloping soil on uplands. Slopes are plane to slightly convex. Areas are long and narrow in shape and range from 5 to 300 acres in size.

Typically, the surface layer is very dark gray clay about 10 inches thick. The layer below that to a depth of 16 inches is dark gray clay, and to a depth of 19 inches it is dark grayish brown clay that is about 10 percent, by volume, coarse fragments of limestone. The underlying layer is fractured indurated limestone bedrock.

This soil is well drained. Surface runoff is medium. Permeability is moderately slow. The available water capacity is very low. The rooting zone is shallow. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Doss, Brackett, and Eckrant soils. Also included are a

few areas of Rock outcrop. The included soils make up less than 15 percent of a mapped area.

Purves soil is used mainly as rangeland. In a few areas it is used as pastureland and cropland. Small grains and forage sorghums are the main crops.

This soil is moderately well suited to use as pastureland. The shallow rooting depth and the very low available water capacity are limitations. King Ranch bluestem, Kleberg bluestem, kleingrass, and medio bluestem grow well. Good management includes proper stocking, controlled grazing, and brush management.

This soil produces medium yields of range forage if good management is practiced.

This soil is poorly suited to use as cropland. The shallow rooting depth and the very low available water capacity are the main limitations. The available water capacity can be increased, and good tilth and fertility can be maintained if proper residue management is used.

This soil provides fair habitat for most openland wildlife.

For urban and recreational uses, the clayey texture, high shrink-swell potential, shallowness, and slope are severe limitations that can be difficult to overcome and can require expensive construction measures.

This soil is in capability subclass IVe and in the Shallow range site.

RaD—Real gravelly loam, 1 to 8 percent slopes.

This is a shallow, gently sloping to sloping soil on convex slopes of low hills and ridges on uplands in the Edwards Plateau Land Resource Area. The areas of this soil are irregular in shape and range from 75 to 600 acres in size.

Typically, the surface layer is 9 inches thick. It is dark grayish brown gravelly loam in the upper part and very gravelly loam in the lower part. The layer below that extends to a depth of 14 inches. It is dark grayish brown extremely stony loam. The underlying material is strongly cemented platy chalk. The soil is moderately alkaline and calcareous throughout. The calcium carbonate (lime) content is about 55 percent.

This soil is well drained. Surface runoff is rapid. Permeability is moderate, and the available water capacity is very low. The rooting zone is shallow. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Eckrant, Comfort, and Doss soils. Local areas are underlain by indurated limestone. The included soils make up less than 15 percent of a mapped area.

This soil is used as rangeland and wildlife habitat. It is not suited to use as cropland or pastureland. The shallow rooting depth, high content of lime, and the very low available water capacity are severe limitations for crops and pasture grasses.

On rangeland, forage production from native range plants is low to medium. Good management includes

proper stocking, controlled grazing, and brush management.

This soil produces a limited amount of food for deer, turkey, and quail.

For urban and recreational uses, the shallowness of the soil, gravel, corrosivity to uncoated steel, and slope are the main limitations. These limitations can be difficult to overcome. Good design and careful installation are necessary.

This soil is in capability subclass VI_s and in the Adobe range site.

RcD—Real-Comfort-Doss complex, undulating. This complex consists of shallow, loamy and clayey soils on low hills and ridges on uplands in the Edwards Plateau Land Resource Area. Slopes are convex and range from 1 to 8 percent. Mapped areas range from 25 to 3,000 acres in size.

The Real soil makes up 22 to 54 percent of the complex, but on the average it makes up 40 percent. The Comfort soil makes up 18 to 40 percent, but the average is 30 percent. The Doss soil makes up 9 to 39 percent, but the average is 20 percent. Eckrant, Purves, and Brackett soils and areas of Rock outcrop make up 1 to 19 percent, but the average is 10 percent. The soils are in areas so small or so intricately mixed that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Real soil is very dark grayish brown gravelly loam about 8 inches thick. The upper part is about 25 percent, by volume, angular gravel of limestone and caliche, and the lower part is about 55 percent fragments. The underlying material is weakly cemented limestone interbedded with thin layers of indurated limestone. The soil is moderately alkaline and calcareous throughout.

Typically, the surface layer of the Comfort soil is dark brown very stony clay about 7 inches thick. The subsoil extends to a depth of 13 inches. It is dark reddish brown extremely stony clay. The underlying material is indurated fractured limestone. The soil is moderately alkaline and noncalcareous throughout.

Typically, the surface layer of the Doss soil is dark brown clay loam about 7 inches thick. The subsoil extends to a depth of 12 inches. It is reddish brown clay loam that is about 15 percent limestone and caliche gravel. The underlying material is weakly cemented limestone and marl. The soil is moderately alkaline and calcareous throughout.

The soils in this complex are well drained. Surface runoff is medium to rapid. Permeability in the Real soil is moderate, in the Comfort soil it is slow, and in the Doss soil it is moderately slow. The available water capacity is very low in the Real and Comfort soils and low in the Doss soil. Erosion is a moderate hazard. The rooting zone is shallow.

The soils in this complex are used as rangeland and wildlife habitat. Under good range management, they

produce medium yields of forage. Production is limited because of the restricted rooting depth and the very low available water capacity. Ashe juniper invades these soils if the range is overgrazed. Good management includes proper stocking, controlled grazing, and brush management.

These soils provide a fair amount of food and cover for deer, turkey, and quail.

The soils in this complex are not suited to use as cropland and are poorly suited to use as pastureland. The shallow rooting zone, the very low available water capacity, and small areas of rock outcrop are severe limitations for cultivated crops.

For urban and recreation uses, shallowness, small stones, slope, low strength affecting roads and streets, and corrosivity to uncoated steel are the major limitations. These limitations can be difficult to overcome. Good design and careful installation are required.

These soils are in capability subclass VI_s. The Real soil is in the Adobe range site, the Comfort soil is in the Low Stony Hills range site, and the Doss soil is in the Shallow range site.

RUD—Rumple-Comfort association, undulating.

This association consists of shallow and moderately deep soils on uplands in the Edwards Plateau Land Resource Area. Slopes are plane or convex and range from 1 to 8 percent. The areas are irregular in shape and range from 50 to several thousand acres in size.

Rumple soil makes up about 60 percent of the association, Comfort soil makes up 20 percent, and other soils, mainly Tarpley soils, make up 20 percent. The Rumple soil makes up 39 to 82 percent of the individual areas, the Comfort soil makes up 5 to 42 percent, and the other soils make up less than 5 to 34 percent. The Rumple soil is on broad ridgetops and side slopes. It is mainly gently sloping. The Comfort soil is mainly in the more sloping areas near drainageways and near outcrops of rock. In places, there are narrow ledges of limestone. The mapped areas of this association are much larger and more variable than areas of the other map units in the survey area. Mapping has been controlled well enough, however, for the anticipated use of the soils.

Typically, the surface layer of the Rumple soil is dark reddish brown very cherty clay loam about 10 inches thick. Rounded chert and limestone cobbles and gravel cover about 20 percent of the surface. The subsoil to a depth of 14 inches is dark reddish brown very cherty clay, and to a depth of 28 inches it is dark reddish brown extremely stony clay that is about 75 percent, by volume, limestone fragments. The underlying material is indurated fractured limestone. The soil is mildly alkaline and noncalcareous throughout. The texture of the surface layer ranges to very cherty loam and cherty clay.

Typically, the surface layer of the Comfort soil is dark brown, neutral, extremely stony clay about 7 inches

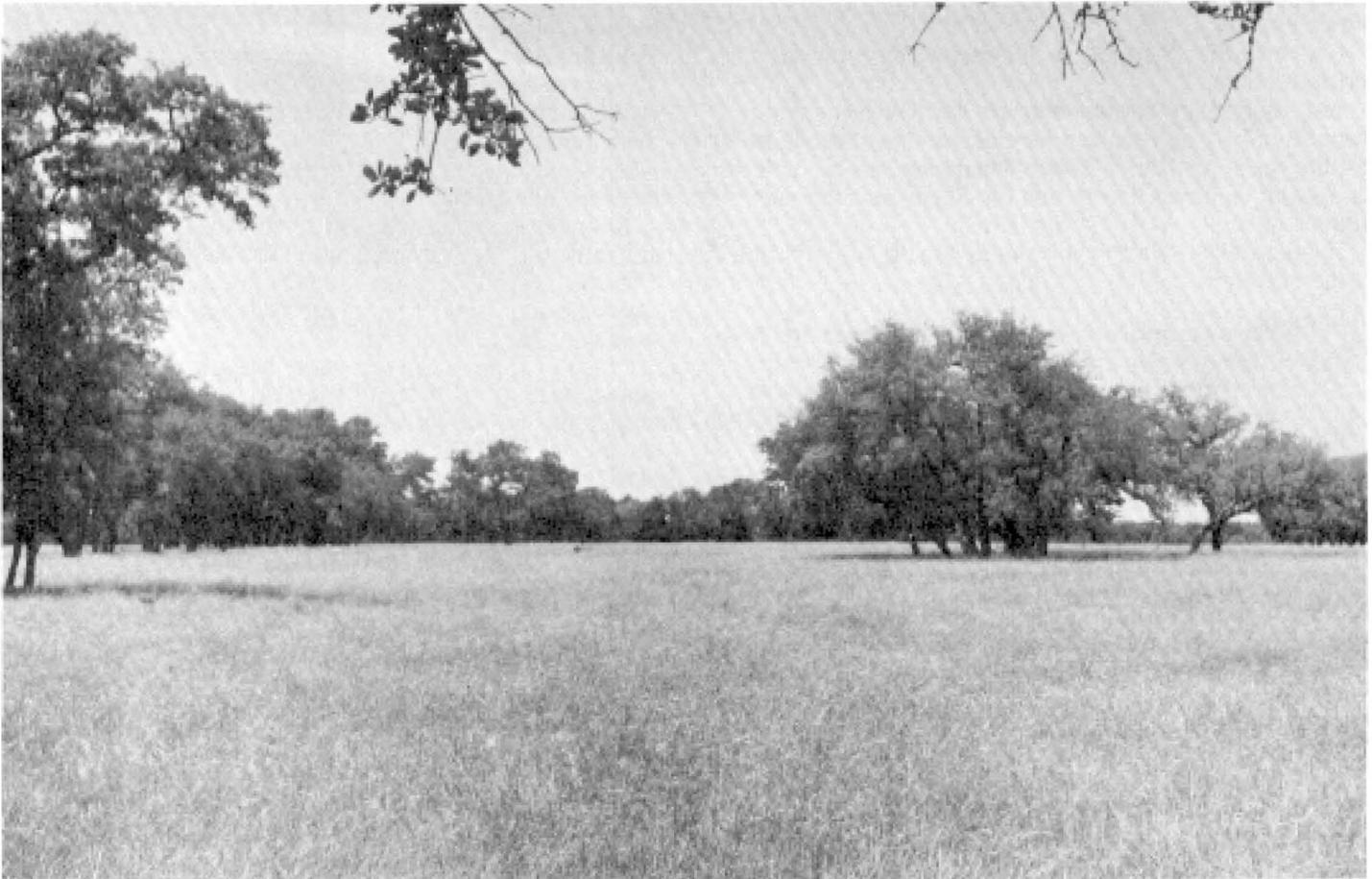


Figure 12.—Rumple very cherty clay loam, in an area of Rumple-Comfort association, undulating, is used mainly as rangeland. This soil is in the Gravelly Redland range site.

thick. The subsoil to a depth of 12 inches is dark reddish brown, mildly alkaline, extremely stony clay. The underlying material is indurated fractured limestone. The soil is noncalcareous throughout.

The soils in this association are well drained. Surface runoff is medium. However, runoff from large areas is much slower than from local areas because some of the water enters caves, sinks, rock crevices, and streambeds. Permeability is moderately slow in the Rumple soil and slow in the Comfort soil. The available water capacity is very low. The rooting zone is shallow in Comfort soil and moderately deep in Rumple soil. Water erosion is a moderate hazard.

These soils are used as rangeland and as habitat for wildlife (fig. 12). They are not suited to cultivated crops or pasture. Cobbles and stones on the surface and within the soil, the limited rooting zone, and the very low available water capacity are severe limitations.

Yields of range forage are medium. Forage production is limited because of the restricted rooting depth and the very low available water capacity. Good management includes proper stocking, controlled grazing, and brush control. Texas persimmon and Ashe juniper invade on the Comfort soil, and mesquite invades on the Rumple soil if the range is overgrazed. Cattle tend to graze the grasses more closely on the Rumple soil than on the Comfort soil. On the Comfort soil, the grasses generally are not overgrazed because of the large stones in the grassed areas. Therefore, stocking rates for proper grazing can be keyed to the Rumple soil.

The soils provide fair habitat for deer, turkey, and quail.

The stony surface layer, shallowness to bedrock, and corrosivity to uncoated steel are severe limitations to use of the soils for urban and recreation uses. The limitations are difficult to overcome.

These soils are in capability subclass VIs. The Rumble soil is in the Gravelly Redland range site, and the Comfort soil is in the Low Stony Hills range site.

SeB—Seawillow clay loam, 1 to 3 percent slopes.

This is a deep, gently sloping soil on low ridges on stream terraces. Slopes are convex. The areas are mostly long and narrow in shape and range from 5 to 100 acres in size.

Typically, the surface layer is grayish brown clay loam about 11 inches thick. The subsoil to a depth of 26 inches is very pale brown clay loam. About 70 percent of this layer is calcium carbonate (lime). The underlying material to a depth of 60 inches is very pale brown clay loam. The soil is moderately alkaline and limy throughout.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is medium. The rooting zone is deep. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Lewisville and Boerne soils and a soil that is similar to this Seawillow soil except that it has a dark colored surface layer. The included soils make up less than 15 percent of a mapped area.

This soil is used as cropland, pastureland, and rangeland.

The soil is moderately well suited to use as pastureland. It produces medium yields of improved pasture grasses, for example, improved bermudagrasses and improved bluestems. Good management includes proper stocking, controlled grazing, weed control, and fertilization.

This soil produces high yields of range forage if good management is practiced.

This soil is moderately well suited to use as cropland. Forage sorghums, wheat, and oats are the main crops. Low to medium yields can be expected if good management is used. The susceptibility of some plants to lime-induced iron chlorosis caused by excessive calcium carbonate is a limitation. Fertilization and proper residue management increase organic matter, maintain the level of fertility, and help prevent erosion. Minimum tillage helps prevent runoff, reduce compaction, and conserve energy. Contour farming is needed to prevent erosion.

The Seawillow soil provides habitat for openland wildlife. In most areas, however, cover for deer and turkey is not adequate.

This soil is suited to septic tank absorption fields and area landfills. Sites near streams should be avoided because of the risk of contamination. Seepage, corrosivity to uncoated steel, and low strength, which affects roads and streets, are moderate limitations to use of the soil for urban uses. The limitations can be partly overcome through good design and careful installation. Slope is the only limitation for recreation uses.

This soil is in capability subclass IIe and in the Blackland range site.

SeD—Seawillow clay loam, 3 to 8 percent slopes.

This is a deep, gently sloping to sloping soil on stream terraces. Slopes are convex. These areas are long and narrow or oblong in shape and range from 5 to 80 acres in size.

Typically, the surface layer is brown clay loam about 8 inches thick. The subsoil to a depth of 38 inches is very pale brown clay loam. About 58 percent of this layer is calcium carbonate (lime). The underlying material to a depth of 80 inches is very light brown gravelly clay loam. The soil is moderately alkaline and limy throughout.

This soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is medium. The rooting zone is deep. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Lewisville and Gruene soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In a few areas it is used as pastureland and cropland.

This soil is poorly suited to use as cropland. Erosion is a severe hazard. Crop yields are generally low. Oats and forage sorghums are the main crops. Some plants are affected by lime-induced iron chlorosis.

This soil is moderately well suited to use as pastureland. It produces medium forage yields of improved pasture grasses if good management is practiced. Good management includes proper stocking, controlled grazing, brush management, and fertilization.

On rangeland, this soil produces high yields of forage if good management is practiced.

The soil provides habitat for openland wildlife. In some areas, however, cover for deer and turkey is not adequate.

This soil is well suited to septic tank absorption fields and area landfills. Nevertheless, sites near streams should be avoided because of the risk of contamination. Seepage, clayey texture, corrosivity to uncoated steel, and low strength, which affects roads and streets, are moderate limitations to use of the soils for urban uses. The limitations can be partly overcome through good design and careful installation. Slope is the main limitation for recreation uses.

This soil is in capability subclass IVe and in the Blackland range site.

SuA—Sunev silty clay loam, 0 to 1 percent slopes.

This is a deep, nearly level soil on low stream terraces on uplands. Slopes are plane to slightly convex. The areas are mostly irregular in shape and range from 10 to 300 acres in size.

Typically, the surface layer is brown silty clay loam about 15 inches thick. The subsoil to a depth of 33 inches is very pale brown silty clay loam, and to a depth

of 65 inches it is reddish yellow silty clay loam. The underlying material is reddish yellow silty clay loam. The soil is moderately alkaline and calcareous throughout. The subsoil is about 60 percent calcium carbonate.

This soil is well drained. Surface runoff is slow. Permeability is moderate, and the available water capacity is medium. The rooting zone is deep. Water erosion is a slight hazard.

Included with this soil in mapping are small areas of Lewisville, Seawillow, Boerne, and Gruene soils and small areas of gently sloping Sunev soils. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as cropland. In a few areas it is used as pasture or rangeland.

This soil is moderately well suited to use as cropland. The main crops are oats, wheat, grain sorghum, and forage sorghums. Medium yields can be expected if good management is practiced. The high content of lime is the major limitation. The lime lowers the available water capacity and causes chlorosis in some plants, especially sorghums. Fertilization, proper residue management, and minimum tillage help conserve moisture, improve fertility, reduce compaction, and conserve energy. This soil is suited to irrigation.

This soil is well suited to use as pasture. Forage yields are high for pasture grasses, including improved bermudagrasses, improved bluestems, and kleingrass. These grasses respond well to fertilizer. Good management includes proper stocking, controlled grazing, and weed and brush control.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides adequate food and cover for rangeland and openland wildlife. In cultivated areas, however, food and cover for deer and turkey may not be adequate.

For urban and recreational uses, slope, seepage, the clayey texture, and corrosivity to uncoated steel are moderate limitations. These limitations can be overcome through good design and careful installation.

This soil is in capability subclass IIs and in the Clay Loam range site.

SuB—Sunev clay loam, 1 to 3 percent slopes. This is a deep, gently sloping soil on valley slopes and foot slopes of hills on uplands in the Edwards Plateau Land Resource Area. Slopes are convex to concave and average 2 percent. The areas are long and narrow and range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown clay loam about 11 inches thick. The subsoil to a depth of 35 inches is brown clay loam. To a depth of 45 inches, it is reddish yellow clay loam that is about 15 percent, by volume, soft masses and concretions of calcium carbonate. The soil is moderately alkaline and calcareous throughout. It is about 45 percent calcium carbonate (lime).

This soil is well drained. Surface runoff is medium to rapid. Permeability is moderate, and the available water capacity is medium. The rooting zone is deep. Water erosion is a moderate hazard. This soil receives runoff from adjacent higher slopes.

Included with this soil in mapping are small areas of Bolar, Krum, Denton, and Lewisville soils, which are generally at a lower elevation. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In some areas it is used as pasture or cropland.

This soil is well suited to use as cropland. Grain sorghum, oats, and forage sorghums are the main crops. Medium yields can be expected if good management is used. The high content of lime is the major limitation. It lowers the available water capacity and causes chlorosis in some plants, especially sorghums. Fertilization, proper residue management, and minimum tillage help conserve moisture, improve fertility, reduce compaction, and conserve energy.

This soil is well suited to use as pasture. Forage yields are high if good management is practiced. The main pasture grasses are improved bermudagrasses, improved bluestems, and kleingrass. These grasses respond well to fertilizer. Good management includes proper stocking, controlled grazing, and weed and brush control.

This soil produces high yields of range forage if good management is practiced.

This soil provides good habitat for wildlife. In cultivated areas, however, food and cover for deer and turkey may not be adequate.

For most urban and recreational uses, seepage, slope, and corrosivity to uncoated steel are the main limitations. These limitations can be overcome through good design and careful installation.

This soil is in capability subclass IIIe and in the Clay Loam range site.

TaB—Tarpley clay, 1 to 3 percent slopes. This is a shallow, gently sloping soil on plane to slightly concave slopes on uplands in the Edwards Plateau Land Resource Area. The areas are irregular in shape and range from 5 to 250 acres in size.

Typically, the surface layer is dark brown clay about 6 inches thick. The subsoil to a depth of 17 inches is dark reddish brown clay. The underlying layer is fractured, indurated limestone bedrock. The soil is neutral and noncalcareous throughout.

This soil is well drained. Surface runoff is medium. Permeability is slow. Water enters rapidly when the soil is dry and cracked and slowly when it is wet. The available water capacity is very low. The rooting zone is shallow. Water erosion is a moderate hazard.

Included with this soil in mapping are small areas of Anhalt and Rumble soils and a few small areas of Rock outcrop. Also included are areas of a soil that is similar

to this Tarpley soil except that it is underlain by gravel. In a few areas as much as 5 percent of the surface is covered with stones. The included soils make up less than 15 percent of a mapped area.

This soil is used mainly as rangeland. In a few areas it is used as pastureland and for cultivated crops.

This soil is moderately well suited to use as cropland. The shallow rooting zone and the very low available water capacity are limitations. Small grains and forage sorghums are the main crops.

This soil is moderately well suited to use as pastureland. The shallow rooting zone and the very low available water capacity are limitations. King Ranch bluestem, Kleberg bluestem, kleingrass, and medio bluestem grow well. Good management includes proper stocking, controlled grazing, and brush management.

On rangeland, this soil produces high yields of forage if good management is practiced.

The soil provides habitat for rangeland wildlife. It produces a moderate amount of food and cover for deer, turkey, and quail.

For urban and recreational uses, the clayey texture, high shrink-swell potential, and depth to rock are severe limitations that can be difficult to overcome. Good design and careful installation are required.

This soil is in capability subclass IIIe and in the Redland range site.

Tn—Tinn clay, frequently flooded. This is a deep, nearly level soil on flood plains along small streams. The areas are long and narrow in shape and range from 10 to 200 acres in size.

Typically, the surface layer is dark gray clay about 25 inches thick. The layer below that, to a depth of 80 inches, is grayish brown clay. The soil is moderately alkaline and calcareous throughout.

This soil is somewhat poorly drained. Surface runoff is very slow. Permeability is very slow. Water enters rapidly when the soil is dry and cracked. The available water capacity is high. The rooting zone is deep. However, the clay impedes root penetration. The soil is very sticky when wet and very hard and cloddy when dry. Water erosion is a slight hazard. This soil is subject to frequent flooding. In some areas it is protected by flood prevention dams, and consequently flooding has been reduced.

Included with this soil in mapping are small areas of Branyon and Houston Black soils. The included soils make up less than 10 percent of a mapped area.

Tinn soil is used mainly as pastureland. In some areas it is used as cropland.

This soil is well suited to pasture grasses, for example, improved bermudagrasses, medio bluestem, and kleingrass. Good management includes fertilization, weed control, proper stocking, and controlled grazing.

This soil, where it is protected from frequent flooding, is well suited to use as cropland. Grain sorghum, wheat, oats, and cotton are the main crops. Very slow permeability and poor tilth are limitations. These conditions can be improved through proper residue management.

If this soil is used as rangeland, it produces high yields of forage if good management is practiced.

This soil provides good wildlife habitat for species that inhabit the areas along creeks and streams.

This soil is not suited to most urban and recreational uses because it is subject to frequent flooding. The very slow permeability, clayey texture, shrink-swell potential, and wetness are limitations which are difficult to overcome and can require expensive construction measures.

This soil is in capability subclass Vw and in the Clayey Bottomland range site.

prime farmland

In this section, prime farmland is defined and discussed, and the prime farmland soils in Comal and Hays Counties are listed.

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognized that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may presently be in use as cropland, pasture, or woodland, or they may be in other uses. They either are used for producing food or fiber or are available for these uses. Urban or built-up land and water areas cannot be considered prime farmland.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not flooded during the growing season. The slope ranges mainly from 0 to 5 percent.

Soils that have a high water table, are subject to flooding, or are droughty may qualify as prime farmland soils if the limitations or hazards are overcome by drainage, flood control, or irrigation. Onsite evaluation is necessary to determine the effectiveness of corrective measures. More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

About 14 percent of Comal County, 52,910 acres, and 18 percent of Hays County, 77,327 acres, are prime farmland. The largest areas are in map units 3, 4, and 5 on the general soil map. Substantial areas of prime farmland are in map units 6 and 7, and small scattered areas are in units 1 and 2. Approximately 44,000 acres of prime farmland in Comal and Hays Counties is used for cultivated crops. The rest is used as pastureland or rangeland.

A recent trend in land use in some parts of the survey area has been the conversion of some prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are wet, more erodible, droughty, or difficult to cultivate and less productive than prime farmland.

The following map units, or soils, make up prime farmland in Comal and Hays Counties. Some areas of these soils, however, are urban or built-up land, which is defined as any contiguous unit of land 10 acres or more in size that is used for nonfarm uses including housing, industrial, and commercial sites, sites for institutions or public buildings, small parks, golf courses, cemeteries, railroad yards, airports, sanitary landfills, sewage treatment plants, and water control structures. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 4. The soil qualities that affect use and management are described in the section "Detailed soil map units." This list does not constitute a recommendation for a particular land use.

AnA	Anhalt clay, 0 to 1 percent slopes
AnB	Anhalt clay, 1 to 3 percent slopes
BrB	Bolar clay loam, 1 to 3 percent slopes
ByA	Branyon clay, 0 to 1 percent slopes
ByB	Branyon clay, 1 to 3 percent slopes
DeB	Denton silty clay, 1 to 3 percent slopes
HeB	Heiden clay, 1 to 3 percent slopes
HoB	Houston Black clay, 1 to 3 percent slopes
HvB	Houston Black gravelly clay, 1 to 3 percent slopes
HvD	Houston Black gravelly clay, 3 to 8 percent slopes ¹
KrA	Krum clay, 0 to 1 percent slopes
KrB	Krum clay, 1 to 3 percent slopes
KrC	Krum clay, 3 to 5 percent slopes
LeA	Lewisville silty clay, 0 to 1 percent slopes
LeB	Lewisville silty clay, 1 to 3 percent slopes

Oa Oakalla silty clay loam, rarely flooded
PdB Pedernales fine sandy loam, 1 to 5 percent slopes
SuA Sunev silty clay loam, 0 to 1 percent slopes

SuB Sunev clay loam, 1 to 3 percent slopes

¹ Only those areas of Houston Black soils where the slopes are dominantly 3 to 5 percent are prime farmland.

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 and as rangeland; 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

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils 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 "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 32,500 acres in Comal County and 58,000 acres in Hays County were used for crops and pasture in 1980, according to records of the local office of the Soil Conservation Service. Of these totals, Comal County had about 8,400 acres in permanent pasture, 10,400 acres in row crops, and 13,700 acres in small grains. Hays County had about 38,000 acres in permanent pasture, 9,000 acres in row crops, and 11,000 acres in small grains. Pastures consisted mainly of King Ranch bluestem, Kleberg bluestem, and Coastal bermudagrass. To a lesser extent, medio bluestem and kleingrass were also grown for pasture. The main row crops were grain sorghum and cotton. Some corn was grown and so were oats and wheat.

The potential for increased food production is good. There is a large acreage of soils that are suited to use as cropland that is presently being used as rangeland and pastureland. In addition to the reserve productive capacity represented by that acreage, food production could be increased considerably by applying the latest crop production technology to all of the cropland in the survey area.

The acreage of the agricultural land in the survey area has gradually decreased as more land is used for urban development. It was estimated that in 1980 more than 57,000 acres in the survey area was urban or built-up land.

Soil erosion is the major soil problem on about 87 percent of the land suitable for cultivation. Where the slope is more than 1 percent, erosion is a hazard.

Erosion of the surface layer results in reduced productivity because the surface layer is the most productive part of the soil. Erosion is especially damaging to soils that have a thin surface layer, for example, Altoga, Bolar, Castephen, Doss, and Seawillow soils. It is also especially damaging to soils that do not have a deep rooting zone, for example, Anhalt, Austin, Bolar, Castephen, Denton, Doss, Gruene, Purves, and Tarpley soils.

Soil erosion also results in the sedimentation of streams. Controlling erosion minimizes the pollution of streams by sediment; thus, it improves the quality of

water for municipal use, for recreation, and for fish and wildlife.

Erosion control practices provide a protective cover on the surface, reduce runoff, and increase infiltration. A cropping system that keeps plant cover on the soil for extended periods holds soil erosion losses to an amount that does not reduce the productive capacity of the soil. On livestock farms, where pasture and hay are required, legumes and grass forage crops in the cropping system help reduce erosion on sloping soils and improve soil tilth for the crop that follows. Furthermore, legumes add nitrogen to the soil.

Reduced tillage systems that leave crop residue on the surface help reduce runoff and erosion. Soil compaction is reduced because of fewer trips over the soil. Residue management and less soil disturbance reduce evaporation of moisture from the soil. Reduced tillage systems conserve energy because fewer tillage operations are used.

Terraces and diversions help prevent erosion by reducing the length of slope and safely removing runoff from the field. Most of the cultivated soils in the survey area are suitable for terraces and diversions. However, soils that have bedrock or a cemented layer within 20 inches of the surface, for example, Castephen, Doss, Gruene, Purves, and Tarpley soils, are not well suited to terraces and diversions.

Contour farming is a widespread method of controlling erosion. In fields that are not terraced, it is best adapted to soils that have smooth uniform slopes. Contour farming is most effective if combined with terraces.

Information on erosion control practices for each kind of soil in the survey area is available at local offices of the Soil Conservation Service.

Fertility is naturally high in soils on flood plains; Oakalla and Tinn soils, for example. It varies considerably on terrace and upland soils. For example, Boerne and Seawillow soils are naturally low in fertility, whereas Lewisville, Krum, Heiden, and Houston Black soils are moderately high in fertility.

Most of the cultivated soils in the survey area are low in nitrogen and phosphorus. Additions of fertilizer should be based on the results of soil tests, on the needs of the crop, and on the desired yields. The Cooperative Extension Service can help in determining the kind and amount of fertilizer to apply.

The soils that are cultivated are moderately alkaline and calcareous, except for Anhalt and Tarpley soils, which are noncalcareous and neutral or mildly alkaline. Soils that are calcareous have a moderate to high level of calcium carbonate (lime). Altoga, Austin, Bolar, Castephen, Doss, Oakalla, Seawillow, and Sunev soils have an excessive amount of lime. Lime-induced iron chlorosis, characterized by a yellowing of the leaves, is a problem in some plants on these soils.

Soil tilth is an important factor in the germination of seeds and in the movement of air, moisture, and roots.

Soils that are granular and porous have good tilth. Tilth is improved by adding organic matter.

The common pasture grasses in the survey area are kleingrass, improved bermudagrasses, and improved bluestems. Fertilizer increases production and improves the quality of the forage. Controlling weeds and maintaining the proper grazing height help maintain plant vigor and healthy stands of grass.

A planned sequence of grazing and resting improves forage quality and production. Pasture can be used in combination with rangeland or cropland to ensure sufficient forage for the year. Forage that remains after grazing can be cut for hay, or the pasture can be left ungrazed and saved for hay.

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 5. 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 5 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 for those crops.

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 and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. 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, wildlife habitat, or recreation.

rangeland

Dalton Merz, range conservationist, Soil Conservation Service, helped prepare this section.

Rangeland consists of areas where the native vegetation includes a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. The vegetation generally is suitable for grazing, and the amount of vegetation is large enough to justify grazing. Rangeland, or native grassland, receives no regular or frequent cultural treatment. The composition and production of the plant community is determined by soil, climate, topography, overstory canopy, and grazing management.

According to records of the local office of the Soil Conservation Service, about 266,000 acres in Comal County and 335,000 acres in Hays County are used as rangeland or a combination of rangeland and wildlife habitat. The Blackland Prairie in the eastern part of the survey area was once an open prairie with trees near the streams and in a few scattered motts on adjacent uplands. The Edwards Plateau in the western part of the survey area was once a savannah characterized by tall and mid grasses, forbs, and trees, including live oak, shin oak, Spanish oak, and post oak.

The plant community of the rangeland in Comal and Hays Counties has changed drastically over the past 50 years. Much of the higher quality vegetation has been grazed out, and tall grasses flourish only in a few places. Short to mid grasses and poor quality forbs have replaced the tall grasses. However, in protected areas some of the original plant species remain. In most areas, high-quality plants can be reestablished if proper grazing management is practiced.

Most of the local ranches and livestock farms are cow-calf operations; some are stocker-calf enterprises. Many ranchers supplement their own cow herds with stockers, thus providing greater flexibility during periods of drought and grazing stress. Sheep and goats were once numerous in the survey area. Since the 1960's, however, few have been raised.

For most livestock operations, native grassland is supplemented by tame pasture and grazing crops. Coastal bermudagrass, kleingrass, and the Kleberg, medio, Gordo, and King Ranch bluestems are the common tame pasture grasses. Forage sorghums and small grains generally are grown on cropland to supplement the native rangeland.

Range forage production generally is highest during two distinct growth periods. Approximately 70 percent of the annual growth is produced in April, May, and June; spring rains and moderate temperatures promote the growth of warm season plants. A second growth period commonly occurs in September and October, resulting from the fall rains and gradually cooling temperatures. Droughts of varying length are frequent in the survey area. Each year, short midsummer droughts are normal, but droughts lasting many months can occur.

range sites and condition classes

Soils vary in their capacity to produce grass and other plants for grazing. The soils making up each range site are similar in the kind, amount, and proportion of forage they produce.

Throughout the survey area, the climax vegetation consists of the plants that were in the region when it was first settled. If a site is characterized by at least 75 percent climax vegetation, the plant community is relatively stable, reproducing itself and varying very little in composition as long as the environment remains unchanged. If cultivated crops are not grown, the most productive combination of forage plants on a range site is generally the climax vegetation.

Decreasers are plants in the climax vegetation that tend to decrease in proportion under close continuous grazing. Generally they are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

Increasesers are plants in the climax vegetation that increase in proportion as the more desirable decreaser plants are reduced by close grazing. Increasesers commonly are shorter than decreaseers and generally are less palatable to livestock.

Invaders are plants that ordinarily are not able to compete with other plants in the climax plant community for moisture, nutrients, and light. Invaders enter the plant community and grow in conjunction with increaseers after the climax vegetation has been reduced by heavy continuous grazing. They generally are of little value for grazing. However, they can help protect the soil from erosion until the more desirable plants are reestablished.

Range condition is judged according to standards determined by the characteristics of the individual range site and is expressed as a comparison between the present kind and amount of vegetation and the climax plant community.

Four range condition classes are used to indicate the degree to which the present vegetation differs from the potential, or climax, vegetation as a result of grazing or other uses. A range is in *excellent* condition if 76 to 100 percent of the vegetation is similar to that in the climax stand; in *good* condition if the percentage is 51 to 75; in *fair* condition if the percentage is 26 to 50; in *poor* condition if the percentage is 25 or less.

Potential forage production depends on the characteristics of the range site. Current forage production depends on the condition of the range and the moisture available to plants during the growing season.

Table 6 shows, for each soil listed, the range site and the total annual production of vegetation in favorable, average, and unfavorable years. Only those soils that are used as rangeland or are suited to use as rangeland are listed. Explanation of the column headings in table 6 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.

Potential annual 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, average, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an average year, growing conditions are about normal. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

A primary objective of good range management is to keep the range in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected. The main management concern is recognizing important changes in the kind of cover on a range site. Such changes take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall can lead to the conclusion that the range is in good condition when actually the cover is weedy and the long-term trend is toward lower production. On the other hand, rangeland that has been closely grazed for short periods, temporarily may have a degraded appearance that conceals its high quality and its ability to recover.

After prolonged overuse of rangeland, seed sources of the desirable vegetation are eliminated. The vegetation can be reestablished by one or more of the following practices: brush control, range seeding, fencing, water development, or other mechanical treatment to revitalize stands of native plants. Thereafter, deferred grazing, proper grazing use, and a planned grazing system are necessary to maintain and improve the range.

The soils in the survey area have been assigned to 15 range sites. The range sites are described in the paragraphs that follow.

Adobe range site. The soils making up this range site are Brackett soils (BtD) and Real soils (RaD, RcD).

Grasses make up about 80 percent of the potential plant community, and woody plants and forbs make up the rest.

Typically, little bluestem makes up about 50 percent of the vegetation; indiangrass, 5 percent; sideoats grama and tall grama, 15 percent; other mid grasses, such as muhlys, green sprangletop, dropseeds, hairy grama, perennial threeawn, tridens, and sedges, 15 percent. Woody plants, such as live oak and Spanish oak, make up about 10 percent; and forbs, such as orange zexmenia, prairie-clover, daleas, and vetch, make up 5 percent.

Little bluestem, indiangrass, and sideoats grama are removed from the plant community by heavy grazing by livestock and are replaced by hairy grama, green sprangletop, tridens, perennial threeawn, and orange zexmania. If heavy grazing continues for many years, woody plants, such as Ashe juniper and agarita, and grasses and forbs, such as Texas grama, red grama, hairy tridens, tumblegrass, poverty dropseed, and queensdelight, can take over the site. In extreme cases, the juniper can become so dense that it nearly excludes other vegetation.

This site produces forage of low quality because of the limited phosphorus available to plants. Brush control and rotation grazing are particularly important on this site.

Blackland range site. The soils that make up this range site are Branyon soils (ByA, ByB), Heiden soils (HeB, HeC3, HeD3, HgD), Houston Black soils (HoB, HvB, HvD), Medlin soils (MEC, MED), and Seawillow soils (SeB, SeD).

The potential plant community is a tall grass prairie. Typically, little bluestem makes up 50 percent of the plant community; indiangrass and big bluestem, 25 percent; eastern gamagrass, switchgrass, Texas cupgrass, sideoats grama, wildrye, Texas wintergrass, and vine-mesquite, 10 percent; woody plants such as live oak, elm, and hackberry, 5 percent; and forbs such as Maximilian sunflower, Engelmann-daisy, gayfeather, bundleflower, snoutbeans, wildbeans, and western indigo, 10 percent.

Big and little bluestem, indiangrass, eastern gamagrass, switchgrass, Maximilian sunflower, and Engelmann-daisy are removed from the plant community through heavy grazing by livestock and are replaced by silver bluestem, Texas wintergrass, tall dropseed, sideoats grama, and less palatable forbs. If heavy grazing continues for many years, buffalograss, Texas wintergrass, mesquite, elm, Texas grama, croton, broomweed, and many composites dominate the site.

Mesquite and desert willow encroach in most places. Cool-season grasses, such as Texas wintergrass and rescuegrass, naturally fill the voids left when the shade and moisture competition drive out the tall warm-season grasses. In reestablishing formerly cropped areas, reseeding of desirable range grasses is necessary because of the lack of a natural seed source.

Chalky Ridge range site. The Castephen soils (AuB, AuC3, CaC3) make up this range site.

The potential plant community is a mid-grass prairie. Typically, little bluestem makes up 50 percent of the plant community; indiangrass, big bluestem, and wildrye, 20 percent; sideoats grama, silver bluestem, and dropseed, 15 percent; threeawn, slim tridens, fall switchgrass, and low panicum, 5 percent; and forbs such as gayfeather, bundleflower, penstemon, sensitivebrier, prairie-clover, vetch, and wild bean, 10 percent.

Little bluestem, big bluestem, indiangrass, and the palatable forbs are removed from the plant community through heavy grazing by livestock. These plants are replaced by sideoats grama, silver bluestem, threeawn, and less palatable forbs. If heavy grazing continues for many years, hairy grama, red grama, Texas grama, broomweed, baccharis, queensdelight, red threeawn, and hairy tridens will dominate the site. Most areas have scattered motts of live oak.

The vegetation on this site deteriorates more easily and quickly than that on most of the associated sites. Low-producing, coarse forbs and grasses invade if the range is continuously overgrazed. However, the range condition quickly improves if proper grazing management is practiced. In most places, this site recovers so quickly that it can provide a seed source for adjoining sites. Rotation grazing is the most important management practice on this site.

Clayey Bottomland range site. The Tinn soils (Tn) make up this range site.

The potential plant community is a savannah. Typically, switchgrass, indiangrass, big bluestem, and little bluestem make up 30 percent of the plant community; meadow dropseed, sideoats grama, vine-mesquite, and silver bluestem, 20 percent; wildrye, sedges, and Texas wintergrass, 20 percent; buffalograss, white tridens, Scribner panicum, and eastern gamagrass, 10 percent; woody plants such as live oak, elm, hackberry, pecan, willows, and western soapberry, 15 percent; and forbs, such as Maximilian sunflower, bundleflower, snoutbean, tickclover, and wild bean, 5 percent.

Eastern gamagrass, indiangrass, switchgrass, big bluestem, little bluestem, and Maximilian sunflower are removed from the plant community through grazing by livestock. Meadow dropseed, sideoats grama, silver bluestem, Texas wintergrass, vine-mesquite, buffalograss, and less palatable forbs are the initial increasers. If heavy grazing continues for many years, the overstory canopy thickens, and shade-tolerant species such as wildrye, sedges, and low panicum increase. If the rangeland is deteriorated, buffalograss, common bermudagrass, Texas grama, ragweed, sumpweeds, annual sunflower, cocklebur, broomweed, beebalm, iceweed, and croton dominate the site.

Some common bermudagrass and weeds as well as desirable tall range grasses and forbs are growing in most areas. Continuous close overgrazing causes bermudagrass and other low-growing plants to increase

and the desirable tall grasses to decrease. Grazing can be regulated to allow the tall range grasses to reseed and crowd out the less desirable bermudagrass.

Clay Loam range site. The soils making up this range site are Altoga soils (AgC3, AgD3), Austin soils (AuB, AuC3), Bolar soils (BrB), Denton soils (DeB, DeC3), Krum soils (KrA, KrB, KrC), Lewisville soils (LeA, LeB), and Sunev soils (SuA, SuB).

The potential plant community is a true prairie. Typically, little bluestem makes up 30 percent of the plant community; indiagrass, 10 percent; big bluestem, 5 percent; other mid grasses, such as tall dropseed, silver bluestem, sideoats grama, buffalograss, perennial threeawn, and Texas wintergrass, 50 percent; and forbs such as Engelmann-daisy, bundleflower, sensitivebrier, and bushsunflower, 5 percent.

Little bluestem, indiagrass, big bluestem, and Engelmann-daisy are removed from the plant community through overgrazing by livestock. These plants are replaced by sideoats grama and buffalograss. If heavy grazing continues, plants such as silver bluestem, perennial threeawn, and Texas wintergrass increase. Invaders, such as Ashe juniper and broomweed, follow.

This range site generally produces more forage and better grasses than adjacent sites. Consequently, livestock prefer this site to the others and tend to overgraze it sooner. If grazing is not controlled, grasses are replaced by brush such as agarita, persimmon, and Ashe juniper and by some elm and oak trees. Deferred grazing is an important practice in controlling brush and improving composition of the plant population.

Deep Redland range site. The Anhalt soils (AnA, AnB) make up this range site.

The potential plant community is a tall grass, post-oak savannah. The species composition, by weight, is 90 percent grasses, 5 percent forbs, and 5 percent woody plants.

Typically, little bluestem makes up 30 percent of the plant community; indiagrass, 15 percent; sideoats grama, 10 percent; other mid grasses such as Texas cupgrass, pinhole bluestem, meadow dropseed, vine-mesquite, curlmesquite, and buffalograss, 25 percent; Texas wintergrass and Canada wildrye, 10 percent; woody plants such as post oak, blackjack oak, live oak, and greenbrier, 5 percent; and forbs such as Engelmann-daisy, bushsunflower, and sensitivebrier, 5 percent.

Little bluestem, indiagrass, and Engelmann-daisy are preferred by livestock and are removed from the plant community as a result of heavy grazing. These plants are replaced by sideoats grama, pinhole bluestem, buffalograss, and post oak. If continuous heavy grazing continues for many years, oaks increase to a dense stand and the understory consists of plants such as threeawn, Texas wintergrass, Ashe juniper, Texas persimmon, pricklypear, and mesquite.

Eroded Blackland range site. The Ferris soils (FeF4) make up this range site.

The potential plant community is a tall grass prairie. Typically, little bluestem makes up 50 percent of the plant community; indiagrass and big bluestem, 20 percent; sideoats grama, wildrye, tall dropseed, silver bluestem, Texas wintergrass, and vine-mesquite, 15 percent; woody plants such as live oak, hackberry, and elm, 5 percent; and forbs such as Engelmann-daisy, Maximilian sunflower, gayfeather, snoutbean, and wildbean, 10 percent.

Little bluestem, indiagrass, big bluestem, and Maximilian sunflower are removed from the plant community as a result of heavy grazing by livestock. These plants are replaced by vine-mesquite, silver bluestem, and tall dropseed. If heavy grazing continues for many years, buffalograss, Texas wintergrass, and mesquite dominate the site.

In many areas lack of a seed source is a problem. Recovery of deteriorated range is slow because fertility is very low in the gullied areas. Brush generally is a minor problem. In most areas there is only a scattering of desert willow and mesquite. Important management practices include reseeding and deferred grazing.

Gravelly Redland range site. The Rumble soils (RUD) make up this range site.

The potential plant community is an open savannah of post oak and blackjack oak, which shade about 10 percent of the ground. The plant community is about 90 percent grasses, 5 percent woody plants, and 5 percent forbs.

Typically, the dominant plants are little bluestem, making up 25 percent of the plant community; sideoats grama, 25 percent; indiagrass, 5 percent; Arizona cottontop, pinhole bluestem, and silver bluestem, 15 percent; Canada wildrye, Texas cupgrass, and plains lovegrass, 10 percent; other mid grasses such as buffalograss, curlmesquite, Texas wintergrass, and meadow dropseed, 10 percent. Woody species such as live oak make up about 5 percent, and forbs such as bundleflower, western indigo, and gayfeather make up 5 percent.

Little bluestem, sideoats grama, wildrye, and plants such as daleas are removed from the plant community as a result of heavy grazing by livestock. These plants are replaced by curlmesquite, buffalograss, and Texas wintergrass. If heavy grazing continues for many years, threeawn, red grama, Texas grama, hairy tridens, and woody plants such as mesquite, catclaw, persimmon, and agarita dominate the site.

Loamy Bottomland range site. The soils making up this range site are Boerne soils (BoB), Oakalla soils (Oa, Ok), and Orif soils (Or).

The potential plant community is a savannah. Oak, pecan, hackberry, elm, cottonwood, sycamore, and other woody plants shade about 30 percent of the ground. Typically, Virginia wildrye and sedges make up 25 percent of the plant community; rustyseed paspalum and beaked panicum, 15 percent; switchgrass, indiagrass,

big bluestem, and little bluestem, 15 percent; white tridens and knotroot bristlegrass, 10 percent; eastern gamagrass, 5 percent; uniola, 5 percent; woody plants such as pecan, oak, hackberry, elm, cottonwood and sycamore, greenbrier, Alabama supplejack, and legumes, 25 percent.

This site is a preferred grazing area. Plants such as big bluestem, little bluestem, eastern gamagrass, and other nutritious forage plants are removed from the plant community as a result of overgrazing by livestock and are replaced by trees, shrubs, and woody vines. As the overstory continues to close in, production of grasses and forbs is reduced. If the rangeland is allowed to deteriorate, broomsedges and bushy bluestem, vaseygrass, cocklebur, sumpweed, osageorange, and other woody plants dominate the site.

Extensive shading by trees and bushy plants such as greenbrier and low-growing elm, ash, and sycamore is a problem on this site. Brush control is necessary in many places to improve the stand of grasses, and deferred grazing can improve the composition of the plant population.

Brush invades this site quickly if it is not properly managed. Agarita and persimmon, mixed with some Ashe juniper, elm, and shin oak, form dense thickets that large animals cannot penetrate. Brush control and rotation grazing are particularly important on this site.

Low Stony Hills range site. The soils making up this range site are Comfort soils (BtD, CrD, RcD, RUD) and Eckrant soils (MEC).

The potential plant community is a live oak savannah. Typically, little bluestem makes up 50 percent of the plant community; indiagrass and big bluestem, 20 percent; other mid grasses, such as wildrye, sideoats grama, Texas cupgrass, plains lovegrass, green sprangletop, dropseed, silver bluestem, vine-mesquite, buffalograss, sedges, Texas wintergrass, and perennial threeawn, 15 percent; woody plants, such as live oak, elm, and hackberry, 10 percent; and forbs, such as orange zexmenia, bushsunflower, bundleflower, prairie-clover, milk pea, snapbean, and Engelmann-daisy, 5 percent.

Little bluestem, indiagrass, and big bluestem are removed from the plant community as a result of excessive grazing by livestock and wild animals and are replaced by sideoats grama, Texas wintergrass, buffalograss, and silver bluestem. If heavy grazing continues, the replacement plants disappear. Texas wintergrass and buffalograss can best withstand overgrazing and generally are the last to disappear. If the range is allowed to deteriorate, Ashe juniper, agarita, mesquite, Texas persimmon, pricklypear, tasajillo, prairie coneflower, broomweed, burclover, plantains, hairy tridens, Texas grama, and annual grasses and forbs can dominate the site.

Redland range site. The Tarpley soils (TaB) make up this range site.

The potential plant community is about 90 percent tall and mid grasses. The rest is mostly trees and forbs.

Typically, little bluestem makes up 50 percent of the plant community; indiagrass, 15 percent; big bluestem and wildrye, 15 percent; other mid grasses such as sideoats grama, dropseed, silver bluestem, Texas cupgrass, Texas wintergrass, wildrye, buffalograss, vine-mesquite, and perennial threeawn, 10 percent. Woody species such as post oak, live oak, and elm make up about 5 percent, and forbs such as wild bean, Engelmann-daisy, gayfeather, bundleflower, sensitivebrier, and vetch make up 5 percent.

Little bluestem, big bluestem, indiagrass, wildrye, and Engelmann-daisy are removed from the plant community as a result of heavy grazing by livestock and are replaced by sideoats grama, buffalograss, Texas wintergrass, and vine-mesquite. If heavy grazing continues for many years, woody plants such as live oak, post oak, and elm increase, and an understory of plants such as dropseed, sedges, and perennial threeawn forms. Eventually, after continued abuse, invaders such as coneflower, broomweed, Ashe juniper, and mesquite dominate.

The forage on this site is more nutritious than that on most of the adjoining sites and is preferred by domestic animals. Controlling invading mesquite, persimmon, and agarita and maintaining the quality and quantity of forage is a problem. Seasonal and deferred grazing are important management practices.

Shallow range site. The soils making up this range site are Doss soils (DoC, RcD), Gruene soils (GrC), and Purves soils (PuC).

The potential plant community is grassland and scattered motts of live oak. Typically, little bluestem makes up 25 percent of the plant community; sideoats grama, 30 percent; other mid grasses, such as silver bluestem, green sprangletop, Texas wintergrass, wildrye, curlymesquite, buffalograss, and perennial threeawn, 35 percent; woody plants, such as live oak, kidneywood, and elbowbush, 5 percent; and forbs such as Engelmann-daisy, bundleflower, neptunia, bushsunflower, and gayfeather, 5 percent.

If the range is overgrazed, little bluestem and sideoats grama are removed from the plant community and are replaced by curlymesquite, buffalograss, Texas wintergrass, silver bluestem, and green sprangletop. Woody plants such as live oak and Ashe juniper increase if heavy grazing continues. If the range becomes extremely deteriorated, broomweed, threeawn, and annual grasses and forbs invade.

Encroachment of Ashe juniper, persimmon, agarita, condalia, and mesquite is a problem. Brush control and rotation grazing are important management practices.

Steep Adobe range site. The soils making up this range site are Brackett soils (BtG) and Real soils (BtG).

Grasses make up about 75 percent of the potential plant community. Woody plants and forbs make up the rest.

Typically, little bluestem makes up 40 percent of the plant community; indiagrass, 5 percent; sideoats grama and tall grama, 15 percent; other mid grasses such as muhlys, green sprangletop, dropseed, hairy grama, perennial threeawn, tridens, and sedges, 15 percent. Woody plants, such as live oak and Texas oak, make up about 15 percent; and forbs, such as orange zexmenia, prairie-clover, daleas, and vetch, make up about 10 percent.

Little bluestem, indiagrass, and sideoats grama are removed from the plant community as a result of overgrazing and are replaced by hairy grama, green sprangletop, tridens, perennial threeawn, and orange zexmenia. If heavy grazing continues for many years, woody plants such as Ashe juniper increase significantly. If the range is allowed to deteriorate, Texas grama, red grama, hairy tridens, tumblegrass, poverty dropseed, and queensdelight are dominant on this site.

Most areas of this site presently are covered with Ashe juniper and other brush. Even where the brush is cleared, the quality and quantity of forage are low, and there is little incentive to improve this site for domestic use. Steep slopes and outcrops of rock are additional limitations. This site generally is better suited to use as habitat for wildlife than to use as rangeland.

Steep Rocky range site. The Eckrant soils (ErG, MED) make up this range site.

The potential plant community is live oak and Texas oak savannah. It is 75 percent, by weight, grasses, 10 percent forbs, and 15 percent woody plants.

Little bluestem makes up 40 percent of the plant community; sideoats grama, 10 percent; other grasses, such as indiagrass, big bluestem, Texas cupgrass, cane and pinhole bluestem, tall grama, purple threeawn, plains lovegrass, and green sprangletop, 25 percent; woody plants, such as live oak, Texas oak, sumac, Texas madrone, 15 percent; and forbs, such as Engelmann-daisy, bushsunflower, and bundleflower, 10 percent.

Little bluestem, indiagrass, and Engelmann-daisy are the preferred plants. These plants are removed from the plant community as a result of heavy grazing and are replaced mainly by sideoats grama, pinhole bluestem, and live oak. If heavy grazing continues for many years, woody plants such as the oaks form a dense stand that has an understory of plants such as threeawn, Texas wintergrass, slim tridens, Ashe juniper, and Texas persimmon.

In most areas, this site is dominated by invaders such as Ashe juniper, Mexican buckeye, persimmon, and agarita and a scattering of live oak and Texas oak. It has remained in brush because of the cost of brush removal. Furthermore, steep slopes and an extremely stony surface inhibit grazing by livestock.

Tight Sandy Loam range site. The Pedernales soils (PdB) make up this range site.

The potential plant community is a tall grass, post oak savannah. The composition, by weight, is about 85 percent grasses, 10 percent woody plants, and 5 percent forbs.

Typically, sideoats grama makes up 20 percent of the plant community; little bluestem, 20 percent; indiagrass, 5 percent; pinhole bluestem and Arizona cottontop, 15 percent; vine-mesquite, 10 percent; wildrye, 10 percent; Texas wintergrass, paspalums, and panicums, 5 percent; woody plants such as live oak and post oak, and forbs such as Engelmann-daisy, snoutbean, orange zexmenia, and bushsunflower, 15 percent.

Little bluestem, indiagrass, wildrye, sideoats grama, and palatable forbs are grazed out of the plant community with continuous heavy grazing by livestock. These plants are replaced by buffalograss, paspalums, hairy grama, and hooded windmillgrass. Also, a variety of woody plants, such as agarita, persimmon, mesquite, and lotebush, and cactus begin to take over.

In a deteriorated condition, a heavy woody canopy and an understory of plants such as red lovegrass, tumblegrass, baccharis, broomsedge bluestem, ragweed, and bitterweed dominate the site.

recreation

The soils of the survey area are rated in table 7 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 7, 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 7 can be supplemented by other information in this survey, for example,

interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

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.

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.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

wildlife habitat

Dalton Merz, range conservationist, Soil Conservation Service, prepared this section.

Comal and Hays Counties provide habitat for a plentiful and varied wildlife population. The principal species are deer, turkey, squirrel, bobwhite quail, dove, rabbit, and many nongame birds and animals. Furbearing species include fox, raccoon, ringtail cat, skunk, opossum, bobcat, beaver, nutria, and coyote. Several exotic big game species, for example, axis deer, sika deer, fallow deer, red deer, black buck, barbados sheep,

and mouflon sheep, have been introduced into the survey area by ranchers.

Fish and waterfowl are also resources of economic importance. Approximately 8,398 acres in the survey area is inland water. Water is impounded in Canyon Lake and elsewhere by flood retarding structures built by the Soil Conservation Service. These water areas, as well as numerous farm and ranch ponds and many streams and rivers, are used by migrating ducks and geese. Most of the ponds are stocked with fish, and all of the lakes and rivers provide fishing. Black and white bass, channel and yellow catfish, crappie, and sunfish are important fish species. Rainbow trout are stocked and harvested in the Guadalupe River below Canyon Lake.

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 8, 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* 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 created, 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, grain sorghum, and sunflowers.

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 clover, vetch, switchgrass, kleingrass, wildrye, and johnsongrass.

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, western ragweed, croton, panicums, sunflowers, and Texas needlegrass.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are agarita, elbow bush, Texas colubrina, skunkbush, greenbrier, chokecherry, and kidneywood.

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, dove, meadowlark, field sparrow, cottontail, and fox.

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

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include white-tailed deer, jackrabbit, coyote, bobcat, and wild turkey.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and

topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps; the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

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

building site development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 10 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site

features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the 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.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good*, *fair*, or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil

after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as caliche, marl, shale, and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil

texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil

material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; and susceptibility to flooding. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A low available water capacity, restricted rooting depth, toxic substances such as salts or sodium,

and restricted permeability adversely affect the growth and maintenance of the grass after construction.

gardening and landscaping

A knowledge of the soils and their properties is helpful in selecting flowers, ground cover, vines, shrubs, and trees that are suited to an area. In some areas, plants that are used for esthetic purposes may also be helpful in controlling erosion.

Soils that are well suited to yard and garden plants are those that have a deep root zone, a loamy texture, a balanced supply of plant nutrients, plenty of organic matter in various stages of decomposition, an adequate available water capacity, good drainage, and granular structure that allows free movement of water, air, and roots. The degree of acidity or alkalinity suitable for the particular plants to be grown is also important. For example, roses and most annual flowers, most vegetables, and most grasses generally grow best in soils that are neutral or slightly acid. Azaleas, camellias, and similar plants need acid soils. If some plants are grown in soils that have a high content of lime, they develop a condition called chlorosis, a yellowing of the leaves. Many flowers, shrubs, and trees, however, grow well on limy (calcareous) soils. Shasta daisies, hollyhocks, petunias, zinnias, gladiolus, crapemyrtle, pecan, and fruitless mulberry are some of the flowers, shrubs, and trees that grow well on limy soils. Many plants and trees native to the survey area are well suited to use in landscaping, including live oak, Spanish oak, sycamore, poplar, pecan, baldcypress, mountain laurel, lantana, yaupon, wild plum, yucca, Lindheimer silk-tassel, redbud, and evergreen sumac.

It is generally less expensive to condition the native soil than to replace it with an artificially prepared soil mixture. The soil should be tested and fertility needs determined for the plants to be grown. The most important addition the soil generally needs is organic matter. The organic matter can be cotton burs, peat moss, compost, rotted sawdust, or manure.

In some areas the soils are so shallow or stony that it may be necessary to construct raised beds for growing flowers and some shrubs. Brick, tile, metal, cedar, and redwood make good retainers for flowerbeds. Beds should be filled with good soil that is well balanced physically and chemically.

All plants, whether grown in native soil or introduced soil, require careful maintenance, especially during the period of establishment. Good management practices include fertilizing, watering, weed control, and insect control. The potential of the native soil for plants should be considered when selecting sites for urban construction, and existing trees should be protected during construction. Large, healthy trees are a valuable asset to the property and can be worked into the landscaping plan.

town and country planning

Residential subdivision development and the accompanying extension of public utilities create a need for different information about soils than that needed for farming. Many people, those who are building summer houses or recreation facilities, for example, need soils information about individual residential tracts that are outside the range of public utilities.

Land appraisers, realtors, city planners, builders, and individuals need to have facts that help them know what sites are suitable for homes or other buildings and what areas are more suitable for other uses. Most soil properties that are important for town and country planning are also important for engineering. The information in the "Engineering" and "Engineering index properties" sections of this soil survey does not, however, eliminate the need for more detailed onsite studies if the soils are to be used intensively. Most mapped areas of soils contain areas of contrasting soils that are too small to be shown separately on the soil map.

In this section, site selection, foundations, sewage disposal systems, underground utility lines, erosion and runoff, and public health are discussed in terms of their effect on urban and residential development.

site selection

When a site is selected for the construction of urban works and structures, the soil at the site should be carefully studied. Lack of information about the soils can result in costly failures. If a soil is poorly suited to an intended use, changing it can be expensive. In some instances a structure can be designed to overcome the limitations of the soil, if these limitations are recognized prior to construction.

A primary consideration in choosing a site is the hazard of flooding. Oakalla, Orif, and Tinn soils, for example, are subject to occasional or frequent flooding and are therefore severely limited as sites for permanent structures. These soils are better suited to use as greenbelts, sound barriers, wildlife habitat, hiking trails, bike trails, and picnic areas.

Other soil features that affect site selection are permeability, available water capacity, drainage, reaction (pH), corrosivity to steel and concrete, and hydrologic classification.

foundations

Certain types of soils require special attention if they are to be used as a site for buildings. In some parts of the survey area the soils are clayey and have a high content of montmorillonite. These soils swell when wet and shrink and crack as they dry, creating enough pressure to crack walls and foundations that are not properly designed and installed.

Foundations on Anhalt, Branyon, Ferris, Heiden, Houston Black, and Medlin soils are most susceptible to damage from shrinking and swelling. Denton, Krum, and Tinn soils also have a high content of montmorillonitic clay. Soils likely to swell and shrink enough to damage foundations are those that have a high liquid limit and high plasticity index and are classified as CH in the Unified system of classification (see tables 9 and 13). Soils that are subject to flooding or have low strength or high corrosivity should also be given special attention.

sewage disposal systems

Many new houses are being built in areas beyond municipal sewerlines. These houses must have onsite sewage disposal systems. The effectiveness of these systems depends largely on the absorptive capacity and permeability of the soils in the filter field and on the percolation rate, wetness, hazard of flooding, seepage, and slope.

The soils of Comal and Hays Counties generally have severe limitations as sites for septic tank absorption fields. Some of the soils in the survey area are clayey and consequently are very slowly permeable. Others are shallow to bedrock.

By using the general soil map to identify the soils and by referring to the ratings in table 10, a user of this soil survey can get a general idea of how well a septic tank system functions in a selected area. Nevertheless, a detailed inspection of the soils should be made at the exact site that is to be used as a filter field.

underground utility lines

Water mains, gas pipelines, communication lines, and sewer pipes buried in the soil can corrode and break unless protected against electrochemical reactions resulting from the inherent properties of the soil.

All metals corrode to some degree if they are buried in soil. Some metals corrode more rapidly than others. The corrosion potential depends on the physical, chemical, electrical, and biological characteristics of the soil. For example, the amount of oxygen or of anaerobic bacteria, the moisture content, and external factors such as manmade electrical currents can influence the corrosion potential. Corrosion is greatest where two dissimilar metals are connected, where metal structures are buried at varying depths, and where pipelines extend through different kinds of soils.

Measurements of electrical resistivity of a soil indicate probable corrosion potential. Electrical resistivity is the resistance of the soil to the flow of an electrical current when the soil is wetted to field capacity. It is measured in ohms per cubic centimeter. A low value indicates low resistance (or high conductivity) and high corrosion potential.

In soils that have a high shrink-swell potential (see table 14), the stress created by changes in volume can

cause cast-iron pipe to break. To prevent breakage, pipes should be cushioned with sand.

control of runoff and erosion

During construction, the natural vegetation is generally removed, and the soil is covered with impervious pavement, concrete, or buildings. Consequently, runoff in urban areas is generally greater than in areas where the soils are in other uses. Runoff after a heavy rain in an urban area can be several times more than in an area where the soil is used for farming. The runoff concentrates in streets and gutters, instead of flowing into natural waterways, resulting in flooding, erosion, and deposition of sediment in lower lying areas. Careful planning can prevent or reduce the problems caused by erosion, runoff, and sedimentation.

public health

Soils provide sites for sewage disposal and for sanitary landfills. Such areas, as well as some naturally

wet areas, can be breeding grounds for disease-carrying insects.

Sewerlines, septic tank systems, and sewage lagoons should be constructed so that seepage or drainage cannot pollute water supplies. The stability of the soil needs to be considered in locating sewage lines. If the gradeline is interrupted, the sewage system breaks down, creating a hazard to the public health. Tables 14 and 15 provide information on shrink-swell potential, corrosion potential, and volumetric shrinkage that can be helpful in selecting suitable soils for pipelines. Water wells, streams, and lakes can become contaminated by runoff from clogged filter fields, and rapid percolation of septic tank effluent can result in the pollution of underground water. Seepage from sewage lagoons built on unsuitable soil material can be a source of pollution. Table 10 provides information on the suitability of the soils as sites for septic tank absorption fields and sewage lagoons.

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 16.

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 13 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 their 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 the content of particles coarser than sand is as much as 15 percent, 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. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 16.

Rock 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.

physical and chemical properties

Table 14 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.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

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.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 14, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 15 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 are not considered flooding.

Table 15 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.

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 excavation.

Cemented pans are cemented or indurated subsurface layers within a depth of 5 feet. Such pans cause difficulty in excavation. Pans are classified as thin or thick. A thin pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A thick pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

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 such factors as 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 layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

engineering index test data

Table 16 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil series and their morphology." The soil samples were tested by the Texas State Department of Highways and Public Transportation.

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); Specific gravity (Particle index), Method A—T 100 (AASHTO), D 653 (ASTM); California bearing ratio—

T 193 (AASHTO), D 1883 (ASTM); Shrinkage—T 92 (AASHTO), D 427 (ASTM); Limestone bearing ratio—Florida Highway Standard; Volume change (Abercrombie)—Georgia Highway Standard.