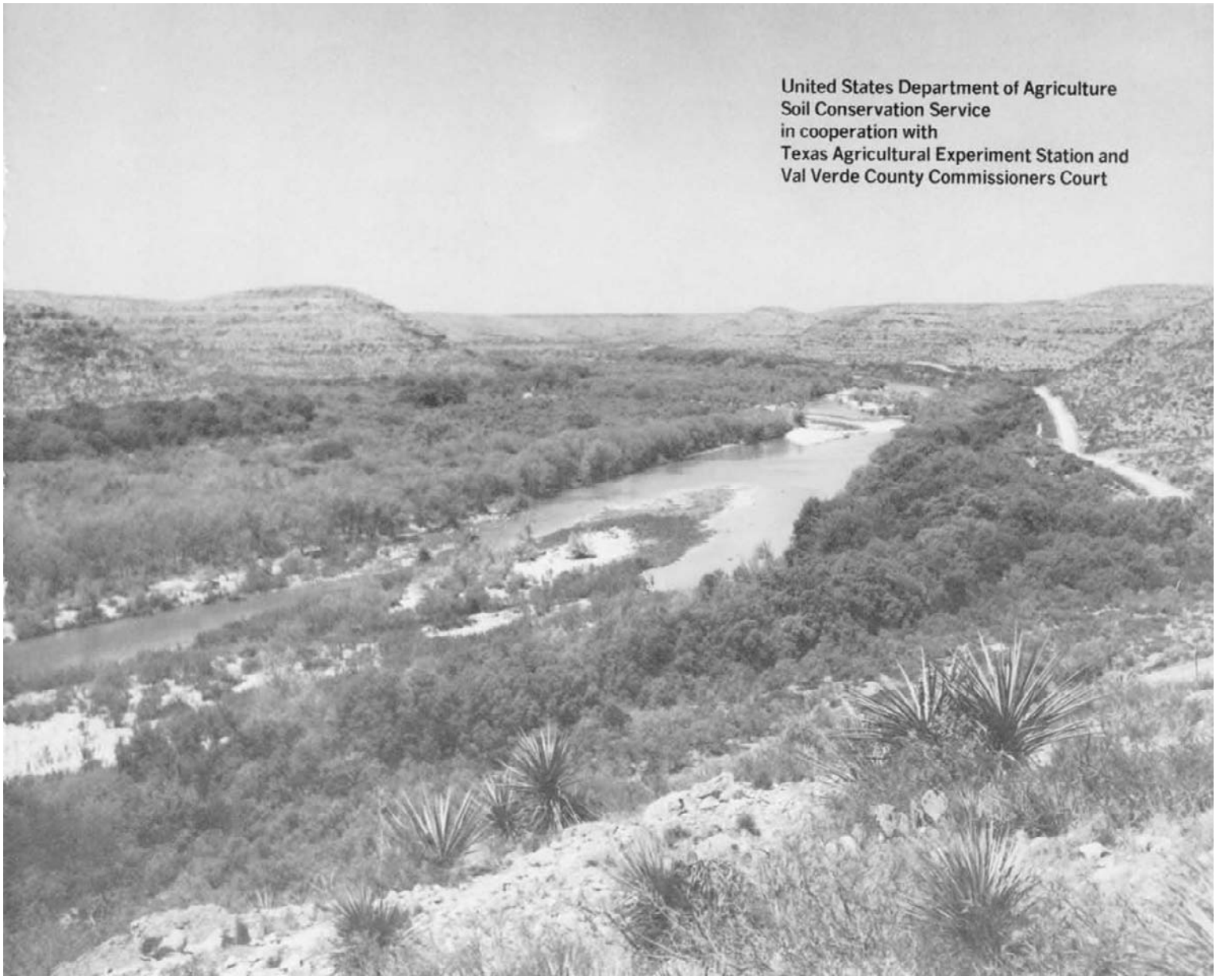
SOIL SURVEY

Val Verde County, Texas

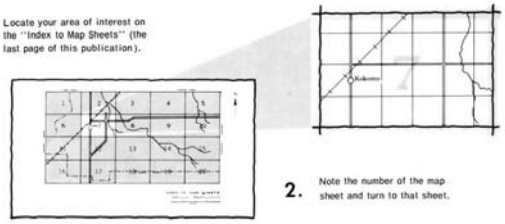


ELECTRONIC VERSION

This soil survey is an electronic version of the original printed copy, dated January 1982. It has been formatted for electronic delivery. Additional and updated information may be available from the Web Soil Survey. In Web Soil Survey, identify an Area of Interest (AOI) and navigate through the AOI Properties panel to learn what soil data is available.

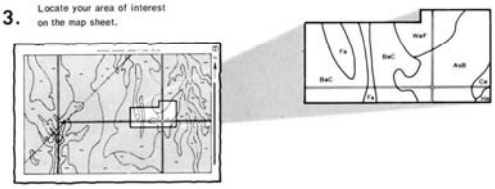
HOW TO USE THIS SOIL SURVEY

1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

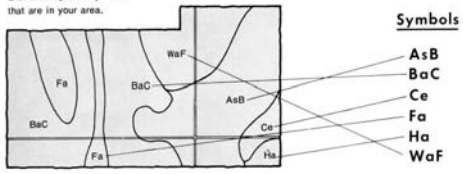


2. Note the number of the map sheet and turn to that sheet.

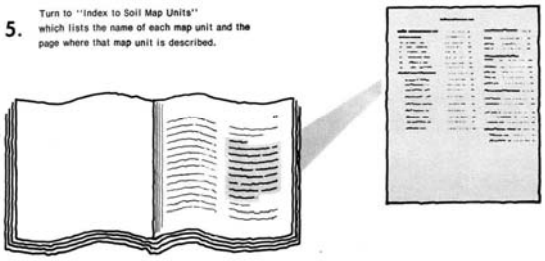
3. Locate your area of interest on the map sheet.



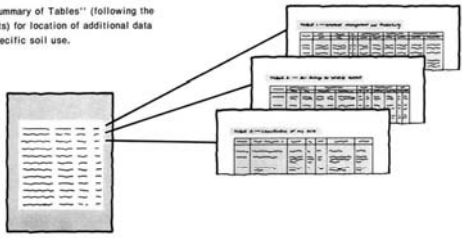
4. List the map unit symbols that are in your area.



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



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



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

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

Major fieldwork for this soil survey was performed in the period 1972-79. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1979. This survey was made cooperatively by the Soil Conservation Service, the Texas Agricultural Experiment Station, and the Val Verde County Commissioners Court. It is part of the technical assistance furnished to the Devil's River 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: Area along Devils River in Val Verde County. River bottom is Dev soils, frequently flooded, and hillsides are Ector-Rock outcrop association, very steep.

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Foreword

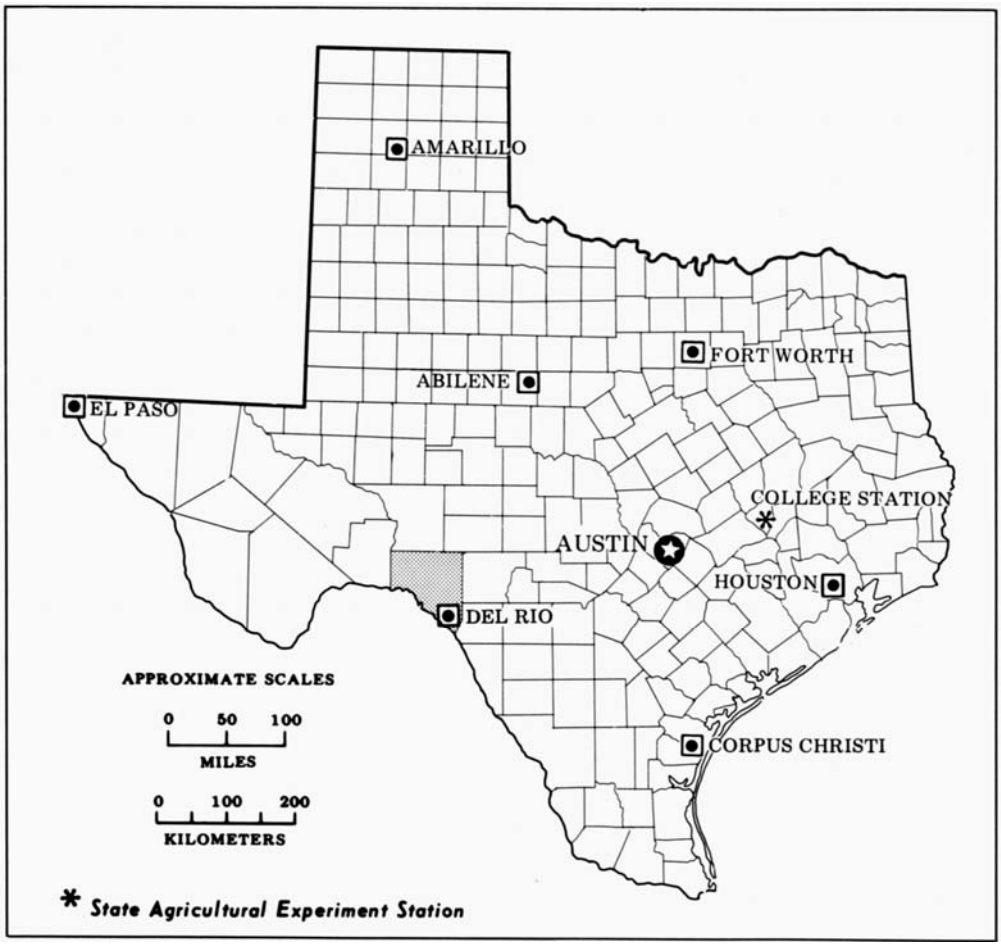
This soil survey contains information that can be used in land-planning programs in Val Verde County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact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

This soil survey is designed for many different users. Farmers, ranchers, agronomists, and wildlife biologists 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 Val Verde County in Texas.

Soil Survey of

Val Verde County, Texas

By Micheal L. Golden, Wayne J. Gabriel, and Jack W. Stevens

Soils surveyed by Micheal L. Golden, Wayne J. Gabriel,
William M. Risinger, and Robert N. Ramsey, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
Texas Agricultural Experiment Station and
Val Verde County Commissioners Court

Val Verde County is in southwestern Texas. Its southern boundary is the Rio Grande. The county is irregularly shaped and has an area of 3,259 square miles, or 2,085,760 acres. Of this, 36,990 acres is water areas larger than 40 acres. These areas are mainly Lake Amistad, the Rio Grande, and Pecos and Devils Rivers.

Del Rio, the county seat and major town, is about 150 miles west of San Antonio. Other communities include Comstock, Langtry, Juno, Pumpville, Pandale, and Loma Alta. In 1980 the population of the county was 35,722.

Most of the county is in the Edwards Plateau major land resource area, but the southeastern part is in the Rio Grande Plain *(3)*. Sheep and goat production is the main enterprise in the county. About 98 percent of the county is rangeland, and about 2 percent is pasture, vineyards, and orchards.

Val Verde County is primarily ranch country and is second in Texas and in the United States in population of sheep with 127,000 breeding ewes. The county produced 1,321,000 pounds of wool in 1978. There is also a large Angora goat and mohair industry with 98,000 goats that produced 660,000 pounds of mohair, which is the second largest production in Texas. About 22,000 head of cattle and 122,000 laying hens were in Val Verde County in 1978.

The southern part of Val Verde County is nearly level to undulating. In the northern and northwestern parts, the topography is nearly level to very steep. Altitude ranges from about 900 feet in the south to 2,350 feet in the north.

Most of this county is rangeland, and mapping was done mainly with broadly defined units. However, about 400,000 acres near Del Rio and Lake Amistad was mapped in more detail to provide soil survey information for planning and development. Most of the map units in this area are narrowly defined.

Descriptions, names, and delineations of soils in this survey do not fully agree with those on soil maps of adjacent counties because of better knowledge of soils, modifications in series concepts, or differences in intensity of mapping or in the extent of soils within the survey areas.

General Nature of the County

This section provides general information about Val Verde County. It contains brief discussions of the history and transportation, climate, and natural resources of the county.

History and Transportation

Indians lived in this area as early as 10,000 years ago. Val Verde County has one of the richest concentrations of aboriginal art and artifacts in North America, including pictographs painted on the walls of many area caves.

Del Rio was originally named San Felipe del Rio (St. Philip of the River) by Spanish missionaries who arrived on St. Philip's Day in 1635. The name was shortened in 1883 to avoid confusion with San Felipe de Austin.

Val Verde County was established in 1885. It was formed out of Pecos, Kinney, and Crockett Counties. In Spanish, the name means "green valley."

Judge Roy Bean, known as "The Law West of the Pecos" during the late 1880's was a legendary figure in the area.

Fort Clark was built along San Felipe Springs in 1857. In 1942 the Army Air Corps opened Laughlin Field (now Laughlin Air Force Base) as a training base.

Early settlers saw the need for irrigation in this dry region. About 1869 a group of people formed the San Felipe Agriculture Manufacturing and Irrigation Company. They dug canals and laterals and started irrigating some crops.

The Devil's River Soil and Water Conservation District was formed in 1947. Area ranchers joined together to encourage the conservation of soil, water, plants, wildlife, and recreational resources.

Val Verde County is served by U.S. Highways 90, 277, and 377, as well as Texas Highway 163 and several ranch roads. Rail transport for freight and passengers is also available.

Climate

Val Verde County has a semiarid, continental climate with dry winters and hot summers. Table 1 gives data on temperature and precipitation for the county, as recorded at Del Rio from 1937 to 1976.

The prevailing winds are southeasterly from April through October. From November through March northeasterly winds prevail, bringing more abrupt day-to-day changes in temperature. Average windspeed is highest at 11.6 miles per hour in July.

In winter, the average temperature is 53 degrees, and the average daily minimum temperature is 40 degrees. The lowest temperature on record, which occurred at Del Rio in February 1951, was 11 degrees F. In summer the average daily maximum temperature is 98 degrees F. The highest recorded temperature was 111 degrees in July 1960.

Cold periods in winter have strong, dry, dusty northerly and northeasterly winds that may cause temperatures to drop as much as 25 degrees in a few hours. Cold periods usually do not last more than 2 or 3 days. Hot weather is rather persistent from late May to mid September, and temperatures above 100 degrees F have been recorded as early as March and as late as October.

Temperatures below freezing occur on an average of 19 days each year. Temperatures as low as 32 degrees F have been recorded as early as October and as late as March, but the average date of the earliest freezing temperature in autumn is December 9, and the average latest freezing date in spring is February 12. The average growing season at Del Rio is 300 days.

The average annual rainfall at Del Rio is 18.38 inches. Of this, 12.22 inches, about two-thirds, usually falls April through October, which is the growing season for most crops. There is not enough rainfall throughout the county for dryland farming; however, irrigation wells, San Felipe Springs, and the major rivers provide water for irrigating farmland.

The heaviest 1-day rainfall during the period of record was 8.8 inches at Del Rio in June 1935. Thunderstorms occur on about 34 days each year and have occurred in all months of the year. Yearly rainfall has ranged from 37.75 inches in 1914 to 4.34 inches in 1956. The largest monthly rainfall, 13.71 inches, occured in June 1935. Each month of the year has been dry (precipitation of 0.03 inch or less) in one or more years. Rainfall comes chiefly in showers, which are frequently associated with local thunderstorms and characterized by heavy downpours.

Hail occurs in Val Verde County about once a year and reaches severe proportions about once in 5 years. Sleet or snow falls on an average of once a year but frequently melts at it falls, and only about once in 4 or 5 years does a snowfall heavy enough to blanket the ground occur. The heaviest 1-day snowfall on record was 4.7 inches in March 1962.

The average relative humidity in mid-afternoon is about 54 percent. Humidity is higher at night, and the average at dawn is about 79 percent. The proportion of possible sunshine is 80 percent in summer and 53 percent in winter.

This section was compiled from data furnished in the climatological summary by the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

Natural Resources

Soil, water, wildlife, and natural gas are the most important natural resources in Val Verde County.

The deep soils in this county are capable of producing large amounts of forage. The shallow soils are used mainly for sheep, goat, and cattle range.

There are abundant supplies of good quality water from springs, rivers, and wells. San Felipe Springs has an average discharge of more than 65,000,000 gallons per day, making it one of the largest springs in Texas.

Wildlife in the survey area provide recreation and income for many landowners. Deer, javelina, quail, and dove are abundant throughout the county.

The Amistad National Recreation Area is available for water sports, hunting, camping, and fishing. The part of Amistad Reservoir in the United States covers approximately 33,000 acres at conservation pool level. This is one of the clearest inland bodies of water for scuba diving in the United States.

Val Verde County has abundant supplies of rock for construction and caliche for road building. Natural gas in the northern part of the county is also very important.

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 managers, engineers, planners, developers and builders, home buyers, and others.

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.

Descriptions of the Map Units

There are three distinct broad areas of soils in Val Verde County. These areas, and the general soil map units in them, are discussed in this section. The dominant soils in each unit and their suitabilities are described.

One broad area of soils is in the Edwards Plateau land resource area, and another is wholly in the Rio Grande Plain land resource area. The third occurs on bottom lands, terraces, and valley fills in both resource areas.

Soils that Formed in Material Weathered from Limestone

This group makes up about 88 percent of Val Verde County. The major components are Ector, Langtry, Lozier, Mariscal, Shumla, Tarrant, and Zorra soils and Rock outcrop. These very shallow and shallow, nearly level to very steep soils are on uplands of the Edwards Plateau land resource area. The soils are used mainly for wildlife habitat and range.

1. Ector-Rock Outcrop

Very shallow and shallow, loamy soils that are stony, and exposed limestone bedrock; on uplands

This unit consists of gently undulating to very steep soils on a series of plateaus and steep canyons (fig. 1). Slope ranges from 1 to 60 percent.

This unit makes up about 48 percent of the county. It is about 51 percent Ector soils, 30 percent Rock outcrop, and 19 percent other soils.

The gently undulating to very steep Ector soils are on limestone plateaus and side slopes. These soils typically are grayish brown stony loam about 8 inches thick over fractured limestone bedrock.

Rock outcrop is limestone exposures mainly on hilly to very steep sides of canyons. It supports little or no vegetation.

Other, less extensive components are Dev and Rio Diablo soils and Riverwash. The deep, loamy, nearly level to gently undulating Dev soils are on bottom lands. The deep, clayey, nearly level to gently sloping Rio Diablo soils are on stream terraces.

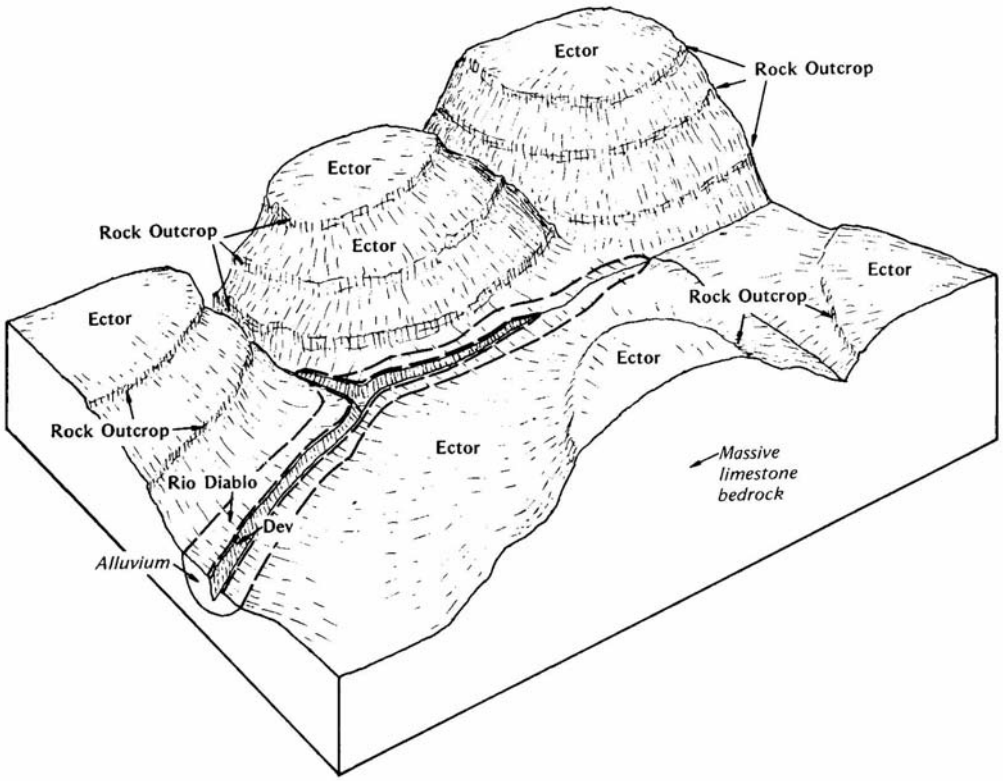


Figure 1.—Relationship of soils and topography in the Ector-Rock outcrop map unit.

Riverwash is unstabilized gravel on the flood plains of high-velocity streams that cut through the area.

The soils in this unit are not suited to crops or pasture. They are used almost entirely for wildlife habitat and range. Slope, very shallow and shallow rooting depth, and large stones are the main limitations.

Low rainfall, very low available water capacity, and restricted rooting depth limit the amount of range forage produced during most years. Forage yields vary with rainfall, which decreases toward the west. Native range plants are mainly short and mid grasses with scattered juniper. Sideoats grama and hairy grama are the dominant grasses. If grazing is too heavy the range deteriorates, and perennial threeawn, red grama, and slim tridens increase along with woody shrubs. If heavy grazing continues, the vegetation becomes mostly woody shrubs with an understory of short grasses. Juniper is a major problem in range management.

This unit provides fair wildlife habitat. Deer and javelina use the areas for cover and browse. Eagles and puma inhabit the steeper areas.

Suitability for most urban and recreational uses is poor. Depth to rock, large stones, and slope are the main limitations.

2. Langtry-Rock Outcrop-Zorra

Very shallow and shallow, loamy soils that are cobbly and stony, and exposed limestone bedrock; on uplands

This unit consists of gently sloping to very steep soils on a series of plateaus and steep canyons (fig. 2). Slope ranges from 1 to 60 percent.

This unit makes up about 28 percent of the county. It is about 31 percent Langtry soils, 17 percent Rock outcrop, 16 percent Zorra soils, and 36 percent other soils.

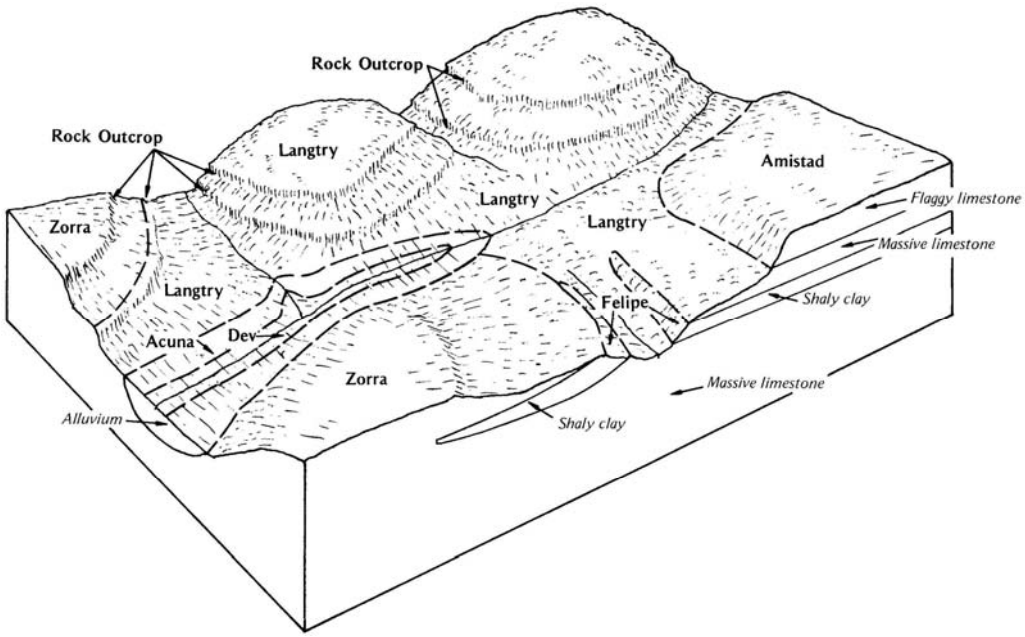


Figure 2..—Relationship of soils and topography in the Langtry-Rock outcrop-Zorra map unit.

The gently sloping to very steep Langtry soils are on limestone plateaus and side slopes. These soils typically are moderately alkaline, dark grayish brown cobbly silt loam about 8 inches thick over fractured limestone bedrock.

Rock outcrop is limestone exposures mainly on hilly to very steep sides of canyons. It supports little or no vegetation.

The gently sloping to rolling Zorra soils are on limestone plateaus and side slopes. These soils typically are moderately alkaline, dark grayish brown stony loam about 8 inches thick over strongly cemented caliche. Fractured limestone bedrock is at a depth of 15 inches.

Other, less extensive components are Acuna, Amistad, Dev, Felipe, Sanderson, Shumla, and Valverde soils. The deep, loamy, nearly level to gently sloping Acuna, Sanderson, and Valverde soils are on terraces and low uplands. The shallow, clayey, strongly sloping to steep Felipe soils are very erodible and are on hillsides. The deep, very gravelly Dev soils are on bottom lands. The very shallow and shallow, loamy, nearly level to gently sloping Shumla soils are on old outwash deposits. The shallow and very shallow Amistad soils are on hillsides and ridges.

The soils in this unit are not suited to crops or pasture. They are used mostly for wildlife habitat and range. Slope, very shallow or shallow rooting depth, and large stones are the main limitations.

Low rainfall, very low available water capacity, and restricted rooting depth limit the amount of range forage produced during most years. Native range plants are mainly short and mid grasses with scattered cenizo and blackbrush. Some of the main grasses are sideoats grama, Rio Grande lovegrass, cane bluestem, and green sprangletop. If grazing is too heavy the range deteriorates, and perennial threeawn, red grama, and slim tridens increase along with woody shrubs. If heavy grazing continues, the vegetation becomes mostly woody shrubs with an understory of short grasses. Blackbrush and cenizo have invaded many areas and are a major problem in range management.

This unit provides fair wildlife habitat. Deer use the areas for cover and browse.

Suitability for most urban and recreational uses is poor. Depth to rock, large stones, and slope are the main limitations.

3. Lozier-Mariscal-Shumla

Very shallow and shallow, loamy soils that are gravelly, flaggy, and cobbly; on uplands

This unit consists of nearly level to very steep soils on a series of plateaus, benches, and steep canyons in the desert shrub area of the Edwards Plateau (fig. 3). Slope ranges from 0 to 60 percent.

This unit makes up about 7 percent of the county. It is about 27 percent Lozier soils, 20 percent Mariscal soils, 20 percent Shumla soils, and 33 percent other soils.

The gently undulating to very steep Lozier soils are on limestone plateaus, hilly footslopes, and side slopes. These soils typically are moderately alkaline, grayish brown very gravelly loam about 8 inches thick. The next 6 inches is fractured limestone, which is underlain by coarsely fractured limestone bedrock. In some places these soils are very cobbly.

The gently undulating to very steep Mariscal soils are on limestone plateaus, hills, and very steep side slopes. These soils typically are moderately alkaline, pale brown very flaggy loam about 7 inches thick. The next 10 inches is fractured limestone, which is underlain by flaggy limestone bedrock.

The nearly level to sloping Shumla soils are on footslopes and terraces. These soils typically have a surface layer of moderately alkaline, brownish loam about 11 inches thick. The next 6 inches is indurated caliche. The next 19 inches is weakly cemented gravelly loam. Factured limestone bedrock extends to a depth of 60 inches.

Other components are Hodgins, Sanderson, and Langtry soils. The deep, loamy, nearly level to gently sloping Hodgins and Sanderson soils are on low uplands and terraces. The very shallow and shallow, cobbly, gently undulating to steep Langtry soils are on limestone plateaus.

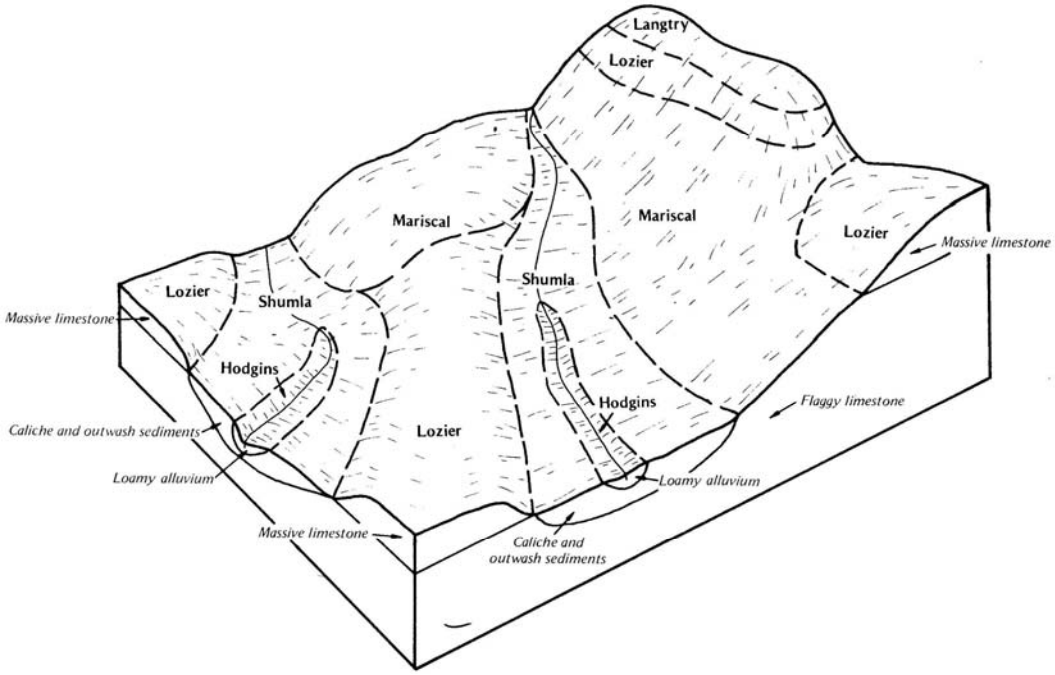


Figure 3.—Relationship of soils and topography in the Lozier-Mariscal-Shumla map unit.

The soils in this unit are not suited to crops or pasture grasses. They are used almost entirely for wildlife habitat and range. Slope, very shallow and shallow rooting depth, and small stones are the main limitations.

Low rainfall, very low available water capacity, and restricted rooting depth limit the amount of range forage produced during most years. Native range plants are mainly short grasses with scattered creosotebush and tarbush. Some of the main grasses are sideoats grama, bush muhly, chino grama, and hairy grama. If grazing is too heavy the range deteriorates, and perennial threeawn, burrograss, red grama, and woody shrubs can take over the site. If heavy grazing continues, the vegetation becomes mostly woody shrubs with an understory of short grasses. Tarbush and creosotebush have invaded many areas and are a major problem in range management.

This unit provides poor habitat for most kinds of wildlife because of the lack of cover. Rabbits and badger are the main kinds found here.

Suitability for most urban and recreational uses is poor. Depth to rock, small stones, and slope are the main limitations.

4. Tarrant-Ector-Rock Outcrop

Very shallow and shallow, clayey and loamy soils that are stony, and exposed limestone bedrock; on uplands

This unit consists of gently undulating to hilly soils on plateaus and hillsides (fig. 4). Slope ranges from 1 to 60 percent.

This unit makes up about 5 percent of the county. It is about 35 percent Tarrant soils, 34 percent Ector soils, 10 percent Rock outcrop, and 21 percent other soils.

The gently undulating to undulating Tarrant soils are on limestone plateaus. These soils typically are moderately alkaline, very stony clay that is very dark gray in the upper 9 inches and very dark grayish brown in the lower 5 inches. Marl or coarsely fractured bedrock is at a depth of 14 inches.

The gently undulating to very steep Ector soils are on uplands. These soils typically are moderately alkaline, grayish brown stony loam about 8 inches thick over fractured limestone that has thin coatings of calcium carbonate in cracks and crevices. Coarse fractured limestone is at a depth of 15 inches.

Rock outcrop is mainly on gently rolling to hilly side slopes. It supports little or no vegetation.

Other, less extensive components are Dev, Kavett, and Rio Diablo soils. The deep, nearly level to gently sloping Dev soils are on bottom lands of small intermittent streams. The shallow, nearly level to gently sloping Kavett soils are on ridgetops and plateaus. The deep, nearly level to gently sloping Rio Diablo soils are on old terraces and valley fills.

The soils in this unit are not suited to crops or pasture grasses. They are used almost entirely for wildlife habitat and range. Slope, very shallow and shallow rooting depth, and large stones are the main limitations.

Low rainfall, very low available water capacity, and restricted rooting depth limit the amount of range forage produced during most years. Native range plants are mainly short and mid grasses with scattered juniper and live oak. Some of the main grasses are little bluestem, sideoats grama, curlymesquite, and slim tridens. If grazing is too heavy the range deteriorates, and perennial threeawn, red grama, and woody shrubs can take over the site. If heavy grazing continues, the vegetation becomes mostly woody shrubs with an understory of short grasses. Juniper and live oak are major problems in range management.

This unit provides fair wildlife habitat. Deer, turkey, javelina, and quail find food, browse, and cover in these areas.

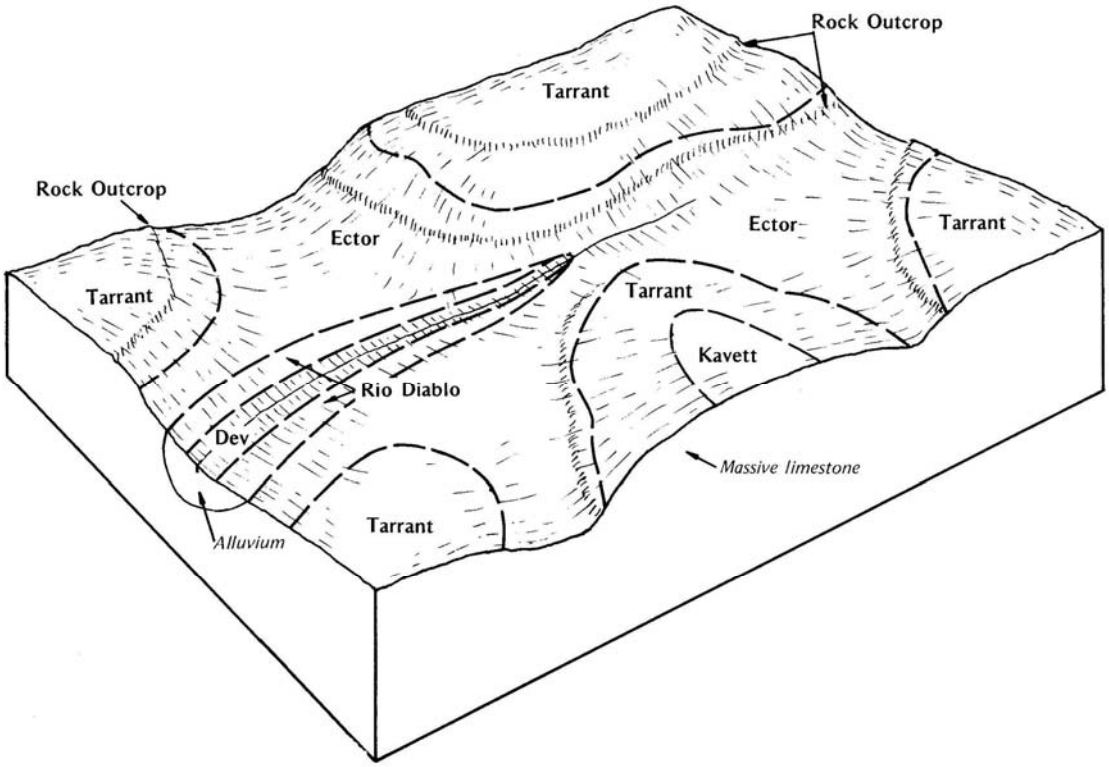


Figure 4.—Relationship of soils and topography in the Tarrant-Ector-Rock outcrop map unit.

Suitability for most urban and recreational uses is poor. Depth to rock, large stones, and clayey texture are the main limitations.

Soils that Formed in Old Alluvium Over Caliche and Limy Earth

This group makes up about 8 percent of the county. The major components are Acuna, Coahuila, Jimenez, Olmos, and Quemado soils. These very shallow to deep, nearly level to sloping soils are on uplands and terraces of the Rio Grande Plain land resource area. These soils are used mainly for wildlife habitat and range; however, some areas are used for improved pasture.

5. Olmos-Acuna-Coahuila

Very shallow, shallow, and deep, clayey and loamy soils that are gravelly. on terraces and uplands

This unit consists of nearly level to sloping soils on a series of old outwash deposits on nearly level to sloping valley fills and low hills (fig. 5). Slope ranges from 0 to 8 percent.

This unit makes up about 7 percent of the county. It is about 50 percent Olmos soils, 22 percent Acuna soils, 11 percent Coahuila soils, and 17 percent other soils.

The gently sloping to sloping Olmos soils are on uplands of outwash sediment. These soils typically are moderately alkaline, brown very gravelly loam about 18 inches thick over indurated caliche that extends to a depth of 24 inches. Weakly cemented caliche extends to a depth of 60 inches.

The nearly level to gently sloping Acuna soils are on terraces and valley fills on uplands. These soils typically have a surface layer of dark grayish brown silty clay about 18 inches thick. The upper 12 inches of the subsoil is brown clay, the middle 30 inches is pink silty clay, and the lower 12 inches is reddish yellow silty clay with a

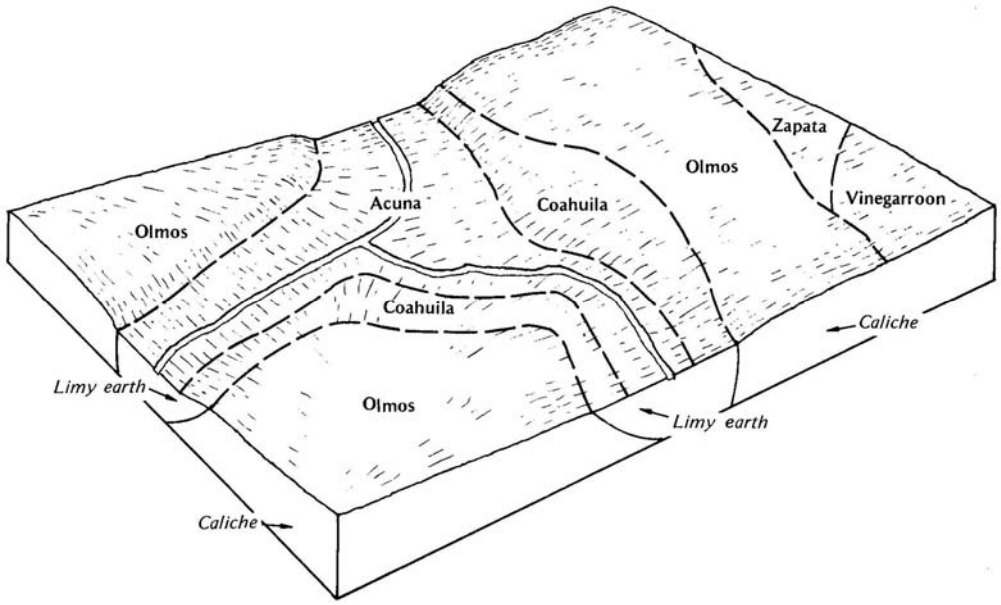


Figure 5.—Relationship of soils and topography in the Olmos-Acuna-Coahuila map unit.

few soft masses of calcium carbonate. These soils are moderately alkaline throughout.

The nearly level to gently sloping Coahuila soils are on valley fills and terraces on uplands. These soils typically have a surface layer of grayish brown clay loam about 9 inches thick. The upper 13 inches of the subsoil is pale brown silty clay loam, the next 11 inches is pale brown silty clay loam, and the lower 29 inches is very pale brown silty clay with many soft masses of calcium carbonate. These soils are moderately alkaline throughout.

Other, less extensive components are Felipe, Vinegarroon, Valverde, Tobosa, and Zapata soils. The deep, clayey, nearly level Tobosa soils are on clay flats on uplands. The very shallow and shallow, loamy, gently sloping Zapata and Vinegarroon soils are on old outwash sediments on uplands. The deep, loamy, nearly level and gently sloping Valverde soils are on valley fills on uplands.

The soils in this unit are moderately well suited to crops and pasture grasses if irrigation water is available. These soils are used mainly for wildlife habitat and range. Excess lime and the shallow rooting depth are the main limitations.

Low rainfall, very low available water capacity, and restricted rooting depth limit the amount of range forage produced in most years. Native range plants are mainly short and mid grasses with scattered too many mesquite and cenizo. The main grasses are sideoats grama, pink pappusgrass, plains bristlegrass, vine-mesquite, and silver bluestem. If grazing is too heavy the range deteriorates, and red grama, perennial threeawn, fall witchgrass, and Hall panicum increase along with woody shrubs. If heavy grazing continues, the vegetation becomes mostly woody shrubs, such as mesquite, whitebrush, agrito, yucca, and cacti, with an understory of red grama, hairy tridens, and perennial threeawn. Cenizo has invaded many areas and is a major problem in range management.

Many kinds of wildlife use this unit, including deer, turkey, javelina, and quail. Grass seed and browse plants provide adequate food, and cover is abundant.

Suitability for most urban uses is poor. Depth to a cemented pan, shrinking and swelling of the soil, and low strength under roads and streets are the main limitations. Suitability for most recreational uses is also poor. The clayey surface layer, cemented pan, and small stones are the main limitations.

6. Jimenez-Quemado

Very shallow and shallow, loamy soils that are gravelly; on uplands

This unit consists of gently undulating to undulating soils that formed in outwash sediment on old high terraces (fig. 6). Slope ranges from 1 to 8 percent.

This unit makes up less than 1 percent of the county. It is 36 percent Jimenez soils, 28 percent Quemado soils, and 36 percent other soils.

The gently undulating to undulating Jimenez soils are on sides of old stream terraces on uplands. These soils typically are moderately alkaline, dark grayish brown very gravelly loam about 10 inches thick. The next 7 inches is indurated caliche that is about 50 percent, by volume, gravel. Weakly cemented caliche extends to a depth of 60 inches.

The gently undulating to undulating Quemado soils are on the crests of ridges of old dissected stream terraces on uplands. These soils typically have a surface layer of mildly alkaline, dark brown very gravelly loam about 5 inches thick. The subsoil is mildly alkaline, reddish brown very gravelly loam to a depth of about 13 inches. The next 5 inches is indurated caliche. Weakly cemented caliche extends to a depth of 60 inches.

Other components are Acuna, Coahuila, Dev, and Olmos soils. The deep, nearly level and gently sloping Acuna and Coahuila soils are on valley fills and old stream terraces. The deep, gravelly, loamy, nearly level and gently sloping Dev soils are along small drainageways on bottom lands. The very shallow and shallow, gravelly, loamy, gently sloping and sloping Olmos soils are on uplands at slightly higher elevations.

The soils in this unit are not suited to crops or pasture grasses. They are used mainly for wildlife habitat and range. Very shallow and shallow rooting depth, small stones, and very low available water capacity are the main limitations.

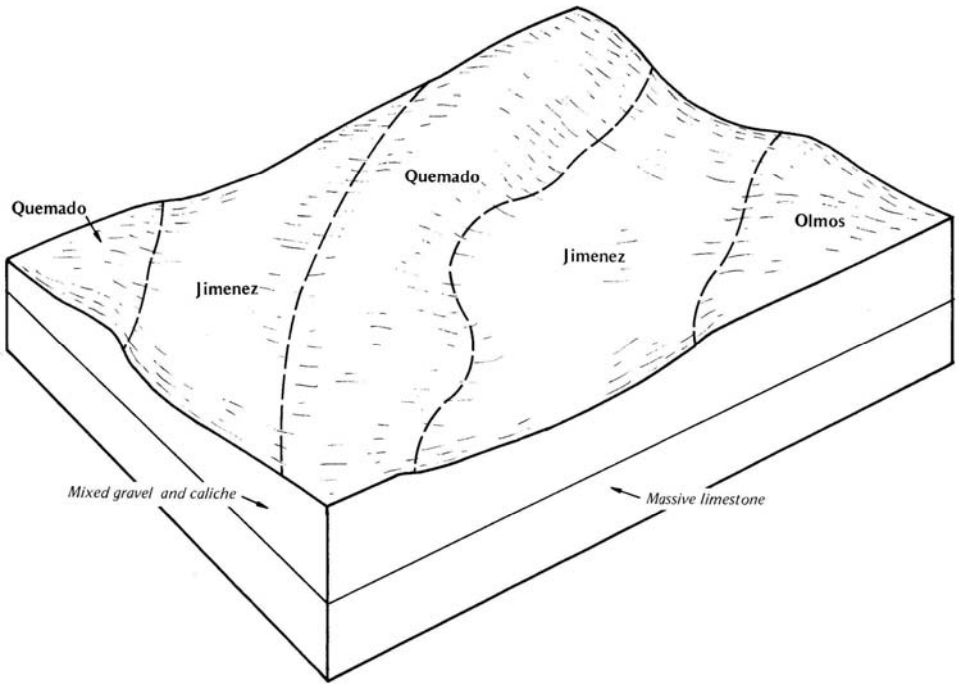


Figure 6.—Relationship of soils and topography in the Jimenez-Quemado map unit.

Low rainfall, very low available water capacity, and very shallow and shallow rooting depth limit production of range forage. Range plants are mainly short and mid grasses with scattered guajillo and cenizo. Some of the main grasses are tanglehead, pinhole bluestem, and plains bristlegrass. If grazing is too heavy the range deteriorates, and red grama, perennial threeawn, and hairy tridens increase along with woody shrubs. If heavy grazing continues, the vegetation becomes mostly woody shrubs, such as cenizo, catclaw acacia, and pricklypear.

This unit provides fair wildlife habitat. Deer, turkey, and dove use these areas.

Suitability for most urban and recreational uses is poor. Depth to a cemented pan, small stones, and a thin surface layer are the main limitations.

Soils that Formed in Recent Alluvium

This group makes up about 2 percent of Val Verde County. The major components are Dev, Lagloria, Rio Diablo, Rio Grande, and Reynosa soils. These deep, nearly level to gently sloping and gently undulating soils are on bottom lands and terraces of the Edwards Plateau and Rio Grande Plain land resource areas. These soils are used mainly for wildlife habitat, range, and pasture; a few areas are used for special crops.

7. Dev-Rio Diablo

Deep, loamy and clayey soils that are gravelly; on bottom lands and terraces

This unit consists of nearly level to gently sloping soils on flood plains, valley fills, and terraces in the Edwards Plateau land resource area (fig. 7). Slope ranges from 0 to 3 percent.

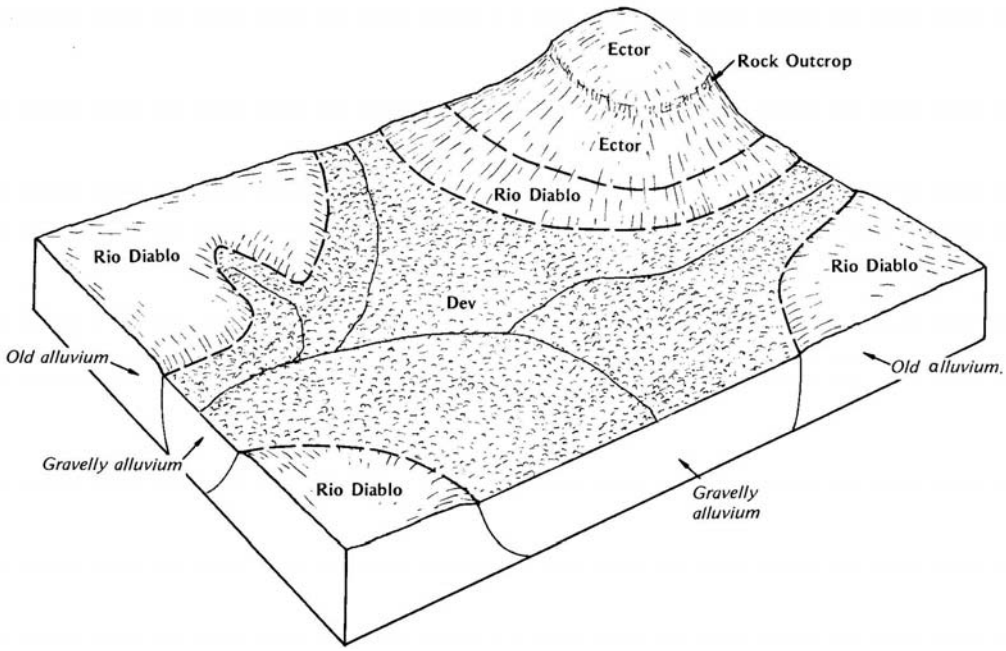


Figure 7.—Relationship of soils and topography in the Dev-Rio Diablo map unit.

This unit makes up less than 1 percent of the county. It is about 55 percent Dev soils, 25 percent Rio Diablo soils, and 20 percent other soils.

The nearly level Dev soils are on bottom lands of high-velocity streams. These soils typically have a surface layer of dark brown very gravelly clay loam about 25 inches thick. The underlying layer is pale brown very gravelly clay loam to a depth of 60 inches. These soils are moderately alkaline throughout.

The nearly level to gently sloping Rio Diablo soils are on terraces and valley fills. These soils typically have a surface layer of dark grayish brown silty clay about 17 inches thick. The upper 29 inches of the subsoil is brownish clay, and the lower 14 inches is light brown clay with a few soft masses and concretions of calcium carbonate.

Other, less extensive components are Acuna, Ector, Hodgins, Olmos, and Sanderson soils, Riverwash, and Rock outcrop. The deep, loamy, nearly level and gently sloping Acuna and Hodgins soils are on valley fills and low uplands. The very shallow to shallow, stony, gently sloping to hilly Ector soils are on ridges and side slopes. The very shallow and shallow, gravelly, loamy, gently sloping and sloping Olmos soils are on outwash sediments at slightly higher elevations. The deep, gravelly, loamy, nearly level to gently sloping Sanderson soils are on terraces. Riverwash is on flood plains and consists of unstabilized gravel bars. Rock outcrop is barren exposures of limestone.

The soils in this unit are not suited to crops, and they are poorly suited to pasture grasses. Irrigation is needed. These soils are used mainly for wildlife habitat and range. The flooding hazard, low available water capacity, and small stones are the main limitations.

Low rainfall and the content of gravel limit production of range forage. Native range plants are mainly short and mid grasses with scattered whitebrush and mesquite. The main grasses are sideoats grama, cane bluestem, buffalograss, and Arizona cottontop. If gazing is too heavy the range deteriorates, and such grasses as fall witchgrass and perennial threeawn increase along with woody plants. If heavy grazing continues, hairy tridens, perennial threeawn, and red grama can take over the site. Mesquite and whitebrush have invaded most areas and are a major problem in range management.

This unit provides fair wildlife habitat. Deer, turkey, javelina, and quail find food and cover in these areas.

Suitability for most urban and recreational uses is poor. The flooding hazard, clayey surface layer, and small stones are the main limitations.

8. Rio Grande-Reynosa-Lagloria

Deep, loamy soils; on bottom lands and terraces

This unit consists of nearly level to gently sloping soils on flood plains and terraces in the Rio Grande Plain land resource area (fig. 8). Slope ranges from 0 to 3 percent.

This unit makes up 1 percent of the county. It is about 39 percent Rio Grande soils, 23 percent Reynosa soils, 18 percent Lagloria soils, and 20 percent other soils.

The nearly level to gently sloping Rio Grande soils are on bottom lands of the Rio Grande. These soils typically have a surface layer of pale brown silt loam about 9 inches thick. The next 46 inches is light brownish gray and pale brown silt loam and loam with evident bedding planes. These soils are moderately alkaline throughout.

The nearly level to gently sloping Reynosa soils are on terraces. These soils typically have a surface layer of grayish brown and light brownish gray silty clay loam about 16 inches thick. The subsoil is brownish silty clay loam with threads, films, soft masses, and concretions of calcium carbonate and extends to a depth of 64 inches. These soils are moderately alkaline throughout.

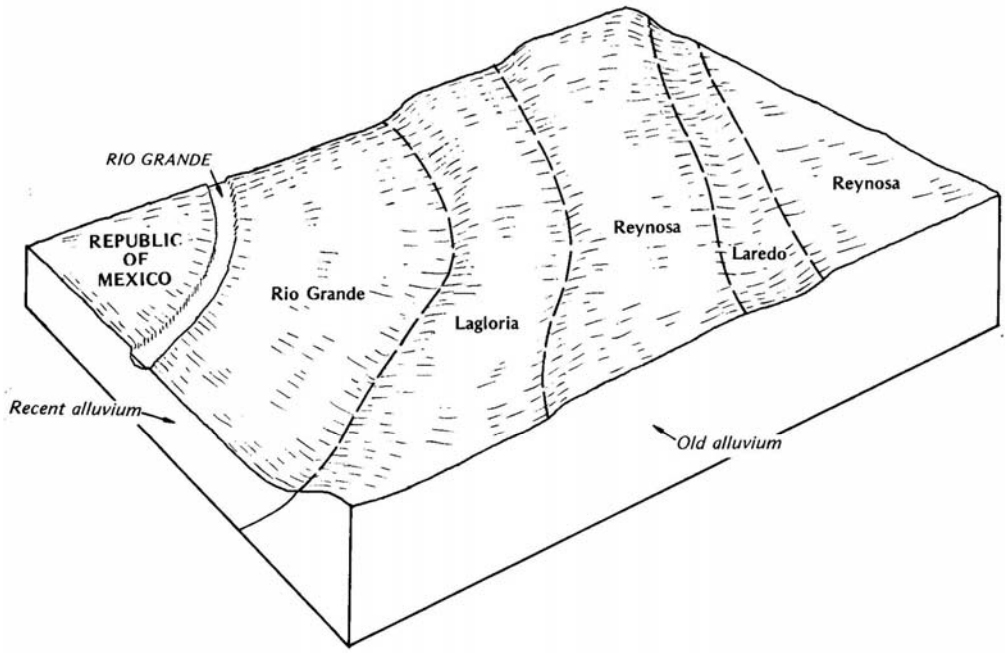


Figure 8.—Relationship of soils and topography in the Rio Grande-Reynosa-Lagloria map unit.

The nearly level to gently sloping Lagloria soils are on terraces and bottom lands. These soils typically have a surface layer of brown loam about 13 inches thick. The subsoil is light yellowish brown loam about 43 inches thick. The underlying layer is pale brown silt loam to a depth of 72 inches. These soils are moderately alkaline throughout.

Other, less extensive components are Dev, Laredo, Laredo Variant, and Pintas soils. The deep, gravelly, loamy, nearly level and gently sloping Dev soils are on bottom lands along the sides of streams and rivers. The deep, loamy, nearly level Laredo and Laredo Variant soils are on bottom lands and in slight depressions. The deep, loamy, nearly level Pintas soils are along perennial streams and have a high water table.

The soils in this unit are moderately well suited to cultivated crops and special crops and to pasture plants, such as forage sorghums, wheat, oats, bermudagrass, and kleingrass. These soils are used mostly for pasture. A few areas are used for grapes and citrus fruits.

Low rainfall limits production of range forage. Some of the main range grasses are little bluestem, southwestern bristlegrass, switchgrass, fourflower trichloris, Arizona cottontop, and vine-mesquite. If grazing is too heavy the range deteriorates, and such grasses as fall witchgrass and perennial threeawn increase along with woody plants. If heavy grazing continues, hairy tridens, perennial threeawn, and red grama can take over the site. Huisache or hackberry has invaded many areas and is a major problem in range management.

This unit provides fair habitat for turkey, deer, quail, dove, and some furbearers.

The soils in this unit are moderately well suited to most urban uses. Seepage and flooding are the main limitations. These soils are well suited to most recreational 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, Amistad very flaggy loam, 8 to 15 pecent slopes, is one of several phases in the Amistad 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. Zapata-Vinegarroon complex, 1 to 5 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. Mariscal-Lozier association, very steep, 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. Felipe and Zorra soils, very rocky, 8 to 40 percent slopes, 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.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Riverwash 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 2 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.

Soil Descriptions

AcB—Acuna silty clay, 0 to 3 percent slopes. This deep, nearly level to gently sloping soil is on stream terraces and low uplands. Slope averages about 0.5 percent. Mapped areas are irregular to long and narrow in shape and range from 10 to 1,000 acres in size.

Typically, the surface layer is dark grayish brown silty clay about 18 inches thick. The upper 12 inches of the subsoil is brown clay, the next 8 inches is pink silty clay, and the lower 22 inches is pink silty clay with common soft masses of calcium carbonate. The underlying layer extends to a depth of 72 inches and is reddish yellow silty clay that has a few soft masses of calcium carbonate. This soil is moderately alkaline throughout.

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

Included with this soil in mapping are spots of a soil that is similar to this Acuna soil but that does not have a distinct layer of calcium carbonate accumulation above a depth of 40 inches; small areas of Coahuila, Dev, Olmos, Valverde, Vinegarroon, and Zorra soils; and a few low areas that receive extra run on water that causes short-term flooding. Included areas make up less than 15 percent of any mapped area.

This Acuna soil is used mainly for wildlife habitat and range. Some areas are used for improved pasture.

This soil is moderately well suited to irrigated crops. Excess lime limits yields. This soil is not suited to most dryland crops because of low rainfall.

This soil is moderately well suited to pasture (fig. 9). Forage sorghums, wheat, oats, and kleingrass are the main irrigated pasture grasses. Kleingrass, blue panicum, King Range bluestem, and forage sorghums are the main dryland pasture grasses. Low rainfall and excess lime limit forage production.

Figure 9.—Cattle grazing oats on Acuna silty clay, 0 to 3 percent slopes.

The potential plant community is mainly mid grasses. Sideoats grama, cane and silver bluestem, plains bristlegrass, pink pappusgrass, plains lovegrass, and vine-mesquite make up 50 percent of the plant cover. Slim tridens, tobosa, Texas wintergrass, Arizona cottontop, buffalograss, curlymesquite, threeawn, and fall witchgrass make up 40 percent. Forbs, such as velvet bundleflower, bushsunflower, and orange zexmenia, make up 5 percent; and woody plants, such as guayacan, spiny hickberry, mesquite, condalia, and cacti, make up 5 percent.

Sideoats grama, cane and silver bluestem, plains bristlegrass, plains lovegrass, and vine-mesquite are preferred by livestock and are grazed out under continued heavy use. They are replaced by woody shrubs, threeawns, curlymesquite, slim tridens, and tobosa. If deterioration continues, a large proportion of the plant cover is woody shrubs, such as mesquite, whitebrush, paloverde, condalia, pricklypear, tasajillo, and other brush. Gray coldenia, ragweed, red grama, Hall panicum, and hairy tridens also invade the site.

This soil has fair potential for wildlife habitat. The areas are used extensively by many kinds of wildlife. Deer, turkey, quail, javelina, and several songbirds feed in these areas and have adequate cover for protection. Some birds also nest in these areas.

This soil is moderately well suited to most urban uses. Seepage, clayey texture, excess lime, shrinking and swelling, low strength under roads and streets, and corrosivity to uncoated steel are the main limitations. This soil is only moderately well suited to recreational uses because of the clayey surface layer.

This soil is in capability subclasses IVe, nonirrigated, and IIe, irrigated. It is in Clay Loam range site.

AmD—Amistad flaggy clay loam, 1 to 8 percent slopes. This very shallow and shallow, gently sloping to sloping soil is on ridges on uplands. Slope averages about 3 percent. About 50 percent of the surface is covered by fragments and flagstones of limestone. Mapped areas are irregular in shape and range from 10 to 1,000 acres in size.

Typically, the surface layer is moderately alkaline, dark grayish brown flaggy clay loam about 6 inches thick. The next 11 inches is caliche that is strongly cemented in the upper few inches and weakly cemented in the lower part. This layer contains a few thin limestone fragments. Flaggy limestone bedrock is at a depth of 17 inches.

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

Included with this soil in mapping are small areas of Acuna, Langtry, Olmos, and Zorra soils. Also included are spots of a soil that is similar to this Amistad soil but that does not have a layer of indurated caliche. Included soils make up less than 15 percent of any mapped area.

This Amistad soil is used mainly for wildlife habitat and range.

This soil is not suited to crops or improved pasture. Very low available water capacity, large stones, and depth to rock are the main limitations.

The potential plant community is mainly short and mid grasses with some low-growing shrubs and forbs. Sideoats grama, green sprangletop, and cane bluestem make up 35 percent of the plant cover. Tanglehead, bristlegrass, plains lovegrass, reverchon panicum, and Arizona cottontop make up 20 percent; and perennial threeawn, slim tridens, hairy grama, and fall witchgrass make up 30 percent. Forbs, such as bushsunflower, Texas desertrue, lyreleaf parthenium, and orange zexmenia, make up 5 percent. Woody plants, such as Texas kidneywood, guajillo, skeletonleaf goldeneye, agrito, Texas persimmon, cenizo, blackbrush and catclaw acacia, sotol, dalea, yucca, littleleaf sumac, Texas false-mesquite, range ratany, wolfberry, desert yaupon, and cacti, make up 10 percent.

Sideoats grama, cane bluestem, green sprangletop, and plains lovegrass are preferred by livestock and decrease under heavy use. They are replaced by such grasses as fall witchgrass, slim tridens, perennial threeawn, and hairy grama and by woody plants. If heavy grazing continues, the site becomes dominated by brush, such as catclaw and blackbrush acacia; annual forbs; and short grasses, such as hairy tridens, red grama, Hall panicum, and perennial threeawn.

Low rainfall, very low available water capacity, and very shallow and shallow rooting depth limit the amount of range forage produced.

This soil has fair potential for wildlife habitat. Deer and quail use the areas for food and cover.

This soil is poorly suited to most urban uses. Corrosivity to uncoated steel, depth to rock, the cemented pan, and stones are the main limitations. The flaggy bedrock is a good source of building stone. This soil is poorly suited to most recreational uses. Stones, slope, and depth to rock are the main limitations.

This soil is in capability subclass VIIs and Flagstone range site.

AsE—Amistad very flaggy loam, 8 to 15 percent slopes. This very shallow and shallow, strongly sloping to moderately steep soil is on side slopes and ridges on uplands. Slope averages about 10 percent. About 60 percent of the surface is covered by fragments and flagstones of limestone. Mapped areas are irregular in shape and range from 10 to 800 acres in size.

Typically, the surface layer is moderately alkaline, brown very flaggy loam about 5 inches thick. The next 5 inches is caliche that is strongly cemented in the upper few inches and weakly cemented below. This layer has a few thin limestone channers. Flaggy limestone bedrock is at a depth of 10 inches.

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

Included with this soil in mapping are small areas of Acuna, Langtry, Olmos, and Zorra soils. Also included are spots of a soil that is similar to this Amistad soil but that does not have a layer of cemented caliche. Included soils make up less than 15 percent of any mapped area.

This Amistad soil is used mainly for wildlife habitat and range.

This soil is not suited to crops or improved pasture. Very low available water capacity, large stones, depth to rock, and slope are the main limitations.

The potential plant community is mainly mid and short grasses with some low-growing shrubs and forbs. Sideoats grama, green sprangletop, and cane bluestem make up 35 percent of the plant cover. Tanglehead, bristlegrass, plains lovegrass, reverchon panicum, and Arizona cottontop make up 20 percent; and perennial threeawn, slim tridens, hairy grama, and fall witchgrass make up 30 percent. Forbs, such as bushsunflower, Texas desertrue, lyreleaf parthenium, and orange zexmenia, make up 5 percent. Woody plants, such as Texas kidneywood, guajillo, skeletonleaf goldeneye, agrito, Texas persimmon, cenizo, blackbrush acacia, catclaw acacia, sotol, dalea, yucca, littleleaf sumac, Texas false-mesquite, range ratany, wolfberry, desert yaupon, and cacti, make up 10 percent.

Sideoats grama, cane bluestem, green sprangletop, and plains lovegrass are preferred by livestock and are grazed out first under continued heavy use. They are replaced by such grasses as fall witchgrass, slim tridens, perennial threeawn, and hairy grama and by woody plants. If heavy grazing continues, the site becomes dominated by brush, such as catclaw acacia and blackbrush acacia; annual forbs; and short grasses, such as hairy tridens, red grama, Hall panicum, and perennial threeawn.

Low rainfall, very low available water capacity, and shallow rooting depth limit the amount of range forage produced.

This soil has fair potential for wildlife habitat. Deer use the areas for cover and browse.

This soil is poorly suited to most urban uses. Corrosivity to uncoated steel, slope, depth to rock, the cemented pan, and stones are the main limitations. The flaggy bedrock is a good source of building stone. This soil is poorly suited to most recreational uses. Stones, depth to rock, and slope are the main limitations.

This soil is in capability subclass VIIs and Flagstone range site.

ATE—Amistad association, rolling. This association consists of very shallow and shallow, gently undulating to rolling soils on ridges and side slopes on uplands. Slope ranges from 1 to 15 percent but averages about 6 percent. About 65 percent of the surface is covered by fragments and flagstones of limestone. Mapped areas are irregular in shape and range from 20 to 1,500 acres in size.

This association is about 90 percent Amistad soils and 10 percent other soils. The surface layer of the Amistad soils is very flaggy clay loam or very flaggy loam with channers and flagstones. Individual mapped areas range from 75 to 95 percent Amistad soils and 5 to 15 percent other soils. The composition of this association is more variable than that of most map units in this county, but mapping has been controlled well enough for the anticipated use of the soils.

A typical Amistad soil has a surface layer of moderately alkaline, grayish brown very flaggy loam about 5 inches thick. The next 6 inches is strongly cemented caliche that is laminated in the upper few inches and strongly to weakly cemented below. This layer contains few to common thin limestone fragments. Flaggy limestone bedrock is at a depth of 11 inches.

These soils are well drained. Surface runoff is medium to rapid. Permeability is moderate in the upper part and slow in the indurated caliche. Available water capacity is very low. The rooting zone is very shallow and shallow. The water erosion hazard is moderate or severe.

Included with these soils in mapping are small areas of Acuna, Langtry, Lozier, Mariscal, and Olmos soils.

Included soils make up less than 15 percent of any mapped area.

These Amistad soils are used mainly for wildlife habitat and range.

These soils are not suited to crops or improved pasture. Very low available water capacity, fragments and flagstones, depth to rock, and slope are the main limitations.

The potential plant community is mainly mid and short grasses with some low-growing shrubs and forbs. Sideoats grama, green sprangletop, and cane bluestem make up 35 percent of the plant cover. Tanglehead, bristlegrass, plains lovegrass, reverchon panicum, and Arizona cottontop make up 20 percent; and perennial threeawn, slim tridens, hairy grama, and fall witchgrass make up 30 percent. Forbs, such as bushsunflower, Texas desertrue, lyreleaf parthenium, and orange zexmenia, make up 5 percent. Woody plants, such as Texas kidneywood, guajillo, skeletonleaf goldeneye, agrito, Texas persimmon, cenizo, blackbrush acacia, catclaw acacia, sotol, dalea, yucca, littleleaf sumac, Texas false-mesquite, range ratany, wolfberry, desert yaupon, and cacti, make up 10 percent.

Sideoats grama, cane bluestem, green sprangletop, and plains lovegrass are preferred by livestock and are grazed out first under continued heavy use. They are replaced by such grasses as fall witchgrass, slim tridens, perennial threeawn, and hairy grama and by woody plants. If heavy grazing continues, the site becomes dominated by brush, such as catclaw acacia and blackbrush acacia; annual forbs; and short grasses, such as hairy tridens, red grama, Hall panicum, and perennial threeawn.

Low rainfall, very low available water capacity, and shallow rooting depth limit the amount of range forage produced.

This soil has fair potential for wildlife habitat. Deer use the areas for cover and browse.

These soils are poorly suited to most urban uses. Corrosivity to uncoated steel, slope, depth to rock, the cemented pan, and the flagstones and thin fragments are the main limitations. The flaggy bedrock is a good source of building stone. These soils are poorly suited to most recreational uses. Stones, depth to rock, and slope are the main limitations.

These soils are in capability subclass VIIs and Flagstone range site.

CoB—Coahuila clay loam, 0 to 3 percent slopes. This deep, nearly level to gently sloping soil is on old stream terraces and low uplands. Slope averages about 1 percent. Mapped areas are irregularly shaped to long and narrow and range from 10 to 1,000 acres in size.

Typically, the surface layer is grayish brown clay loam about 9 inches thick. The upper 13 inches of the subsoil is pale brown silty clay loam; the next 11 inches is pale brown silty clay loam with common threads, films, and soft masses of calcium carbonate; and the lower 29 inches is very pale brown silty clay with many threads, films, and soft masses of calcium carbonate. This soil is moderately alkaline and calcareous throughout.

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

Included with this soil in mapping are small areas of Acuna, Felipe, Olmos, Valverde, Vinegarroon, and Zapata soils. Also included are a few low areas that receive extra run on water that causes short-term flooding. Included areas make up less than 15 percent of any mapped area.

This Coahuila soil is used mainly for wildlife habitat and range. Some areas are used for improved pasture.

This soil is moderately well suited to irrigated crops. Excess lime limits yields. This soil is not suited to most dryland crops because of low rainfall.

This soil is moderately well suited to pasture. Forage sorghums, wheat, oats, and kleingrass are the main irrigated pasture grasses. Kleingrass, blue panicum, King Ranch bluestem, and forage sorghums are the main dryland pasture grasses. Low rainfall and excess lime limit the forage production.

The potential plant community is mainly mid grasses. Sideoats grama, cane and silver bluestem, plains bristlegrass, pink pappusgrass, plains lovegrass, and vine-mesquite make up 50 percent of the plant cover. Slim tridens, tobosa, Texas wintergrass, Arizona cottontop, buffalograss, curlymesquite, threeawn, and fall witchgrass make up 40 percent. Forbs, such as velvet bundleflower, bushsunflower, and orange zexmenia, make up 5 percent; and woody plants, such as guayacan, spiny hackberry, mesquite, condalia, and cacti, make up 5 percent.

Sideoats grama, cane and silver bluestem, plains bristlegrass, plains lovegrass, and vine-mesquite are preferred by livestock and are grazed out under continued heavy use. They are replaced by woody shrubs, threeawns, curlymesquite, slim tridens, and tobosa. If deterioration continues, a large proportion of the plant cover is woody shrubs, such as mesquite, whitebrush, paloverde, condalia, pricklypear, and tasajillo. Gray coldenia, ragweed, red grama, Hall panicum, and hairy tridens also invade the site.

This soil has fair potential for wildlife habitat. Deer, turkey, javelina, quail, and several songbirds feed in these areas and have adequate cover for protection. Several kinds of bird also nest in these areas.

This soil is moderately well suited to most urban uses. Excess lime, shrinking and swelling, low strength under roads and streets, corrosivity to uncoated steel, and seepage are the main limitations. This soil is moderately well suited to most

recreational uses. Slope is a limitation in places, and the high content of carbonates causes the surface to be dusty when dry.

This soil is in capability subclasses IVe, nonirrigated, and IIe, irrigated. It is in Clay Loam range site.

De—Dev soils, frequently flooded. This unit consists of deep, nearly level to gently sloping soils on bottom lands along high-velocity streams that drain limestone hills. Areas are flooded 2 to 3 times every 1 to 2 years for a few hours to a few days. Some areas are smooth; others are channeled by many shallow drainageways. Slope ranges from 0 to 3 percent but averages about 1 percent. About 50 percent of the surface is covered by limestone gravel. Mapped areas are long, narrow bands that are parallel to and about 2 to 15 feet above the stream channel. Areas range from 20 to 500 acres in size.

This unit consists of 90 percent Dev soils and 10 percent other soils. The surface layer of the Dev soils is very gravelly loam or very gravelly clay loam. Individual areas range from 75 to 95 percent Dev soils and from 5 to 25 percent other soils. The composition of this unit is more variable than that of other map units in this county, but mapping has been controlled well enough for the anticipated use of the soils.

A typical Dev soil has a surface layer of dark brown very gravelly clay loam about 25 inches thick. The next 35 inches is pale brown very gravelly clay loam that contains about 65 percent by volume limestone gravel. These soils are moderately alkaline and calcareous throughout. The fine earth fraction ranges from loam to clay loam. Some of the soils do not have gravel in the upper 10 inches.

These soils are well drained. Surface runoff is slow to medium. Permeability is moderately rapid, and available water capacity is low because of the gravel. This soil receives extra water as run on from adjacent soils. The rooting zone is deep. The water erosion hazard is slight to moderate.

Included with these soils in mapping are small areas of Acuna, Coahuila, Ector, Hodgins, Langtry, Olmos, Rio Diablo, Sanderson, and Valverde soils and Riverwash. Included soils make up less than 25 percent of any mapped area.

These Dev soils are used mainly for wildlife habitat and range. A few areas of Dev soils with little gravel in the surface layer are used for improved pasture.

These soils are generally not suited to crops or improved pasture. Flooding, high gravel content, low available water capacity, and moderately rapid permeability are the main limitations.

Kleingrass, blue panicum, and King Ranch bluestem are the main dryland pasture grasses.

The potential plant community is mid and short grasses with a variety of woody plants and forbs. Sideoats grama, cane bluestem, and vine-mesquite make up 35 percent of the plant cover. Plains bristlegrass, Arizona cottontop, green sprangletop, plains lovegrass, Texas wintergrass, white tridens, buffalograss, and curlymesquite make up 45 percent; and perennial threeawn and tobosa make up 10 percent. Forbs, such as hairy tubetonge, ruellia, and bushsunflower, make up 5 percent; and woody plants, such as hackberry, vine ephedra, guayacan, mesquite, elbowbush, tarbush, cedar, littleleaf sumac, and cacti, make up 5 percent.

Sideoats grama, cane bluestem. vine-mesquite, plains lovegrass, and green sprangletop are preferred by livestock and are grazed out under continuous heavy use. They are replaced mainly by woody plants, buffalograss, and threeawn. If overgrazing continues. mixed brush forms a dense canopy and red grama, burrograss, ear muhly, and annual forbs invade.

These soils have fair potential for wildlife habitat. The areas are used extensively by most kinds of wildlife in Val Verde County. such as deer, turkey, javelina. quail, and songbirds. Food and cover are abundant.

These soils are severely limited for most urban and recreational uses by frequent flooding, corrosivity to uncoated steel, seepage, and gravel.

These soils are in capability subclass VIw and Draw (East) range site.

ERF—Ector-Rock outcrop association, hilly. This association consists of very shallow and shallow soils and Rock outcrop on ridges and side slopes on uplands (fig. 10). Slope ranges from 1 to 20 percent and averages about 5 percent. Mapped areas are irregular in shape and range from 20 acres to several thousand acres in size.

This association consists of about 70 percent Ector soils, 20 percent Rock outcrop, and 10 percent other soils. The fine earth fraction of the Ector soils is loam to clay loam, and coarse fragments range from gravel to stones. Individual mapped areas range from 60 to 80 percent Ector soils. from 10 to 30 percent Rock outcrop, and 5 to 20 percent other soils. The compositor of this association is more variable than of most map units in this county, but mapping has been controlled well enough for the anticipated use.

A typical Ector soil has a surface layer of moderately alkaline, grayish brown stony loam about 8 inches thick. The next 7 inches is fractured and indurated limestone with thin coatings of calcium carbonate in cracks and crevices. Coarsely fractured limestone bedrock is at a depth of 15 inches. About 47 percent of the surface is covered with limestone gravel and cobbles, and about 3 percent is covered with stones.

These soils are well drained. Surface runoff is rapid. Permeability is moderate, and available water capacity is very low. The rooting zone is very shallow and shallow. The water erosion hazard is moderate to severe.

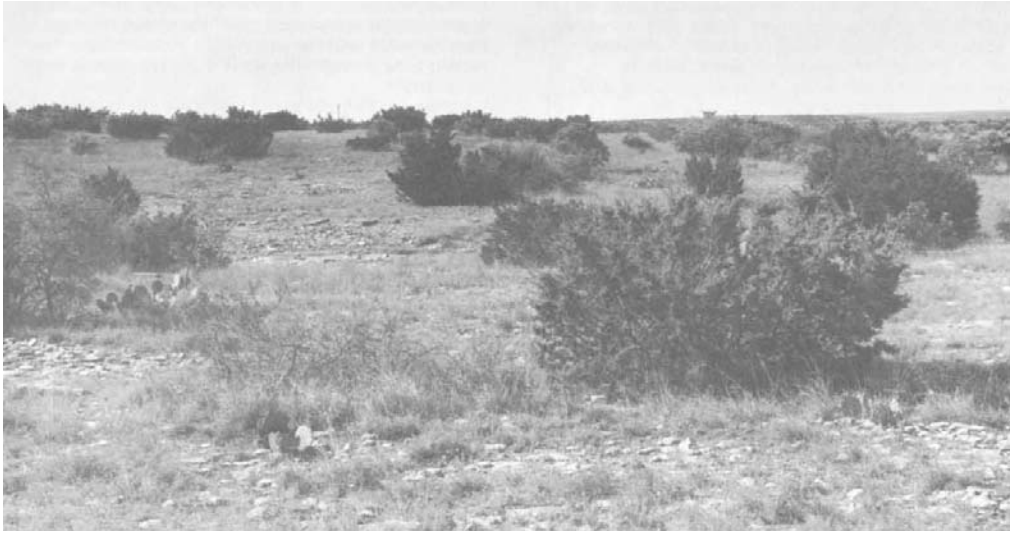
Rock outcrop consists of exposed limestone bedrock and areas with less than 2 inches of soil material over limestone.

Included in mapping are small areas of Acuna, Amistad, Dev, Olmos, Rio Diablo, and Valverde soils.

Included soils make up less than 20 percent of any mapped area.

This association is used mainly for wildlife habitat and range.

The soils are not suited to crops or to improved pasture. Slope, very shallow and shallow rooting depth, and large stones are the main limitations.



F***igure 10—Scattered cedar on Ector stony loam in an area of Ector-Rock outcrop association, hilly: Low Stony Hills range site.***

The potential plant community on the Ector soils consists of a wide variety of grasses, low shrubs, and forbs. Sideoats grama, cane and little bluestem, and green sprangletop make up 35 percent of the plant cover. Plains bristlegrass, black grama, hairy grama, slim tridens, fall witchgrass, perennial threeawn, Texas wintergrass, Texas cupgrass, plains lovegrass, curly mesquite, and buffalograss make up 45 percent. Forbs, such as bushsunflower, Engelmann-daisy, menodora, Mexican sagewort, and velvet bundleflower, make up 10 percent; and woody plants, such as feather dalea, agrito, vine ephedra, Texas false-mesquite, hackberry, elbowbush, lechuguilla, catclaw acacia, juniper, sacahuista, shin oak, live oak, and cacti, make up 10 percent.

Sideoats grama, green sprangletop, and cane and little bluestem are preferred by livestock and are grazed out under continuous use. They are replaced by fall witchgrass, perennial threeawn, and hairy grama and woody plants. If heavy grazing continues, woody plants, especially juniper, continue to increase along with such plants as coyotillo, mescal bean, and leatherstem. Hall panicum, hairy tridens, red grama, perennial threeawn, and annuals become the main grasses.

Low rainfall, very low available water capacity, and very shallow and shallow rooting depth limit the amount of range forage produced.

This unit has fair potential for wildlife habitat. Deer and javelina use the areas mainly for cover and browse.

The Ector soils are poorly suited to most urban and recreational uses. Corrosivity to uncoated steel, slope, depth to rock, stones, and gravel are the main limitations.

This association is in capability subclass VIIs. The Ector soils are in Low Stony Hills (West) range site; Rock outcrop is not placed in a range site.

ERG—Ector-Rock outcrop association, very steep. This association consists of very shallow and shallow soils and Rock outcrop. Slope ranges from 20 to 60 percent but averages about 35 percent. Many small channels carry water for short periods after heavy rains. Mapped areas are irregular in shape and range from 20 acres to several thousand acres is size.

This association is about 55 percent Ector soils, 35 percent Rock outcrop, and 10 percent other soils. The fine earth fraction of the Ector soils is loam to clay loam, and coarse fragments range from gravel to stones. Individual areas range from 45 to 70 percent Ector soils, from 30 to 50 percent Rock outcrop, and from 5 to 20 percent other soils. The soils and Rock outcrop are in nearly parallel bands on sides of uplands. The composition of this association is more variable than that of most map units in the county, but mapping has been controlled well enough for the anticipated use.

A typical Ector soil has a surface layer of moderately alkaline, dark grayish brown stony loam about 12 inches thick. The next 3 inches is fractured and indurated limestone with thin coatings of calcium carbonate in cracks and crevices. Coarsely fractured limestone bedrock is at a depth of 15 inches. About 50 percent of the surface is covered with limestone gravel and cobbles, and about 10 percent is covered with stones.

These soils are well drained. Surface runoff is rapid. Permeability is moderate, and available water capacity is very low. The rooting zone is very shallow and shallow. The water erosion hazard is severe.

Rock outcrop consists of exposed limestone bedrock and areas with less than 2 inches of soil material over limestone.

Included in mapping are small areas of Acuna, Dev, Langtry, Olmos, Rio Diablo, and Zorra soils. Included soils make up less than 20 percent of any mapped area.

This association is used mainly for wildlife habitat and range.

The Ector soils are not suited to crops or improved pasture. Slope, very shallow and shallow rooting depth, and susceptibility to water erosion are the main limitations.

The potential plant community on the Ector soils is dominated by mid grasses and by woody plants and perennial forbs. Sideoats grama and nealley grama make up 35 percent of the plant cover. Little and cane bluestem, green sprangletop, and tanglehead make up 20 percent; plains bristlegrass, bush muhly, threeflower melic, plains lovegrass, and Texas cupgrass make up 15 percent; and slim tridens, perennial treeawn, fall witchgrass, hairy grama, and curlymesquite make up 10 percent. Forbs, such as Engelmann-daisy, menodora, bushsunflower, and copperleaf, make up 5 percent. Woody plants, such as juniper, sotol, cacti, Texas kidneywood, bush myrtlecroton, Gregg ash, Texas false-mesquite, dalea, agrito, ocotillo, Texas persimmon, and lechuguilla, make up 15 percent.

Sideoats grama, green sprangletop, and little and cane bluestem are preferred by livestock and are grazed out first. They are replaced by woody plants and such grasses as hairy grama, fall witchgrass, and threeawns. If overgrazing continues, the site becomes dominated by mixed brush, such as juniper, condalia, Texas persimmon, coyotillo, ocotillo, cacti, sotol, lechuguilla, and mescal bean with a sparse understory of red grama, Hall panicum, hairy tridens, and perennial threeawn.

Very low available water capacity, very shallow and shallow rooting depth, and a high content of coarse fragments of limestone limit the amount of range forage produced. The steep slopes restrict the grazing to sheep and goats.

This soil has fair potential for wildlife habitat. The main wildlife are eagles and puma. Eagles find many places on cliffs to nest and raise their young. Puma use the numerous caves and shelters for cover and refuge.

This association is not suited to most urban and recreational uses. Slope, large stones, and depth to rock are the main limitations.

This association is in capability subclass VIIs. The Ector soils are in Steep Rocky range site; Rock outcrop is not placed in a range site.

FzG—Felipe and Zorra soils, very rocky, 8 to 40 percent slopes. These very shallow and shallow, rolling to steep soils are on uplands. Slope of the Felipe soils is 10 to 40 percent but averages about 25 percent. Slope of the Zorra soils is 5 to 15 percent but averages about 10 percent. Mapped areas are irregular in shape and range from 20 to 800 acres in size.

This unit is about 55 percent Felipe soils, 30 percent Zorra soils, and 15 percent other soils and Rock outcrop. Individual areas range from 40 to 85 percent Felipe soils, from 0 to 60 percent Zorra soils, from 0 to 15 percent Rock outcrop, and from 0 to 20 percent other soils. The hilly to steep Felipe soils are on side slopes, and the rolling Zorra soils are on ridges. The Felipe soils are in all mapped areas. The Zorra soils and Rock outcrop are in most but not all of the mapped areas. Areas of the Felipe and Zorra soils are so closely associated that separation is not practical at the scale of mapping; the areas are not uniform, and they do not occur in a regular pattern.

A typical Felipe soil has a surface layer of moderately alkaline, light olive brown very gravelly clay about 5 inches thick. The subsoil is moderately alkaline, light olive brown clay 13 inches thick. The underlying layer is olive yellow shaly silty clay to a depth of 72 inches. About 70 percent of the surface is covered by gravel and a few scattered cobbles of limestone, some fossilized shells, and ironstone.

The Felipe soils are well drained. Surface runoff is rapid. Permeability is very slow, and available water capacity is low. The rooting zone is shallow. The water erosion hazard is severe. Geologic erosion is very rapid when the plant cover is removed, and fairly large gullies have formed in some areas.

A typical Zorra soil has a surface layer about 8 inches thick of moderately alkaline, dark grayish brown stony loam that contains about 10 percent limestone stones. The next layer is strongly cemented caliche in the upper 1 inch and weakly

cemented caliche in the lower 4 inches. Indurated limestone bedrock is at a depth of 13 inches.

The Zorra soils are well drained. Surface runoff is medium to rapid. Permeability is moderate, and available water capacity is very low. The rooting zone is very shallow and shallow. The water erosion hazard is moderate to severe.

Included with these soils in mapping are small areas of Coahuila, Langtry, Olmos, Shumla, Valverde, Vinegarroon, and Zapata soils and Rock outcrop. Included soils and Rock outcrop make up about 15 percent of mapped areas.

This unit is used mainly for wildlife habitat and range.

The Felipe and Zorra soils are not suited to crops or improved pasture. Slope, very shallow and shallow rooting depth, large stones, and susceptibility to water erosion are the main limitations.

The potential plant community on the Felipe soils is mid and short grasses with scattered woody plants. Sideoats grama, pink pappusgrass, and pinhole and cane bluestem make up 35 percent of the plant cover. Rio Grande and plains lovegrass make up 5 percent; perennial threeawn, slim tridens, and curlymesquite make up 40 percent; and red grama, hairy tridens, and Hall panicum make up 5 percent. Forbs, such as menodora, bushsunflower, and orange zexmenia, make up 5 percent. Woody plants, such as Texas false-mesquite, blackbrush, mesquite, desert yaupon, yucca, sotol, cacti, Texas kidneywood, cenizo, lechuguilla, agrito, Texas persimmon, and sacahuista, make up 10 percent.

Sideoats grama, plains lovegrass, cane and pinhole bluestem, pink pappusgrass, and bushsunflower are preferred by livestock and are grazed out first. They are replaced by woody plants and such grasses as slim tridens, perennial threeawn, fall witchgrass, and Hall panicum. If overgrazing continues, brush invades and such plants as blackbrush, cenizo, condalia, acacia, and cacti dominate the site, along with a very sparse cover of red grama, hairy tridens, Hall panicum, and gray coldenia. Several years of overgrazing creates a serious erosion problem.

Low rainfall, low available water capacity, and shallow rooting depth limit the amount of range forage produced.

The potential plant community on the Zorra soils is grasses, low shrubs, and forbs. Sideoats grama, cane bluestem, and sprangletop make up 35 percent of the plant cover. Plains bristlegrass, black grama, hairy grama, slim tridens, fall witchgrass, perennial threeawn, Texas wintergrass, Texas cupgrass, plains lovegrass, curlymesquite, and buffalograss make up 45 percent. Forbs, such as bushsunflower, Engelmann-daisy, menodora, Mexican sagewort, and velvet bundleflower, make up 10 percent; and woody plants, such as feather dalea, skeletonleaf goldeneye, agrito, vine ephedra, Texas false-mesquite, hackberry, elbowbush, catclaw acacia, guajillo, cenizo, blackbrush acacia, and cacti, make up 10 percent.

Sideoats grama, plains lovegrass, green sprangletop, plains bristlegrass, and cane bluestem are preferred by livestock and are grazed out first under heavy continuous grazing. They are replaced by fall witchgrass, perennial threeawn, and hairy grama and some woody plants. If heavy grazing continues, woody plants, such as blackbrush and cenizo, continue to increase, along with coyotillo, mescal bean, and leatherstem. Hall panicum, hairy tridens, red grama, perennial threeawn, and annuals become the main grasses.

Low rainfall, very low available water capacity, and very shallow and shallow rooting depth limit the amount of forage produced.

The Felipe soils have poor potential for wildlife habitat because of lack of cover. The Zorra soils have fair to poor potential for wildlife habitat. Deer use areas of the Zorra soils for browse and cover, and some rabbits. badger, and songbirds also use the areas.

These soils are poorly suited to most urban and recreational uses. Slope, depth to rock, the large stones, thin surface layer, corrosivity to uncoated steel, and shrinking and swelling are the main limitations.

The Felipe soils are in capability subclass VIIe and Adobe range site. The Zorra soils are in capability subclass VIIs and Low Stony Hills (West) range site.

HdB—Hodgins silt loam, 0 to 3 percent slopes. This deep, nearly level and gently sloping soil is on old stream terraces, valley fills, and low uplands (fig. 11). Slope averages about 1 percent. Mapped areas are irregular to long and narrow in shape and range from 20 to 500 acres in size.

Typically, the surface layer is pale brown silt loam about 8 inches thick. The upper 12 inches of the subsoil is light yellowish brown silty clay loam. the next 25 inches is light yellowish brown silty clay loam that contains a few soft masses of calcium carbonate, and the lower 17 inches is pink clay loam. This soil is moderately alkaline and calcareous throughout.

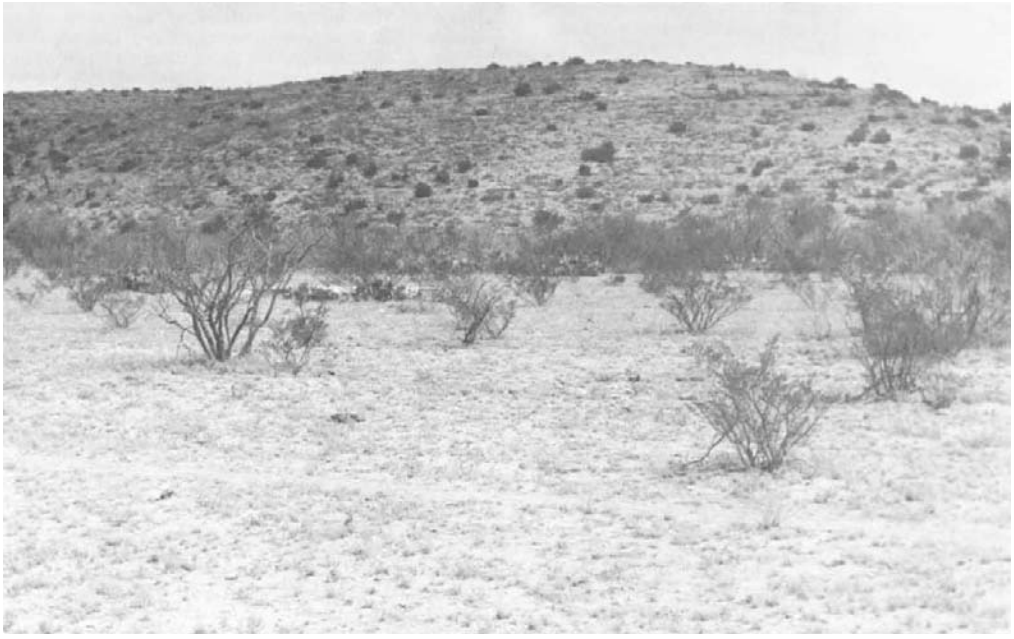
This soil is well drained. Surface runoff is slow. Permeability is moderate, and available water capacity is high. The rooting zone is deep. The water erosion hazard is moderate.

Included with this soil in mapping are small areas of Dev, Langtry, Lazier, Sanderson, Shumla, and Valverde soils. Included soils make up less than 15 percent of any mapped area.

This Hodgins soil is used mainly for wildlife habitat and range.

The soil is moderately well suited to irrigated crops: however, because most areas are remote and are small and narrow, irrigating them is not presently practical. This soil is unsuited to most dryland crops because of low rainfall.

This soil is moderately well suited to irrigated pasture, but it is not suited to dryland pasture because of low rainfall. Kleingrass and blue panicum are the main pasture grasses.



F***igure 11.—Desert-shrub vegetation is characteristic of Hodgins silt loam, 0 to 3 percent slopes. Loamy range site (foreground). Background is Langtry-Rock outcrop association, rolling; Low Stony Hills range site.***

The potential plant community is short and mid grasses with some forbs and scattered woody shrubs. Sideoats grama makes up 15 percent of the plant cover. Buffalograss, bush muhly, vine-mesquite, cane bluestem, fall witchgrass, sand dropseed, Arizona cottontop, plains bristlegrass, and tobosa make up 65 percent; and slim tridens, threeawn, and burrograss make up 10 percent. Forbs, such as croton, desert holly, and eveningprimrose, make up 5 percent; and woody plants, such as dalea, fourwing saltbush, desert yaupon, vine ephedra, tarbush, sticky selloa, catclaw acacia, mesquite, and cacti, make up 5 percent.

Sideoats grama, bush muhly, vine-mesquite, cane bluestem, plains bristlegrass, and buffalograss are preferred by livestock and are grazed out under continued heavy use. They are replaced by woody plants, such as tarbush, mesquite, sticky selloa, and creosotebush; grasses, such as treeawn, tobosa, and burrograss; and forbs, such as gray coldenia and perennial broomweed. If overgrazing continues, the site becomes dominated by tarbush, creosotebush, and mesquite with an understory of short grasses, such as burrograss, fluffgrass, Hall panicum, and ear muhly, and perennial broomweed, gray coldenia, and annual forbs.

This soil has fair potential for wildlife habitat. Mule deer and javelina browse in these areas.

This soil is moderately well suited to most urban uses. Low strength under roads and streets, corrosivity to uncoated steel, seepage, and shrinking and swelling are the main limitations. This soil is moderately suited to most recreational uses. The dusty surface and in some places slope are limitations.

This soil is in capability subclasses VIe, nonirrigated, and IIe, irrigated. It is in Loamy (Desert Grassland) range site.

Ho—Hodgins silty clay loam, frequently flooded. This deep, nearly level soil is on valley fills that are subject to flooding. The areas are flooded 2 to 3 times every 1 to 2 years. Flooding lasts from less than an hour to a few days. Slope ranges from 0 to 1 percent but averages about 0.3 percent. Mapped areas are long and narrow in shape and range from 20 to 200 acres in size.

Typically, the soil has a surface layer of pale brown silty clay loam about 7 inches thick. The upper 13 inches of the subsoil is pale brown silty clay, and the lower 40 inches is light brown silty clay that has a few soft masses of calcium carbonate and a few pebbles. This soil is moderately alkaline and calcareous throughout.

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

Included with this soil in mapping are small areas of Dev, Langtry, Sanderson, and Shumla soils. Also included are areas of a soil that is similar to Dev soils but that has a light colored surface layer. Included soils make up less than 20 percent of any mapped area.

This Hodgins soil is used mainly for wildlife habitat and range.

The soil is not suited to crops or irrigated improved pasture. Flooding is the main limitation.

This soil is moderately well suited to dryland pasture. Kleingrass and blue panicum are the main grasses. In some years low rainfall or intense flooding limits forage production; however, in some years additional water flowing from adjacent areas during low intensity rains increases production.

The potential plant community is mid and short grasses with a variety of woody plants and forbs. Sideoats grama, cane bluestem, and vine-mesquite make up 35 percent of the plant cover. Plains bristlegrass, Arizona cottontop, green sprangletop, plains lovegrass, Texas wintergrass, white tridens, buffalograss, and curly mesquite make up 45 percent; and perennial threeawn and tobosa make up 10 percent. Forbs, such as hairy tubetongue, ruellia, and bushsunflower make up 5 percent. Woody

plants, such as hackberry, vine ephedra, guayacan, mesquite, elbowbush, tarbush, juniper, littleleaf sumac, and cacti, make up 5 percent.

Sideoats grama, cane bluestem, vine-mesquite, plains lovegrass, and green sprangletop are preferred by livestock and are grazed out first under continuous heavy use. These plants are replaced by woody plants, buffalograss, and threeawn. If overgrazing continues, mixed brush forms a dense canopy and red grama, burrograss, ear muhly, and several annual forbs invade.

This soil has fair potential for wildlife habitat. Most kinds of wildlife in the western part of Val Verde County use these areas at times. Mule deer, turkey, javelina, and scaled quail fine adequate cover. Wildlife feed on perennial croton, bushsunflower, and orange zexmenia and on shrubs, such as hackberry, littleleaf sumac, vine ephedra, and fourwing saltbush.

This soil is severely limited for most urban and recreational uses by the flooding. Low strength also limits use for local roads and streets.

This soil is in capability subclass Vlw and Draw (Desert Grassland) range site.

JmD—Jimenez-Quemado complex, 1 to 8 percent slopes. This map unit consists of very shallow and shallow, gently undulating to undulating soils on uplands on old terraces along the Rio Grande. Slope averages about 3 percent. About 55 percent of the surface is covered by waterworn gravel of quartzite, chert, limestone, sandstone, and igneous rocks. Mapped areas are irregular in shape and range from 20 to 500 acres in size.

This complex is about 50 percent Jimenez soil, 40 percent Quemado soil, and 10 percent other soils. Individual areas range from 40 to 60 percent Jimenez soil, from 30 to 60 percent Quemado soil, and from 0 to 20 percent other soils. Generally, the Jimenez soil is on the sides of hills and the Quemado soil is on the caps and summits of hills. Areas of the Jimenez and Quemado soils are so intricately mixed that separation is not practical at the scale of mapping.

Typically, the Jimenez soil has a surface layer of moderately alkaline, dark grayish brown very gravelly loam about 10 inches thick. The next 7 inches is indurated caliche that contains about 50 percent by volume imbedded waterworn gravel. The underlying material is weakly cemented caliche to a depth of 60 inches.

Typically, the Quemado soil has a surface layer of mildly alkaline, dark brown very gravelly loam about 5 inches thick. The subsoil, 8 inches thick, is mildly alkaline, reddish brown very gravelly loam that is more clayey than the surface layer. The next 5 inches is indurated caliche that contains about 10 percent by volume embedded gravel. The underlying material is weakly cemented caliche to a depth of 60 inches.

The Jimenez soil is excessively drained, and the Quemado soil is well drained. Surface runoff is medium. Permeability is moderate in the upper part and slow in the indurated caliche. Available water capacity is very low. The rooting zone is very shallow and shallow. The water erosion hazard is moderate.

Included with these soils in mapping are small areas of Acuna, Coahuila, Dev, Langtry, Lozier, Mariscal, Olmos, Shumla, and Zorra soils. Included soils make up 10 percent of mapped areas.

This complex is used mainly for wildlife habitat and range. The soils are not suited to crops or improved pasture. Very shallow and shallow rooting depth, small stones, and very low available water capacity are the main limitations.

The potential plant community is 50 percent tanglehead, Arizona cottontop, sideoats grama, pinhole bluestem, and green sprangletop and 20 percent plains bristlegrass, threeawn, hooded windmillgrass, slim tridens, and fall witchgrass. Forbs, such as bushsunflower, orange zexmenia, and menodora, make up 5 percent; and woody shrubs, such as guajillo, southwestern bernardia, false-mesquite, ratany, guayacan, kidneywood, and blackbrush acacia make up 25 percent.

Tanglehead, sideoats grama, and green sprangletop are preferred by livestock and are grazed out first under continued heavy use. They are replaced by woody plants and such grasses as threeawn, slim tridens, hooded windmillgrass, and fall witchgrass. If the site deteriorates further, a very dense canopy of mixed brush, including cenizo, blackbrush acacia, and guajillo forms with a sparse understory of threeawn, red grama, Hall panicum, and hairy tridens.

These soils have fair potential for wildlife habitat. Deer, turkey, and doves use the areas. Shrubs such as guajillo and acacia provide cover.

These soils are poorly suited to most urban and recreational uses. Depth to the cemented pan, small stones, slope, and thin surface layer are the main limitations.

These soils are in capability subclass VIIs and Gravelly Ridge range site.

KTC—Kavett-Tarrant association, gently undulating. This association consists of very shallow and shallow soils on limestone plateaus on uplands. Slope ranges from 0 to 5 percent but averages about 1 percent. Mapped areas are irregular in shape and range from 50 to 5,000 acres in size.

This association is about 55 percent Kavett soils, 40 percent Tarrant soils, and 5 percent other soils. Individual areas range form 40 to 75 percent Kavett soils, from 25 to 50 percent Tarrant soils, and from 5 to 15 percent other soils. The Kavett soils are on nearly level caps and summits, and Tarrant soils are on gently undulating side slopes. The composition of this association is more variable than that of most map units in the county, but mapping has been controlled well enough for the anticipated use of the soils.

A typical Kavett soil has a surface layer of moderately alkaline stony clay about 13 inches thick; the upper part is dark grayish brown and the lower part is brown. The next 1 inch is pinkish white, strongly cemented caliche. The next 9 inches is moderately alkaline, light brown very gravelly clay. Fractured indurated limestone bedrock is at a depth of 23 inches. About 5 percent of the surface is covered by limestone stones.

A typical Tarrant soil has a surface layer about 10 inches thick of moderately alkaline, dark grayish brown very stony silty clay with thin coatings of calcium carbonate on the coarse fragments. The underlying layer is fractured indurated limestone bedrock with thin coatings of calcium carbonate on the upper surface. About 10 percent of the surface is covered by stones.

These Kavett and Tarrant soils are well drained. Surface runoff is slow to rapid. Permeability is moderately slow, and available water capacity is very low. The rooting zone is very shallow and shallow in the Tarrant soils and shallow in the Kavett soils. The water erosion hazard is slight to moderate.

Included with these soils in mapping are small areas of Ector and Rio Diablo soils. Included soils make up about 10 percent of any mapped area.

This association is used mainly for wildlife habitat and range.

The soils are not suited to crops or improved pasture. Very shallow and shallow rooting depth, stones, and very low available water capacity are the main limitations.

The potential plant community on the Kavett soil consists of mid and short grasses with scattered woody plants. Sideoats grama, cane bluestem, and green sprangletop make up 35 percent of the plant cover. Arizona cottontop, plains bristlegrass, Texas wintergrass, plains lovegrass, and reverchon panicum make up 25 percent; buffalograss and curlymesquite make up 20 percent; and perennial threeawn, slim tridens, and fall witchgrass make up 10 percent. Forbs, such as bundleflower, sensitivebriar, and Engelmann-daisy, make up 5 percent. Woody plants, such as vine ephedra, shin oak, agrito, littleleaf and skunkbush sumac, live oak, and cacti make up 5 percent.

Sideoats grama, green sprangletop, cane bluestem, and plains lovegrass are preferred by livestock and are grazed out under heavy continuous use. They are

replaced by brush, such as mesquite, and by buffalograss, threeawn, and slim tridens. If heavy grazing continues, woody plants, such as mesquite, juniper, condalia, agrito, sumac, pricklypear, and tasajillo, dominate an understory of such plants as threeawn, red grama, hairy tridens, western ragweed, broom snakeweed, and croton.

The potential plant community on the Tarrant soils consists of a wide variety of grasses, low shrubs, and forbs. Sideoats grama, cane and little bluestem, and green sprangletop make up 35 percent of the plant cover. Plains bristlegrass, black grama, hairy grama, slim tridens, fall witchgrass, perennial threeawn, Texas wintergrass, Texas cupgrass, plains lovegrass, curlymesquite, and buffalograss make up 45 percent. Forbs, such as bushsunflower, Engelmann-daisy, menodora, Mexican sagewort, and velvet bundleflower, make up 10 percent; and woody plants, such as feather dalea, agrito, vine ephedra, hackberry, elbowbush, catclaw acacia, juniper, sacahuista, shin oak, live oak, and cacti make up 10 percent.

Sideoats grama, green sprangletop, and cane and little bluestem are preferred by livestock and are grazed out first under heavy continuous use. They are replaced by such grasses as fall witchgrass, perennial threeawn, and hairy grama and by woody plants. If heavy grazing continues, woody plants increase, along with such plants as mescal bean and leatherstem and such grasses as Hall panicum, hairy tridens, red grama, perennial threeawn, and annuals.

On both Kavett and Tarrant soils, low rainfall, very low available water capacity, and very shallow and shallow rooting depth limit the amount of range forage produced.

These soils have fair potential for wildlife habitat. Deer, turkey, javelina, and quail feed on grass seed and acorns and find adequate cover in live oak motts.

These soils are poorly suited to most urban and recreational uses. Depth to rock, the stones, the cemented pan, shrinking and swelling, thin surface layer, and corrosivity to uncoated steel are the main limitations.

The Kavett soils are in capability subclass VIs and Shallow (North) range site. The Tarrant soils are in capability subclass VI Is and Low Stony Hills (East) range site.

LaB—Lagloria loam, 0 to 3 percent slopes. This deep, nearly level to gently sloping soil is on low terraces of the Rio Grande. Slope averages about 0.3 percent. Mapped areas are narrow and oblong in shape and range from 5 to 200 acres in size.

Typically, the surface layer is brown loam about 13 inches thick. The subsoil is light yellowish brown loam 43 inches thick. The underlying layer to a depth of 72 inches is brown loam with evident bedding planes. This soil is moderately alkaline and calcareous throughout.

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

Included with this soil in mapping are small areas of Laredo, Laredo Variant, and Reynosa soils. Included soils make up less than 10 percent of any mapped area.

This Lagloria soil is used mainly for irrigated improved pasture, wildlife habitat, and range.

This soil is moderately well suited to irrigated crops. Medium available water capacity and susceptibility to erosion limit yields. This soil is poorly suited to most dryland crops because of low rainfall. Peaches and certain citrus fruits grow well on this soil. Most vegetables are well suited to this soil. If mulch is added, the tilth and workability of the soil improve.

This soil is well suited to irrigated pasture and moderately well suited to dryland pasture. Forage sorghums, kleingrass, blue panicum, Callie bermudagrass, Coastal bermudagrass, NK-37 bermudagrass, Common bermudagrass, wheat, and oats are

the main irrigated pasture grasses. Kleingrass and forage sorghums are the main dryland pasture grasses. Low rainfall limits dryland forage production.

The potential plant community is a mixture of trees, shrubs, grasses, and forbs. Trichloris, big sacaton, southwestern and plains bristlegrass, little bluestem, Canada wildrye, white tridens, switchgrass, and vine-mesquite make up 50 percent of the plant cover. Sideoats grama, pink pappusgrass, Texas wintergrass, and buffalograss make up 30 percent. Forbs, such as ruellia, Engelmann-daisy, and bundleflower, make up 5 percent; and woody plants, such as live oak, pecan, hackberry, mesquite, and huisache, make up 15 percent.

Under continued heavy use, the tall and mid grasses are grazed out and woody plants and underbrush increase. Buffalograss, curlymesquite, and bermudagrass also increase. If the site deteriorates further, woody plants, such as mesquite and huisache, become dominant, along with an understory of such grasses as threeawn, red grama, and Hall panicum.

This soil has fair potential for wildlife habitat. Shrubs and trees, such as lotebush, spiny hackberry, pecan, and sycamore, provide food and cover for squirrel, deer, and turkey and a nesting place for birds. Furbearers are frequently found in these areas.

This soil is moderately well suited to most urban uses. Corrosivity to uncoated steel is a limitation. Low strength moderately affects local roads and streets. This soil is also moderately well suited to most recreational uses. The main limitations are slope and the erosion hazard in some places.

This soil is in capability subclass IIIe, nonirrigated, and IIe, irrigated. It is in Loamy Bottomland range site.

LnD—Langtry cobbly silt loam, very rocky, 1 to 8 percent slopes. This very shallow and shallow, gently sloping to sloping soil is on ridges on uplands. Slope averages about 4 percent. About 65 percent of the surface is covered by limestone gravel and cobbles, and about 6 percent is Rock outcrop. Mapped areas are irregularly shaped and range from 10 to 1,000 acres in size.

Typically, the surface layer is moderately alkaline, dark grayish brown cobbly silt loam about 8 inches thick. The next 6 inches is fractured limestone that has thin coatings of calcium carbonate. The underlying material indurated limestone bedrock.

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

Included with this soil in mapping are small areas of Acuna, Dev, Lozier, Olmos, Shumla, Sanderson, and Valverde soils and Riverwash. Included soils make up less than 15 percent of any mapped area. The Rock outcrop consists of exposed limestone bedrock and areas with less than 2 inches of soil material over limestone.

This Langtry soil is used mainly for wildlife habitat and range.

This soil is not suited to crops or improved pasture. Very low available water capacity, Rock outcrop, very shallow and shallow rooting depth, slope, and large stones are the main limitations.

The potential plant community consists of a wide variety of grasses, low shrubs, and forbs. Sideoats grama, cane bluestem, and green sprangletop make up 35 percent of the plant cover. Plains bristlegrass, black grama, hairy grama, slim tridens, fall witchgrass, perennial threeawn, Texas wintergrass, Texas cupgrass, plains lovegrass, curlymesquite, and buffalograss make up 45 percent. Forbs, such as bushsunflower, Engelmann-daisy, menodora, Mexican sagewort, and velvet bundleflower, make up 10 percent; and woody plants, such as feather dalea, skeletonleaf goldeneye, agrito, vine ephedra, Texas false-mesquite, hackberry, elbowbush, lechuguilla, catclaw acacia, guajillo, cenizo, blackbrush acacia, and cacti, make up 10 percent.

Sideoats grama, green sprangletop, and cane bluestem are preferred by livestock and are grazed out under heavy continuous use. They are replaced by such grasses as fall witchgrass, perennial threeawn, and hairy grama and by woody plants. If heavy grazing continues, woody plants increase further along with coyotillo, mescal bean, and leatherstem and such grasses as Hall panicum, hairy tridens, red grama, perennial threeawn, and annuals.

Low rainfall, very low available water capacity, and very shallow and shallow rooting depth limit the amount of range forage produced.

This soil has fair potential for wildlife habitat. Deer use the areas for cover and browse.

This soil is poorly suited to most urban and recreational uses. Corrosivity to uncoated steel, depth to rock, Rock outcrop, and large stones are the main limitations.

This soil is in capability subclass VIIs and Low Stony Hills (West) range site.

LnE—Langtry cobbly silt loam, very rocky, 8 to 15 percent slopes. This very shallow and shallow, strongly sloping to moderately steep soil is on sides of ridges of uplands. Slope averages about 10 percent. About 75 percent of the surface is covered by limestone gravel and cobbles, and about 8 percent is Rock outcrop. Areas are irregularly shaped and range from 10 to 2,000 acres in size.

Typically, the surface layer is moderately alkaline, brown cobbly silt loam about 8 inches thick. The next 6 inches is fractured limestone with thin coatings of calcium carbonate. The underlying material is indurated limestone bedrock.

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

Included with this soil in mapping are small areas of Dev, Lozier, Olmos, Shumla, Acuna, Valverde, and Sanderson soils and Riverwash. Included soils make up less than 15 percent of any mapped area. Rock outcrop consists of exposed limestone bedrock and areas with less than 2 inches of soil material over limestone.

This Langtry soil is used mainly for wildlife habitat and range.

This soil is not suited to crops or improved pasture. Slope, Rock outcrop, very low available water capacity, very shallow and shallow rooting depth, and large stones are the main limitations.

The potential plant community consists of grasses, low shrubs, and forbs. Sideoats grama, cane bluestem, and green sprangletop make up 35 percent of the plant cover. Plains bristlegrass, black grama, hairy grama, slim tridens, fall witchgrass, perennial threeawn, Texas wintergrass, Texas cupgrass, plains lovegrass, curlymesquite, and buffalograss make up 45 percent. Forbs, such as bushsunflower, Engelmann-daisy, menodora, Mexican sagewort, and velvet bundleflower, make up 10 percent; and woody plants, such as feather dalea, skeletonleaf goldeneye, agrito, vine ephedra, Texas false-mesquite, hackberry, elbowbush, lechuguilla, catclaw acacia, guajillo, cenizo, blackbrush acacia, and cacti, make up 10 percent.

Sideoats grama, green sprangletop, and cane bluestem are preferred by livestock and are grazed out under heavy continuous use. They are replaced by such grasses as fall witchgrass, perennial threeawn, and hairy grama and by woody plants. If heavy grazing continues, woody plants increase further, along with coyotillo, mescal bean, and leatherstem and such grasses as Hall panicum, hairy tridens, red grama, perennial threeawn, and annuals.

Low rainfall, very low available water capacity, and very shallow and shallow rooting depth limit the amount of range forage produced.

This soil has fair potential for wildlife habitat. Deer use the areas for cover and browse.

This soil is poorly suited to most urban and recreational uses. Rock outcrop, slope, corrosivity to uncoated steel, depth to rock, and large stones are the main limitations.

This soil is in capability subclass VIIs and Low Stony Hills (West) range site.

LRE—Langtry-Rock outcrop association, rolling. This association consists of very shallow and shallow, gently undulating to rolling soils and Rock outcrop on ridges and side slopes on uplands. Slope ranges from 1 to 15 percent and averages about 6 percent. Areas are irregular in shape and range from 20 acres to several thousand acres in size.

This association is 75 percent Langtry soils, 10 percent Rock outcrop, and 15 percent other soils. Individual areas range from 65 to 90 percent Langtry soils, from 10 to 20 percent Rock outcrop, and from 5 to 20 percent other soils. The composition of this association is more variable than that of most map units in this county, but mapping has been controlled well enough for the anticipated use.

A typical Langtry soil has a surface layer of moderately alkaline, dark grayish brown very cobbly loam about 8 inches thick. The next 5 inches is indurated, fractured limestone with thin coatings of calcium carbonate on the surfaces and in cracks and crevices. Coarsely fractured limestone bedrock is at a depth of 13 inches. About 65 percent of the surface is covered by limestone gravel and cobbles, and about 3 percent is covered by stones.

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

Rock outcrop consists of exposed limestone bedrock and areas with less than 2 inches of soil material over limestone.

Included in mapping are small areas of Acuna, Amistad, Dev, Hodgins, Olmos, Sanderson, Valverde, and Zapata soils. Included soils make up less than 20 percent of any mapped area.

This association is used mainly for wildlife habitat and range.

The Langtry soils are not suited to crops or improved pasture. Slope, very shallow and shallow rooting depth, and large stones are the main limitations.

The potential plant community on the Langtry soil consists of a wide variety of grasses, low shrubs, and forbs. Sideoats grama, cane bluestem, and green sprangletop make up 35 percent of the plant cover.

Plains bristlegrass, black grama, hairy grama, slim tridens, fall witchgrass, perennial threeawn, Texas wintergrass, Texas cupgrass, plains lovegrass, curlymesquite, and buffalograss make up 45 percent. Forbs, such as bushsunflower, Englemann-daisy, menodora, Mexican sagewort, and velvet bundleflower, make up 10 percent; and woody plants, such as feather dalea, skeletonleaf goldeneye, agrito, vine ephedra, Texas false-mesquite, hackberry, elbowbush, lechuguilla, catclaw acacia, guajillo, cenizo, blackbrush acacia, and cacti, make up 10 percent.

Sideoats grama, green sprangletop, and cane bluestem are preferred by livestock and are grazed out under heavy continuous use. They are replaced by such grasses as fall witchgrass, perennial threeawn, and hairy grama and by woody plants. If heavy grazing continues, the woody plants increase further, along with coyotillo, mescal bean, and leatherstem and such grasses as Hall panicum, hairy tridens, red grama, perennial threeawn, and annuals.

Low rainfall, Rock outcrop, very low available water capacity, and very shallow and shallow rooting depth limit the amount of forage produced.

This association has fair potential for wildlife habitat. Upland wildlife, such as deer and javelina, use the areas mainly for cover and browse. Other mammals, such as jackrabbit, skunk, and mice, also use the areas.

This association is poorly suited to most urban and recreational uses. Corrosivity to uncoated steel, Rock outcrop, slope, depth to rock, and large stones are the main limitations.

This association is in capability subclass VIIs. The Langtry soils are in Low Stony Hills (West) range site; Rock outcrop is not placed in a range site.

LRG—Langtry-Rock outcrop association, very steep. This association consists of very shallow and shallow, hilly to very steep soils and exposures of limestone bedrock. Slope ranges from 15 to 60 percent but averages about 30 percent. Areas are irregular in shape and range from 20 acres to several thousand acres in size.

This association is about 55 percent Rock outcrop, 40 percent Langtry soils, and 5 percent other soils. Areas range from 45 to 70 percent Rock outcrop, from 30 to 45 percent Langtry soils, and from 0 to 15 percent other soils. The soils and Rock outcrop are in parallel bands on sides of ridges and uplands (fig. 12). The composition of this association is more variable than that of most map units in this county, but mapping has been controlled well enough for the anticipated use.

A typical Langtry soil has a surface layer of moderately alkaline, dark grayish brown cobbly clay loam about 12 inches thick. The next 3 inches is fractured limestone with seams and coatings of calcium carbonate in cracks and crevices. Coarsely fractured limestone bedrock is at a depth of 15 inches. About 51 percent of the surface is covered by limestone gravel and cobbles, and about 9 percent is covered by stones.

Figure 12.—Area of Langtry-Rock outcrop association, very steep; Steep Rocky range site. In the bottom of the draw is Riverwash.

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

Rock outcrop consists of exposed limestone bedrock and areas with less than 2 inches of soil material over limestone.

Included in mapping are small areas of Acuna, Dev, Lozier, Olmos, Shumla, Sanderson, and Valverde soils and Riverwash. Included soils make up as much as 15 percent of any mapped area.

This association is used mainly for wildlife habitat and range.

The Langtry soils are not suited to crops or improved pasture. Rock outcrop, slope, very shallow and shallow rooting depth, and large stones are the main limitations.

The potential plant community on the Langtry soils is dominated by mid grasses with a wide variety of woody plants and perennial forbs. Sideoats and neally grama make up 35 percent of the plant cover. Cane bluestem, green sprangletop, and tangelhead make up 20 percent; plains bristlegrass, bush muhly, threeflower melic, plains lovegrass, and Texas cupgrass make up 15 percent; and slim tridens, perennial threeawn, fall witchgrass, hairy grama, and curlymesquite make up 10 percent. Forbs, such as Englemann-daisy, menodora, bushsunflower, and copperleaf, make up 5 percent; and woody plants, such as shin oak, live oak, blackbrush, gaujillo, sotol, cacti, Texas kindeywood, bush myrtlecroton, Gregg ash, Texas false-mesquite, dalea, agrito, mescal bean, ocotillo, Texas persimmon, lechuguilla, and cenizo make up 15 percent.

Sideoats grama, green sprangletop, and cane bluestem are preferred by livestock and are grazed out first. They are replaced by woody plants and such grasses as hairy grama, fall witchgrass, and threeawn. If overgrazing continues, the site is dominated by mixed brush, such as condalia, Texas persimmon, leatherstem, blackbrush, lechuguilla, coyotillo, ocotillo, cacti, sotol, and mescal bean with a sparse understory of red grama, Hall panicum, hairy tridens, and perennial threeawn.

Low rainfall, very low available water capacity, very shallow and shallow rooting depth, susceptibility to erosion, and Rock outcrop limit the amount of forage produced. The steepness restricts grazing to sheep and goats.

An endangered plant species, the Texas pistache, grows mainly on these soils. It is confined mostly to limestone cliffs and rocky bottoms of canyons along the lower Pecos River and the Rio Grande in Val Verde County.

This association has fair potential for wildlife habitat. Steepness restricts use mostly to birds.

This association is not suited to most urban uses. Slope, Rock outcrop, depth to rock, large stones, and corrosivity to uncoated steel are the main limitations. This unit is poorly suited to recreational uses because of the slope, depth to rock, and large and small stones.

This association is in capability subclass VIIs. The Langtry soils are in Steep Rocky range site; Rock outcrop is not placed in a range site.

Ls—Laredo silty clay loam. This deep, nearly level soil is on old stream terraces. Slope ranges from 0 to 1 percent but averages about 0.5 percent. Mapped areas are irregular to oblong in shape and range from 10 to 200 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 13 inches thick. The upper 19 inches of the subsoil is brown silty clay loam, and the lower 10 inches is pale brown silty clay loam. The next 18 inches is pale brown silty clay loam that is about 10 percent by volume calcium carbonate. This soil is moderately alkaline and calcareous throughout.

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

Included with this soil in mapping are small areas of Lagloria, Laredo Variant, Pintas, and Reynosa soils. Included soils make up less than 10 percent of any mapped area.

This Laredo soil is used mainly for pasture.

This soil is well suited to irrigated crops but is poorly suited to dryland crops because of low rainfall. Grapes, peaches, and certain citrus fruits grow well on this soil.

This soil is well suited to pasture. Forage sorghums, wheat, oats, Callie bermudagrass, Coastal bermudagrass, and kleingrass are the main irrigated pasture grasses. Kleingrass, Common bermudagrass, and forage sorghums are the main dryland pasture grasses.

The potential plant community is a mixture of trees, shrubs, grasses, and forbs. The composition of the plant community depends on the frequency and amount of overflow and the position on the landscape. Trichloris, big sacaton, southwestern and plains bristlegrass, little bluestem, Canada wildrye, white tridens, switchgrass, and vine-mesquite make up 50 percent of the plant cover. Sideoats grama, pink pappusgrass, Texas wintergrass, and buffalograss make up 30 percent. Forbs, such as ruellia, Engelmann-daisy, and bundleflower, make up 5 percent; and live oak, pecan, hackberry, mesquite, and huisache make up 15 percent.

Under continued heavy use, the tall and mid grasses are grazed out and woody plants and underbrush increase. Short grasses, such as buffalograss, curlymesquite, and bermudagrass, also increase. If the site deteriorates further, mesquite and huisache become dominant, along with an understory of threeawn, red grama, and Hall panicum.

This soil has fair potential for wildlife habitat. Wildlife, especially turkey, dove, quail, and other birds, find very good cover and several types of plants that provide food. Squirrel live in the pecan and hackberry trees.

This soil is moderately well suited to most urban uses. Shrinking and swelling, corrosivity to uncoated steel, and low strength under roads and streets are the main limitations. This soil is well suited to most recreational uses.

This soil is in capability subclass IIc, nonirrigated, and class I, irrigated. It is in Loamy Bottomland range site.

Lv—Laredo Variant silty clay loam. This deep, nearly level soil is on old stream terraces. Slope ranges from 0 to 1 percent but averages about 0.2 percent. Mapped areas are irregular to oblong in shape and range from 10 to 200 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 12 inches thick. The upper 16 inches of the subsoil is brown clay, and the lower 20 inches is pale brown clay with a few grayish mottles and concretions of calcium carbonate. The underlying layer to a depth of 60 inches is very pale brown clay with common brownish mottles and concretions of calcium carbonate. This soil is moderately alkaline and calcareous throughout.

This soil is moderately well drained. Surface runoff is slow. Permeability is moderate, and available water capacity is high. The rooting zone is deep, but movement of air and roots is impeded by a seasonal fluctuating water table at a depth of 5 to 6 feet. The water erosion hazard is slight. Most areas are nonsaline; however, a few spots are sightly saline.

Included with this soil in mapping are small areas of Lagloria, Laredo, Pintas, and Reynosa soils. Included soils make up less than 10 percent of any mapped area.

This Laredo Variant soil is used mainly for pasture.

This soil is well suited to pasture and to irrigated crops, but it is poorly suited to dryland crops because of low rainfall.

This soil is well suited to pasture. Forage sorghums, wheat, oats, Callie bermudagrass, Coastal bermudagrass, and kleingrass are the main irrigated pasture grasses. Kleingrass, Common bermudagrass, and forage sorghums are the main dryland pasture grasses.

The potential plant community is a mixture of trees, shrubs, grasses, and forbs. The composition of the plant community varies depending on frequency and amount of overflow and position on the landscape. Trichloris, big sacaton, southwestern and plains bristlegrass, little bluestem, Canada wildrye, white tridens, switchgrass, and vine-mesquite make up 50 percent of the plant cover. Sideoats grama, pink pappusgrass, Texas wintergrass, and buffalograss make up 30 percent. Forbs, such as ruellia, Engelmann-daisy, and bundleflower make up 5 percent; and woody plants, such as live oak, pecan, hackberry, mesquite, and huisache, make up 15 percent.

Under continued heavy use, tall and mid grasses are grazed out and woody plants and underbrush increase. Short grasses, such as buffalograss, curlymesquite, and bermudagrass, also increase. If the site deteriorates further, woody plants, such as mesquite and huisache, become dominant, along with an understory of such grasses as threeawn, red grama, and Hall panicum.

This soil has fair potential for wildlife habitat. Wildlife, especially turkey, dove, quail, and other birds, find very good cover and many kinds of plants for food. Squirrel live in pecan and hackberry trees.

This soil is moderately suited to most urban uses. Low strength under roads and streets, shrinking and swelling, corrosivity to uncoated steel, and seasonal wetness are the main limitations. This soil is well suited to most recreational uses.

This soil is in capability subclass IIc, nonirrigated, and class I, irrigated. It is in Loamy Bottomland range site.

LZD—Lozier-Shumla association, undulating. This association consists of very shallow and shallow soils on ridges and low uplands. The landscape has the appearance of a broad, undulating stair-step plain. Slope ranges from 1 to 8 percent and averages about 4 percent. Mapped areas are irregularly shaped and range from 25 to 1,000 acres in size.

This association is about 50 percent Lozier soils, 40 percent Shumla soils, and 10 percent other soils. Individual areas range from 40 to 65 percent Lozier soils, 30 to 55 percent Shumla soils, and from 5 to 20 percent other soils. The Lozier soils are on horizontal bands where limestone crops out, and slope is mainly 3 to 8 percent. The Shumla soils are in less sloping areas between bands of Lozier soils; slope is mainly 1 to 3 percent. The composition of this association is more variable than that of most map units in the county, but mapping has been controlled well enough for the anticipated use of the soils.

A typical Lozier soil has a surface layer of moderately alkaline, light brownish gray very gravelly loam about 8 inches thick. The next 6 inches is fractured platy limestone with coatings of calcium carbonate in cracks and crevices. Fractured limestone bedrock is at a depth of 14 inches. In most places, about 50 percent of the surface is covered by limestone gravel.

A typical Shumla soil has a surface layer about 3 inches thick of moderately alkaline, pale brown loam that has a few limestone and caliche fragments. The subsoil extends to a depth of 12 inches and is moderately alkaline, light brownish gray loam that has common fragments of limestone and caliche. The underlying layer is indurated caliche in the upper few inches, cemented caliche fragments to a depth of about 33 inches, and limestone bedrock below. As much as 15 percent of the surface is covered by caliche and limestone gravel.

These Lozier and Shumla soils are well drained. Surface runoff is medium. Permeability is moderate, and available water capacity is very low. The rooting zone is very shallow and shallow. The water erosion hazard is moderate.

Included with these soils in mapping are small areas of Acuna, Amistad, Dev, Felipe, Hodgins, Langtry, Mariscal, Sanderson, and Valverde soils. Included soils make up less than 20 percent of any mapped area.

This association is used mainly for wildlife habitat and range.

The soils are not suited to crops or improved pasture. Very shallow and shallow rooting depth and very low available water capacity are the main limitations.

The potential plant community is an open grassland with scattered woody plants and perennial forbs. Bush muhly and chino grama make up 35 percent of the plant cover. Sideoats grama makes up 5 percent; Arizona cottontop, fall witchgrass, slim tridens, perennial threeawn, plains bristlegrass, and pinhole bluestem make up 40 percent; and fluffgrass, Hall panicum, red grama, and hairy tridens make up 5 percent. Forbs, such as perennial croton, gray coldenia, plains zinnia, and Texas desertrue make up 5 percent. Woody plants, such as creosotebush, tarbush, condalia, catclaw mimosa, guayacan, yucca, dalea, fourwing saltbush, skeletonleaf goldeneye, and cacti, make up 10 percent.

Bush muhly, chino grama, sideoats grama, and fall witchgrass are preferred by livestock and are grazed out first under heavy continuous use. They are replaced by brush and such grasses as threeawn, fluffgrass, and red grama. If heavy grazing continues, a dense canopy of creosotebush dominates the site, along with a sparse understory cover of gray coldenia, fluffgrass, red grama, and hairy tridens.

These soils have poor potential for wildlife habitat because of lack of cover. Some rabbits, badger, and songbirds use the areas.

These soils are poorly suited most urban uses. Depth to rock, the cemented pan, small stones, thin surface layer, and corrosivity to uncoated steel are the main limitations. These soils are also poorly suited to recreational uses. The small stones, cemented pan, and depth to rock are the main limitations.

These soils are in capability subclass VIIs. The Lozier soils are in Shallow Ridge (Desert Grassland) range site, and the Shumla soils are in Shallow (Desert Grassland) range site.

MaD—Mariscal very channery silt loam, 1 to 8 percent slopes. This very shallow and shallow, gently sloping to sloping soil is on ridges and low uplands. Slope averages about 3 percent. About 60 percent of the surface is covered with thin fragments of limestone. Mapped areas are irregular in shape and range from 20 to 800 acres is size.

Typically, the surface layer is moderately alkaline, very pale brown very channery silt loam about 7 inches thick. The next 2 inches is fractured platy limestone with coatings of calcium carbonate on fragments and in cracks and crevices. Flaggy limestone bedrock is at a depth of 9 inches.

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

Included with this soil in mapping are small areas of Hodgins, Langtry, Sanderson, and Shumla soils and Riverwash. Included soils make up less than 20 percent of any mapped area.

This Mariscal soil is used mainly for wildlife habitat and range.

The soil is not suited to crops or improved pasture. Very low available water capacity and depth to rock are the main limitations.

The potential plant community is short and mid grasses and some low-growing woody shrubs and forbs. Chino grama makes up 35 percent of the plant cover. Sideoats grama, green sprangletop, tanglehead, and Arizona cottontop make up 20

percent; and bush muhly, slim tridens, perennial threeawn, fall witchgrass, and hairy tridens make up 30 percent. Forbs, such as Texas desertrue, rough menodora, range ratany, and gray coldenia, make up 5 percent; and woody plants, such as vine ephedra, skeletonleaf goldeneye, guajillo, cenizo, lechuguilla, yucca, agrito, guayacan, creosotebush, and catclaw acacia, make up 10 percent.

Chino grama, sideoats grama, tanglehead, green sprangletop, and Arizona cottontop are preferred by livestock and are grazed out first under heavy use. They are replaced by fall witchgrass, threeawn, slim and hairy tridens, and woody plants. If heavy grazing continues, woody plants, such as creosotebush, lechuguilla, cenizo, catclaw acacia, and yucca, continue to increase. The ground between the brush becomes mostly bare, with only a sparse cover of such plants as hairy tridens, red grama, threeawn, and gray coldenia.

Low rainfall, very low available water capacity, and very shallow and shallow rooting depth limit the amount of forage produced.

This soil has poor potential for wildlife habitat because of lack of cover. Some rabbits, badger, and songbirds use the areas.

This soil is poorly suited to most urban and recreational uses. Depth to rock, large stones, and corrosivity to uncoated steel are the main limitations.

This soil is in capability subclass VIIs and Flagstone Hill range site.

MLG—Mariscal-Lozier association, very steep. This association consists of very shallow and shallow, rolling to very steep soils on sides of limestone hills. Slope ranges from 8 to 60 percent and averages about 25 percent. Mapped areas are irregularly shaped and range from 50 to 5,000 acres in size.

This association is about 60 percent Mariscal soils, 30 percent Lozier soils, and 10 percent other soils and Rock outcrop. Individual areas range from 45 to 75 percent Mariscal soils, from 20 to 50 percent Lozier soils, from 0 to 20 percent Rock outcrop, and from 0 to 15 percent other soils. The Lozier soils generally are on the upper parts of hillsides, and the Mariscal soils are on the lower parts. The composition of this association is more variable than that of most map units in the county, but mapping has been controlled well enough for the anticipated use.

A typical Mariscal soil has a surface layer of moderately alkaline, pale brown very flaggy loam about 7 inches thick. The next 3 inches is fractured flaggy limestone with coatings of calcium carbonate on the surfaces and in cracks and crevices. At a depth of 10 inches is flaggy limestone bedrock that is stratified with marl. About 70 percent of the surface is covered by channers and flagstones of limestone.

A typical Lozier soil has a surface layer of moderately alkaline, light yellowish brown very cobbly loam about 6 inches thick. The next 7 inches is fractured limestone with coatings of calcium carbonate on the surface and in cracks and crevices. Indurated limestone is at a depth of 13 inches. About 55 percent of the surface is covered by gravel and cobbles of limestone.

These Mariscal and Lozier soils are well drained. Surface runoff is rapid to very rapid. Permeability is moderate, and available water capacity is very low. The rooting zone is very shallow and shallow. The water erosion hazard is severe, especially in heavily grazed areas where the grass cover is sparse.

Included with these soils in mapping are small areas of Amistad, Langtry, Sanderson, and Shumla soils. Included soils make up less than 15 percent of any mapped area. Rock outcrop consists of exposed limestone bedrock and areas with less than 2 inches of soil material over limestone. Rock outcrop makes up less than 20 percent of any mapped area.

This association is used mainly for wildlife habitat and range.

The soils are not suited to crops or improved pasture. Slope, very shallow and shallow rooting depth, and small stones are the main limitations.

The potential plant community is mostly short grasses and a few mid grasses and some low-growing woody shrubs and forbs. Chino grama makes up 45 percent of the plant cover. Sideoats grama, green sprangletop, Arizona cottontop, plains bristlegrass, and tanglehead make up 20 percent; and bush muhly, hairy grama, threeawn, slim tridens, fall witchgrass, Hall panicum, red grama, and hairy tridens make up 15 percent. Forbs, such as perennial croton, dyssodia, range ratany, Texas desertrue, and gray coldenia, make up 5 percent. Woody shrubs, such as skeletonleaf goldeneye, mesquite, lechuguilla, vine ephedra, ocotillo, cacti, yucca, catclaw acacia, guajillo, dalea, cenizo, mariola, and creosotebush, make up 15 percent.

Sideoats grama, chino grama, green sprangletop, Arizona cottontop, plains bristlegrass, and tanglehead are preferred by livestock and are grazed out under continuous heavy use. They are replaced by lechuguilla and other woody shrubs and by such grasses as hairy tridens, threeawn, burrograss, slim tridens, red grama, and Hall panicum. If heavy grazing continues, creosotebush, lechuguilla, cenizo, and other low-growing woody shrubs increase and invade the site, leaving considerable bare ground and a sparse cover of hairy tridens, red grama, Hall panicum, and gray coldenia.

These soils have poor potential for wildlife habitat. Mule deer use the areas at times for browse. Some badger, rabbits, and songbirds also use the areas.

These soils are poorly suited to most urban and recreational uses. Depth to rock, the large stones, thin surface layer, slope, and corrosivity to uncoated steel are the main limitations.

These soils are in capability subclass VIIs and Flagstone Hill range site.

OmD—Olmos very gravelly loam, 1 to 8 percent slopes. This very shallow and shallow, gently sloping to sloping soil is on old outwash deposits on uplands. Slope ranges from 1 to 8 percent but averages about 3 percent. About 45 percent of the surface is covered by limestone gravel. Mapped areas are irregularly shaped and range from 15 to 1,000 acres in size.

Typically, the surface layer is moderately alkaline, brown very gravelly loam about 18 inches thick. The next 6 inches is indurated caliche. The underlying material to a depth of 60 inches is weakly cemented caliche with embedded gravel.

This soil is well drained. Surface runoff is medium.

Permeability is moderate in the upper part and slow in the indurated caliche. Available water capacity is very low. The rooting zone is very shallow to shallow. The water erosion hazard is moderate.

Included with this soil in mapping are small areas of Acuna, Coahuila, Dev, Ector, Jimenez, Quemado, Valverde, Vinegarroon, Zapata, and Zorra soils. Also included are areas of soils that are similar to this Olmos soil but that have limestone bedrock below a depth of 3 feet. Included soils make up less than 15 percent of any mapped area.

This Olmos soil is used mainly for wildlife habitat and range.

This soil is not suited to crops or improved pasture. Very low available water capacity, low rainfall, and very shallow and shallow rooting depth are the main limitations.

The potential plant community is grasses with scattered woody plants and perennial forbs. Sideoats grama, cane bluestem, silver bluestem, pinhole bluestem, plains bristlegrass, green sprangletop, tanglehead, Arizona cottontop, and plains lovegrass make up 60 percent of the plant cover. Reverchon panicum, perennial threeawn, slim tridens, lovegrass tridens, buffalograss, and curlymesquite make up 25 percent. Forbs, such as menodora, bushsunflower, and orange zexmenia, make up 5 percent; and woody plants, such as guajillo, Texas kidneywood, range ratany, guayacan, ephedra, dalea, desert yaupon, and cenizo, make up 10 percent.

Sideoats grama, cane bluestem, green sprangletop, and tanglehead are preferred by livestock and are grazed out first under continued heavy use. These plants are replaced by woody plants and perennial threeawn, along with lesser amounts of slim tridens, fall witchgrass, buffalograss, and curlymesquite. If heavy grazing continues, woody shrubs continue to invade and cenizo and blackbrush generally become dominant, along with an understory of short grasses, such as threeawn, red grama, and hairy grama, and annual forbs.

Low rainfall, very low available water capacity, and very shallow and shallow rooting depth limit the amount of forage produced.

This soil has fair potential for wildlife habitat. Deer, javelina, turkey, and quail use the areas for feeding.

This soil is poorly suited to most urban and recreational uses. The cemented pan, small stones, thin surface layer, and corrosivity to uncoated steel are the main limitations.

This soil is in capability subclass VIIs and Shallow Ridge (South) range site.

Pn—Pintas clay, frequently flooded. This deep, nearly level soil is on flood plains of small perennial streams on bottom lands. It is flooded 2 to 3 times every 1 to 2 years for a few hours to a few days. Slope ranges from 0 to 1 percent and averages about 0.2 percent. Mapped areas are mostly short, narrow bands 10 to 100 acres in size along streams. The water table is 1 to 6 feet below the surface.

Typically, the surface layer is dark gray clay about 11 inches thick. The subsoil is gray clay about 12 inches thick. The next 19 inches is gray clay with about 20 percent by volume calcium carbonate masses and concretions. The underlying material is light gray mottled clay to a depth of 60 inches. Some areas have strata of water-bearing gravel below a depth of 60 inches. This soil is moderately alkaline throughout.

This soil is somewhat poorly drained. Surface runoff is medium to slow. Permeability is moderate, and available water capacity is high. The rooting zone is deep. The water erosion hazard is slight.

Included with this soil in mapping are small areas of Acuna, Coahuila, Dev, Laredo, Laredo Variant, and Valverde soils. A few areas are slightly saline. Included soils make up less than 10 percent of any mapped area.

This Pintas soil is used mainly for wildlife habitat or range. A few areas that have a low water table are used for improved pasture. The water table, which is within reach of most plants, is beneficial to trees and grasses. This soil supports a wide variety of plants and produces more vegetation than any other soil in the county.

This soil is generally not suited to crops or irrigated pasture. Flooding and poor drainage are the main limitations.

The areas having a low water table are well suited to improved pasture. Forage sorghums and kleingrass are the main dryland pasture grasses.

The potential plant community is a mixture of trees, shrubs, grasses, and forbs. The composition of the plant community varies depending on the frequency and amount of overflow. Trichloris, big sacaton, southwestern and plains bristlegrass, little bluestem, Canada wildrye, white tridens, switchgrass, and vine-mesquite make up 50 percent of the plant cover. Sideoats grama, pink pappusgrass, Texas wintergrass, and buffalograss make up 30 percent. Forbs, such as ruellia, Englemann-daisy, and bundleflower, make up 5 percent; and woody plants, such as live oak, pecan, hackberry, mesquite, and huisache, make up 15 percent.

Little bluestem, plains and southwestern bristlegrass, Canada wildrye, switchgrass, and vine-mesquite are grazed out under heavy continuous use. They are replaced by such grasses as Lindheimer muhly, bushy bluestem, buffalograss, curlymesquite, and bermudagrass and by woody plants. If heavy grazing continues,

woody plants increase along with underbrush, such as baccharis and whitebrush, and such grasses as threeawn, red grama, and Hall panicum.

This soil has fair potential for wildlife habitat. Wildlife are attracted by the good cover, fresh running water that is always close by, and many plants that provide seed and browse. These are some of the best areas for furbearers.

This soil is severely limited for most urban and recreational uses. Flooding, corrosivity to uncoated steel, shrinking and swelling, wetness, and low strength under roads and streets are the main limitations. This soil is well suited to aquifer-fed ponds where the substratum is free gravel.

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

Pt—Pits. Pits are areas excavated in mining for caliche, gravel, and limestone. The pits are a few feet to about 25 feet deep. They range from less than 1 acre to about 20 acres in size. One borrow area below Amistad Dam covers about 140 acres. These areas are locally known as caliche pits, gravel pits, limestone quarries, or borrow areas.

Ra—Reynosa silty clay loam. This deep, nearly level to gently sloping soil is on old stream terraces. Slope ranges from 0 to 2 percent but averages about 0.3 percent. Mapped areas are irregular in shape and range from 15 to 300 acres in size.

Typically, the surface layer is silty clay loam about 16 inches thick; it is grayish brown in the upper part and light brownish gray in the lower part. The upper 8 inches of the subsoil is brown silty clay, the next 16 inches is light yellowish brown silty clay loam that has a few soft masses of calcium carbonate, and the lower 24 inches is light yellowish brown silty clay loam that contains as much as 20 percent by volume soft masses and concretions of calcium carbonate. This soil is moderately alkaline and calcareous throughout.

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

Included with this soil in mapping are small areas of Acuna, Coahuila, Lagloria, Laredo, and Laredo Variant soils. Included soils make up less than 10 percent of any mapped area.

This Reynosa soil is used mainly for irrigated pasture.

This soil is well suited to irrigated crops but is poorly suited to dryland crops because of low rainfall and excess lime. Grapes (fig. 13), peaches, and certain citrus fruits grow well on this soil. Adding organic matter or mulch improves the workability of the soil.

This soil is well suited to irrigated pasture and moderately well suited to dryland pasture. Forage sorghums, wheat, oats, and kleingrass are the main irrigated and dryland pasture grasses.

The potential plant community is a mixture of trees, shrubs, grasses, and forbs. The composition of the plant community varies, depending on frequency and amount of overflow and position on the landscape. Trichloris, big sacaton, southwestern and plains bristlegrass, little bluestem, Canada wildrye, white tridens, switchgrass, and vine-mesquite make up 50 percent of the plant cover. Sideoats grama, pink papusgrass, Texas wintergrass, and buffalograss make up 30 percent. Forbs, such as ruellia, Engelman-daisy, and bundleflower, make up 5 percent; and woody plants, such as live oak, pecan, hackberry, mesquite, and huisache, make up 15 percent.

Under continued heavy use, tall and mid grasses are grazed out and woody plants and underbrush increase. Short grasses, such as buffalograss, curlymesquite, and bermudagrass, also increase. If the site deteriorates further, woody plants, such as mesquite and huisache, become dominant, along with an understory of such grasses as threeawn, red grama, and Hall panicum.

Figure 13.—Vineyard on Reynosa silty clay loam.

This soil has fair potential for wildlife habitat. Squirrels are attracted to pecan and hackberry trees. Turkey, quail, doves, and songbirds are attracted by seed crops. Most furbearers in the county also frequent these areas.

This soil is moderately well suited to most urban uses. Corrosivity to uncoated steel, excess lime, moderate shrinking and swelling, and low strength under roads and streets are the main limitations. This soil is well suited to most recreational uses.

This soil is in capability subclass IIIc, nonirrigated, and class I, irrigated. It is in Loamy Bottomland range site.

Rd—Rio Diablo silty clay. This deep, nearly level to gently sloping soil is on old stream terraces and valley fills on uplands. This soil is subject to rare. abnormal floods less than once in 20 years. Slope ranges from 0 to 2 percent but averages about 0.6 percent. Mapped areas are long and narrow and range from 20 to 1,000 acres in size.

Typically, the surface layer is dark grayish brown silty clay about 17 inches thick. The upper 12 inches of the subsoil is brown clay, the next 17 inches is light brown clay with a few threads and films of calcium carbonate, and the lower 14 inches is light brown clay with a few soft masses and concretions of calcium carbonate. This soil is moderately alkaline and calcareous throughout.

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

Included with this soil in mapping are small areas of Dev and Olmos soils and Riverwash. Included soils make up less than 15 percent of any mapped area.

This Rio Diablo soil is used mainly for wildlife habitat and range. Some areas are used for improved pasture.

This soil is moderately well suited to irrigated crops, but the small size of the areas restricts this use. This soil is not suited to most dryland crops because of low rainfall.

This soil is moderately well suited to pasture. Coastal bermudagrass and forage sorghums are the main irrigated pasture grasses. Kleingrass and King Ranch bluestem are the main dryland pasture grasses (fig. 14).

The potential plant community is grasses with some forbs, an occasional oak or hackberry, and a few mesquite and juniper. Sideoats grama makes up 25 percent of the plant cover. Cane and pinhole bluestem make up 15 percent; Arizona cottontop, vine mesquite, plains lovegrass, and plains bristlegrass make up 20 percent; Texas wintergrass, buffalograss, curlymesquite, fall witchgrass. and slim tridens make up 20 percent; and tobosa and perennial threeawn make up 10 percent. Forbs, such as bundleflower, sensitivebriar, Engelmann-daisy, bushsunflower, and hairy tubetongue, make up 5 percent. Woody plants, such as live oak, hackberry, scattered cacti, condalia, agrito, and juniper, make up 5 percent.

Sideoats grama, cane bluestem, vine-mesquite, plains lovegrass, and plains bristlegrass are preferred by livestock and are grazed out first under heavy continuous use. They are replaced by woody plants and such grasses as buffalograss, curlymesquite, perennial threeawn, tobosa, slim tridens, and fall witchgrass. If overgrazing continues, mesquite, juniper, agrito, cacti, and condalia form a dense canopy with a sparse understory of red grama, threeawn, hairy tridens, Hall panicum, and scattered areas of tobosa.

This soil has fair potential for wildlife habitat. Most kinds of wildlife common to the county use the areas extensively. Deer, turkey, quail, and javelina find adequate cover and food.

This soil is poorly suited to most urban uses. Flooding, moderately slow permeability, corrosivity to uncoated steel, and low strength under roads and streets are the main limitations. This soil is poorly suited to most recreational uses because of flooding and the clayey surface layer.

This soil is in capability subclasses IVe, nonirrigated, and IIe, irrigated. It is in Clay Loam range site.

Figure 14.—Good stand of King Ranch bluestem on Rio Diablo silty clay. Background is Ector-Rock outcrop association, hilly: Low Stony Hills range site.

Rg—Rio Grande silt loam. This deep, nearly level to gently sloping soil is on bottom lands of the Rio Grande. This soil is below Amistad Reservoir and is occasionally flooded when the flood gates are opened. The rest of the time this soil is protected from flooding by the dam. Without protection, this soil would be subject to brief flooding every 4 to 20 years. Slope ranges from 0 to 3 percent but averages about 0.5 percent. Mapped areas are long and parallel the river. They range from 20 to 200 acres in size.

Typically, the surface layer is pale brown silt loam about 9 inches thick. The next 42 inches is light brownish gray loam in the upper part and light brownish gray silt loam in the lower part. Below this is pale brown silt loam to a depth of 64 inches. This soil has bedding planes throughout.

This soil is well drained. Surface runoff is slow. Permeability is moderately rapid, and available water capacity is high. The rooting zone is deep, and the soil is easily penetrated by plant roots. The water erosion hazard is slight to moderate.

Included with this soil in mapping are small areas of soils that are similar to this Rio Grande soil but that have thick sandy strata in the lower part. Also included are areas of Riverwash. Included soils make up less than 10 percent of any mapped area.

This Rio Grande soil is used mainly for wildlife habitat and range.

This soil is well suited to irrigated crops. Flooding and slow runoff reduce yields. This soil is poorly suited to dryland crops; flooding and low rainfall are limitations.

This soil is well suited to irrigated and dryland pasture.

The potential plant community is 40 percent common reed; 25 percent big sacaton; 20 percent white tridens, southwestern bristlegrass, vine-mesquite, and Virginia wildrye; 5 percent forbs, such as spiny aster, ruellia, and annuals; and 10 percent woody plants, such as black willow, baccharis, brickellbush, Apacheplume, black walnut, and mesquite.

Such plants as bristlegrass, vine-mesquite, and Virginia wildrye are preferred by livestock and decrease under heavy continuous grazing. They are replaced by bermudagrass and annuals. If heavy grazing continues or if there is fire, bermudagrass, annual grasses, forbs, and such woody plants as baccharis increase. Some spots become dominated by giant reed.

This soil has fair potential for wildlife habitat. Deer and other foraging wildlife find good cover and a variety of food.

This soil is severely limited for most urban uses. Flooding, seepage, and corrosivity to uncoated steel are the main limitations. This soil is also severely limited for most recreational uses by flooding and the dusty surface.

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

Ro—Rio Grande soils, frequently flooded. These deep, nearly level to gently sloping soils are on bottom lands of the Rio Grande. The soils above Amistad Reservoir are flooded 2 to 3 times every 1 to 2 years for a few hours to a few days. The soils below the dam are flooded every 4 to 20 years when the flood gates are opened; flooding lasts a few hours to a few days. Slope ranges from 0 to 3 percent but averages about 1 percent. Some areas are mounded. Mapped areas are long and parallel the river and are 2 to 20 feet higher than the mean river flow. Areas range from 20 to 500 acres in size.

The surface layer of these soils is silt loam, very fine sandy loam, loam, or loamy very fine sand. The various textures do not occur in a regular pattern. Use and management of the various soils are similar.

A typical Rio Grande soil has a surface layer of light brownish gray very fine sandy loam about 8 inches thick. The upper 8 inches of the underlying layer is light brownish gray very fine sandy loam with few bedding planes, the next 26 inches is pale brown very fine sandy loam to silt loam with common to many bedding planes,

and the lower 22 inches is light brownish gray very fine sandy loam that has many bedding planes and thin strata of different textures. This soil is moderately alkaline and calcareous throughout. Texture of this soil is silt loam, very fine sandy loam, and loamy very fine sand throughout.

These soils are well drained. Surface runoff is slow. Permeability is moderately rapid, and available water capacity is medium to high. The rooting zone is deep. The water erosion hazard is slight to moderate.

Included with these soils in mapping are spots of soils that are similar to Rio Grande soils but have a thin sandy surface layer or sandy strata in the underlying layer. Also included are areas of Dev sols and Riverwash. Included soils make up 0 to 15 percent of any mapped area and average 7 percent of mapped areas.

These Rio Grande soils are used mainly for wildlife habitat and range.

Above Amistad Reservoir, these soils are unsuitable for nonirrigated or irrigated crops or pasture because of the flooding. Below the reservoir these soils are poorly suited to nonirrigated crops because of low rainfall. The soils below the reservoir are moderately well suited to irrigated crops and well suited to nonirrigated and irrigated pasture.

The potential plant community is 40 percent common reed; 25 percent big sacaton; 20 percent white tridens, southwestern bristlegrass, vine-mesquite, and Virginia wildrye; 5 percent forbs, such as spring aster, ruellia, and annuals; and 10 percent woody plants, such as black willow, baccharis, brickellbush, Apacheplume, black walnut, and mesquite.

Such plants as bristlegrass, vine-mesquite, and Virginia wildrye are preferred by livestock and decrease under heavy continuous grazing. They are replaced by bermudagrass and annuals. If heavy grazing continues or if there is fire, bermudagrass, annual grasses, forbs, and such woody plants as baccharis increase. Some spots become dominated by giant reed.

These soils have fair potential for wildlife habitat. Flooding improves the habitat in these areas by bringing in organic material that is a food source for game fish. Deer, quail, turkey, javelina, and other wildlife find a variety of seeds and browse on these soils.

These soils are severely limited for most urban uses. Flooding, seepage, the tendency of cutbanks to cave in, and corrosivity to uncoated steel are the main limitations. This soil is moderately well suited to most recreational uses below Amistad Reservoir, but is only poorly suited above the reservoir. Excessive flooding and the erosion hazard are the main limitations.

These soils are in capability subclass Vw above Amistad Reservoir and capability subclass IIe below the reservoir. They are in Vega range site.

Rv—Riverwash. Riverwash is unstabilized, nearly barren sediment on flood plains of high-velocity streams that drain limestone hills. The map unit is mainly in the northern part of the county. Areas are long and narrow in shape and range from 50 to 500 acres in size.

The sediment is sand, gravel, cobbles, stones, and boulders. Areas of exposed limestone bedrock in the streambed are included.

Areas of Riverwash are washed and reworked by floodwater so often that they support little or no vegetation.

SsC—Sanderson-Shumla complex, 0 to 5 percent slopes. This complex consists of nearly level to gently sloping soils on terraces along secondary drainageways. These soils are very shallow, shallow, and deep. They formed in old outwash sediment. Slope ranges from 0 to 5 percent but averages about 2 percent. Mapped areas are irregular in shape and range from 25 to 800 acres in size.

This complex is about 65 percent Sanderson soil, 25 percent Shumla soil, and 10 percent other soils. Individual areas range from 45 to 90 percent Sanderson soil, from

10 to 40 percent Shumla soil, and from 0 to 20 percent other soils. Areas of the Sanderson and Shumla soils are so intricately mixed that separation is not practical at the scale of mapping.

Typically, the Sanderson soil has a surface layer of pale brown very gravelly loam about 8 inches thick. The subsoil is light brown very gravelly clay loam about 28 inches thick. The underlying layer is pink very gravelly clay loam to a depth of 60 inches. This soil is moderately alkaline and calcareous throughout. About 45 percent of the surface is covered by limestone gravel.

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

Typically, the Shumla soil to a depth of about 14 inches is moderately alkaline, calcareous loam that has common limestone and caliche pebbles; this layer is very pale brown in the upper part and light yellowish brown in the lower part. The next 2 inches is indurated caliche; and the next 8 inches is weakly cemented caliche that contains about 50 percent by volume limestone gravel. Indurated limestone bedrock is at a depth of 24 inches. As much as 15 percent of the surface is covered by caliche and limestone gravel.

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

Included with these soils in mapping are small areas of Coahuila, Dev, Ector, Hodgins, Lozier, Olmos, Valverde, and Zorra soils and Riverwash. Also included are some low areas that receive extra run on water from adjacent soils that causes short floods. Included soils make up less than 20 percent of any mapped area.

This complex is used mainly for wildlife habitat and range.

The soils are not suited to crops or pasture because of gravel, shallow and very shallow rooting depth, and low and very low available water capacity.

The potential plant community on the Sanderson soil is mostly short grasses with occasional woody plants and forbs. Bush muhly, Arizona cottontop, plains bristlegrass, and pinhole bluestem make up 45 percent of the plant cover. Perennial threeawn, burrograss, slim tridens, fluffgrass, red grama, and Hall panicum make up 40 percent. Woody plants, such as tarbush, fourwing saltbush, yucca, dalea, vine ephedra, perennial broomweed, dog cholla, pricklypear, and tasajillo, make up 10 percent; and forbs, such as Texas desertrue, perennial croton, rough menodora, and plains zinnia, make up 5 percent.

Plains bristlegrass, bush muhly, pinhole bluestem, and Arizona cottontop are preferred by livestock and are grazed out first under heavy continuous use. They are replaced by burrograss, fluffgrass, and brushy plants. If heavy grazing continues, creosotebush, tarbush, and a few other brush species take over the site. At this stage exposed crusted bare soil is evident in places.

The potential plant community on the Shumla soil is mostly mid and short grasses. Sideoats grama, plains bristlegrass, reverchon panicum, plains lovegrass, cane and pinhole bluestem, and pink pappusgrass make up 45 percent of the plant cover. Arizona cottontop, slim tridens, threeawn, buffalograss, curlymesquite, and fall witchgrass make up 45 percent. Forbs, such as bushsunflower, bundleflower, orange zexmenia, and halfshrub sundrop, make up 5 percent; and woody shrubs, such as guajillo, skeletonleaf goldeneye, vine ephedra, guayacan, ratany, and cenizo, make up 5 percent.

Sideoats grama, plains bristlegrass, and cane bluestem are preferred by livestock and are grazed out first under continued heavy use. They are replaced by threeawn, slim tridens, fall witchgrass, and woody shrubs. If heavy grazing continues, a large proportion of the plant cover is native woody shrubs and invading creosotebush,

tasajillo, dog cholla, pricklypear, and acacia. The understory at this stage consists of red grama, hairy tridens, threeawns, gray coldenia, and annual weeds.

These soils are fair to poor wildlife habitat because of a lack of food and cover. Deer, javelina, and quail make limited use of the areas.

The Sanderson soil is moderately well suited to most urban uses. Gravel, seepage, low strength under roads and streets, slope, and corrosivity to uncoated steel are the main limitations. This soil is poorly suited to most recreational uses because of the gravel.

The Shumla soil is poorly suited to most urban uses. The cemented pan, depth to rock, thin surface layer, and corrosivity to uncoated steel are the main limitations. This soil is poorly suited to most recreational uses. The cemented pan is the main limitation.

The Sanderson soil is in capability subclass VIs and Gravelly range site. The Shumla soil is in capability subclass VIIs and Shallow (Desert Grassland) range site.

SuC—Shumla loam, 0 to 5 percent slopes. This very shallow and shallow, nearly level to gently sloping soil is on outwash deposits on uplands. Slope ranges from 0 to 5 percent but averages about 2 percent. Mapped areas are irregular in shape and range from 20 to 300 acres in size.

Typically, this soil is loam 11 inches thick; it is pale brown in the upper part and yellowish brown in the lower part. It has common limestone and caliche pebbles. The underlying layer is indurated caliche in the upper few inches, cemented caliche fragments to a depth of about 36 inches, and limestone bedrock below.

This soil is well drained. Surface runoff is medium. Permeability is moderate in the upper part and slow in the indurated caliche. Available water capacity is very low. The rooting zone is very shallow and shallow. The water erosion hazard is moderate.

Included with this soil in mapping are small areas of Langtry, Lozier, Mariscal, Valverde, and Vinegarroon soils. Included soils make up less than 15 percent of any mapped area.

This Shumla soil is used mainly for wildlife habitat and range.

The soil is not suited to crops or improved pasture. Very low available water capacity and very shallow and shallow rooting depth are the main limitations.

The potential plant community is mostly mid and short grasses. Sideoats grama, plains bristlegrass, reverchon panicum, plains lovegrass, bush muhly, cane and pinhole bluestem, and pink pappusgrass make up 45 percent of the plant cover. Arizona cottontop, slim tridens, threeawn, buffalograss, curlymesquite, and fall witchgrass make up 45 percent. Forbs, such as bushsunflower, bundleflower, orange zexmenia, and halfshrub sundrop, make up 5 percent; and woody shrubs, such as guajillo, skeletonleaf goldeneye, vine ephedra, guayacan, ratany, and cenizo, make up 5 percent.

Sideoats grama, plains bristlegrass, and cane bluestem are preferred by livestock and are grazed out under continued heavy use. They are replaced by threeawn, slim tridens, fall witchgrass, and woody shrubs. If heavy grazing continues, a large part of the plant cover will be native woody shrubs and invading plants, such as creosotebush, tarbush, tasajillo, dog cholla, pricklypear, and acacia. At this stage, the understory consists of red grama, hairy tridens, threeawns, gray coldenia, and annual weeds.

This soil has poor potential for wildlife habitat because of lack of food and cover.

This soil is poorly suited to most urban uses. Corrosivity to uncoated steel, depth to rock, the cemented pan, and thin surface layer are the main limitations. This soil is poorly suited to most recreational uses. The cemented pan is the main limitation.

This soil is in capability subclass VIIs and Shallow (Desert Grassland) range site.

TAD—Tarrant association, undulating. This association consists of very shallow and shallow, gently undulating to undulating soils on ridges on uplands.

Slope ranges from 1 to 8 percent but averages about 4 percent. About 21 percent of the surface is covered by gravel and cobbles of limestone, and about 9 percent is covered by stones. Mapped areas are irregular in shape and range from 25 acres to several thousand acres in size.

This association is about 75 percent Tarrant very stony clay and very stony silty clay and 25 percent other soils and Rock outcrop. Use and management of the Tarrant soils are similar. Individual areas range from 70 to 90 percent Tarrant soils and from 10 to 30 percent other soils and Rock outcrop.

A typical Tarrant soil has a surface layer about 14 inches thick of moderately alkaline, very dark gray and very dark grayish brown very stony clay with thin coatings of calcium carbonate on the coarse fragments. Coarsely fractured limestone bedrock is at a depth of 14 inches.

These soils are well drained. Surface runoff is rapid. Permeability is moderately slow, and available water capacity is very low. The rooting zone is very shallow and shallow. The water erosion hazard is moderate.

Included with these soils in mapping are small areas of Dev, Ector, Kavett, and Rio Diablo soils. Included soils make up less than 20 percent of any mapped area. Rock outcrop consists of exposed limestone bedrock and areas with less than 2 inches of soil material over limestone; it makes up less than 10 percent of any mapped area.

These Tarrant soils are used mainly for wildlife habitat and range.

The soils are not suited to crops or pasture. Very shallow and shallow rooting depth and large stones are the main limitations.

The potential plant community consists of a wide variety of grasses, low shrubs, and forbs. Sideoats grama, cane and little bluestem, and green sprangletop make up 35 percent of the plant cover. Plains bristlegrass, black grama, hairy grama, slim tridens, fall witchgrass, perennial threeawn, Texas wintergrass, Texas cupgrass, plains lovegrass, curlymesquite, and buffalograss make up 45 percent. Forbs, such as bushsunflower, Engelmann-daisy, menodora, Mexican sagewort, and velvet bundleflower, make up 10 percent; and woody plants, such as feather dalea, agrito, vine ephedra, hackberry, elbowbush, catclaw acacia, juniper, sacahuista, shin oak, live oak, and cacti, make up 10 percent.

Sideoats grama, green sprangletop, and cane and little bluestem are preferred by livestock and are grazed out under heavy continuous use. They are replaced by fall witchgrass, perennial threeawn, hairy grama, and woody plants. If heavy grazing continues, woody plants native to the site continue to increase, along with such plants as mescal bean and leatherstem. Hall panicum, hairy tridens, red grama, perennial threeawn, and annuals become the main grasses.

Low rainfall, very low available water capacity, and very shallow and shallow rooting depth limit the amount of forage produced.

These soils have fair potential for wildlife habitat. Deer, turkey, javelina, and quail find adequate food and cover.

This unit is poorly suited to most urban uses. Depth to rock, large stones, clayey texture, thin surface layer, and corrosivity to uncoated steel are the main limitations. This unit is poorly suited to most recreational uses. The large stones and depth to rock are the main limitations.

These soils are in capability subclass VIIs and Low Stony Hills (East) range site.

ToA—Tobosa clay, 0 to 1 percent slopes. This deep, nearly level soil is in narrow drainageways and shallow depressions on uplands. Slope ranges from 0 to 1 percent but averages about 0.5 percent. Mapped areas are elongated in shape and range from 10 to 300 acres in size.

In undisturbed areas, the surface has weakly expressed gilgai microrelief consisting of microknolls and microdepressions. The microknolls are 3 to 8 inches

higher than the microdepressions. Distance between the centers of microdepressions and of microknolls ranges from 12 to 24 feet.

In a typical spot in the center of a microdepressions, the surface layer is grayish brown clay about 34 inches thick. The next 17 inches is brown clay that contains a few calcium carbonate concretions. The next 11 inches is pink clay that contains a few soft masses of calcium carbonate. This soil is moderately alkaline and calcareous throughout.

This soil is well drained. A few areas of this soil are a few inches lower than surrounding soils and therefore receive run on water. A few areas are flooded for short periods during seasons of high rainfall. Surface runoff is slow. When dry, this soil has deep, wide cracks. Water enters the soil rapidly when it is cracked. When the soil is wet, the cracks seal and water enters very slowly. Permeability is very slow, and available water capacity is high. The rooting zone is deep, but the high clay content impedes movement of air, water, and roots. The water erosion hazard is slight. Most areas are nonsaline; however, in a few spots the soil is slightly saline below a depth of 3 feet.

Included with this soil in mapping are small areas of Acuna, Coahuila, Olmos, Vinegarroon, Valverde, and Zapata soils. Included soils make up less than 10 percent of any mapped area.

This Tobosa soil is used mainly for wildlife habitat and range.

This soil is poorly suited to irrigated crops. Very slow permeability and high clay content are the main limitations. This soil is not suited to most dryland crops because of droughtiness and low rainfall.

This soil is moderately well suited to pasture. Low rainfall limits forage production.

The potential plant community is mid grasses. Sideoats grama, cane bluestem, vine-mesquite, white tridens, pink pappusgrass, plains bristlegrass, and plains lovegrass make up 55 percent of the plant cover. Buffalograss, curlymesquite, slim tridens, tobosa, Wright threeawn, Texas wintergrass, and fall witchgrass make up 40 percent. Forbs, such as bundleflower, ruellia, and bushsunflower, make up 5 percent. There are a few scattered guayacan, vine ephedra, mesquite, and spiny hackberry.

Sideoats grama, plains bristlegrass, plains lovegrass, and vine-mesquite are preferred by livestock and are grazed out first. They are replaced by curlymesquite, threeawn, tobosa, and woody plants, such as mesquite, whitebrush, spiny hackberry, condalia, and cacti. If the site continues to deteriorate, it becomes dominated by mesquite and woody plants with an understory of red grama, hairy tridens, and Hall panicum.

This soil has fair potential for wildlife habitat. White-tailed deer, turkey, and quail use these areas.

This soil is poorly suited to most urban uses. Very slow permeability, clayey texture, shrinking and swelling, low strength under roads and streets, and corrosivity to uncoated steel are the main limitations. Cutbanks of excavations tend to cave in. This soil is moderately well suited to most recreational uses. Very slow permeability and clayey texture are the main limitations. This soil is well suited to pond reservoir areas where gravel in the substratum is not a problem.

This soil is in capability subclass IIIs, nonirrigated, and IIs, irrigated. It is in Clay Flat range site.

VaB—Valverde silty clay loam, 0 to 3 percent slopes. This deep, nearly level to gently sloping soil is on valley fills on uplands. Slope ranges from 0 to 3 percent but averages about 1 percent. Mapped areas are irregular in shape and range from 10 to 300 acres in size.

Typically, the surface layer is grayish brown silty clay loam about 12 inches thick. The upper 20 inches of the subsoil is light brownish gray silty clay loam that contains a few limestone pebbles and concretions of calcium carbonate, and the lower 16

inches is light gray silty clay loam that contains about 15 percent by volume soft masses and concretions of calcium carbonate. Limestone bedrock is at a depth of 48 inches. This soil is moderately alkaline and calcareous throughout.

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

Included with this soil in mapping are small areas of Acuna, Coahuila, Langtry, Olmos, Shumla, and Vinegarroon soils. Included soils make up less than 15 percent of any mapped area.

This Valverde soil is used mainly for wildlife habitat and range.

This soil is moderately well suited to irrigated crops. Medium available water capacity and excess lime limit yields. This soil is not suited to most dryland crops because of low rainfall.

This soil is moderately well suited to pasture grasses. Low rainfall and high content of lime limit forage production.

The potential plant community is short and mid grasses with some forbs and scattered woody shrubs. Sideoats grama makes up 15 percent of the plant cover. Buffalograss, curlymesquite, vine-mesquite, cane bluestem, fall witchgrass, sand dropseed, Arizona cottontop, plains bristlegrass, and tobosa make up 65 percent; and slim tridens and threeawn make up 10 percent. Forbs, such as velvet bundleflower, bushsunflower, and orange zexmenia, make up 5 percent. Woody plants, such as dalea, fourwing saltbush, cenizo, desert yaupon, blackbrush, vine ephedra, tarbush, sticky selloa, catclaw acacia, mesquite, and cacti, make up 5 percent.

Sideoats grama, vine-mesquite, cane bluestem, plains bristlegrass, and buffalograss are preferred by livestock and are grazed out first under continued heavy use. They are replaced by woody plants, such as cenizo, mesquite, blackbrush, sticky selloa, and catclaw acacia; such grasses as slim tridens, threeawn, tobosa, buffalograss, and curlymesquite; and forbs, such as gray coldenia. If overgrazing continues, the site becomes dominated by cenizo, blackbrush, catclaw acacia, and mesquite with an understory of short grasses, such as Hall panicum, threeawn, and hairy tridens; gray coldenia; and annual forbs (fig. 15).

This soil has fair potential for wildlife habitat. Deer and quail use these areas.

This soil is moderately well suited to most urban uses. Depth to rock, shrinking and swelling, excess lime, low strength under roads and streets, and corrosivity to uncoated steel are the main limitations. This soil is moderately well suited to most recreational uses. Slope, the erosion hazard in some places, and excess lime are the main limitations.

This soil is in capability subclasses IVe, nonirrigated, and IIe, irrigated. It is in Loamy (East) range site.

ZaC—Zapata-Vinegarroon complex, 1 to 5 percent slopes. This complex consists of very shallow and shallow, gently sloping soils on uplands. These soils formed in old outwash sediment over thick beds of caliche. Slope ranges from 1 to 5 percent but averages about 2 percent. As much as 20 percent of the surface is covered by limestone and caliche fragments. Mapped areas are irregularly shaped and range from 20 to 500 acres in size.

This complex is about 60 percent Zapata soil, 30 percent Vinegarroon soil, and 10 percent other soils. Individual areas range from 45 to 70 percent Zapata soil, from 20 to 40 percent Vinegarroon soil, and from 5 to 20 percent other soils. The Zapata soil is generally on the more sloping broad plains, and the Vinegarroon soil is mostly in the less sloping areas. Areas of the Zapata and Vinegarroon soils are so intricately mixed that separation is not practical at the scale of mapping.

Figure 15.—Area of Valverde silty clay loam, 0 to 3 percent slopes; Loamy range site in poor condition. The lack of plant cover has allowed the formation of a hard surface crust.

Typically, the Zapata soil has a surface layer about 8 inches thick of moderately alkaline, light brownish gray clay loam that contains a few caliche fragments. The next 5 inches is strongly cemented caliche that is laminar in the upper part. Weakly cemented caliche is at a depth of 13 inches.

Typically, the Vinegarroon soil has a surface layer of moderately alkaline, light brownish gray gravelly loam about 7 inches thick. The subsoil is moderately alkaline, pale brown gravelly clay loam about 10 inches thick. The next 7 inches is indurated caliche. Weakly cemented caliche is at a depth of 24 inches.

The Zapata and Vinegarroon soils are well drained. Surface runoff is medium. Permeability is moderate, and available water capacity is very low. The rooting zone is very shallow in the Zapata soil and shallow in the Vinegarroon soil. The water erosion hazard is moderate.

Included with these soils in mapping are small areas of Acuna, Coahuila, Felipe, Olmos, Valverde, and Zorra soils. Included soils make up less than 20 percent of any mapped area.

This complex is used mainly for wildlife habitat and range.

The soils are not suited to crops or improved pasture. Very shallow and shallow rooting depth and very low available water capacity are the main limitations.

The potential plant community on the Zapata soil is grasses with scattered woody plants and perennial forbs. Sideoats grama, cane bluestem, silver bluestem, pinhole bluestem, plains bristlegrass, green sprangletop, tanglehead, Arizona cottontop, and plains lovegrass make up 60 percent of the plant cover. Reverchon panicum, perennial threeawn, slim tridens, lovegrass tridens, buffalograss, and curlymesquite make up 25 percent. Forbs, such as menodora, bushsunflower, and orange zexmenia, make up 5 percent; and woody plants, such as guajillo, Texas kidneywood, range ratany, guayacan, mesquite, vine ephedra, dalea, desert yaupon, and cenizo, make up 10 percent.

Sideoats grama, cane bluestem, green sprangletop, and tanglehead are preferred by livestock and are grazed out under continued heavy use. They are replaced by woody plants. There is also usually a large increase in perennial threeawn and some increase in plants such as slim tridens, fall witchgrass, buffalograss, and curlymesquite. If heavy grazing continues, woody shrubs increase and invade; cenizo becomes dominant, along with an understory of short grasses, such as threeawn, red grama, and hairy grama, and annual forbs.

The potential plant community on the Vinegarroon soil is mainly mid and short grasses. Sideoats grama, plains bristlegrass, reverchon panicum, plains lovegrass, cane and pinhole bluestem, and pink pappusgrass make up 45 percent of the plant cover. Arizona cottontop, slim tridens, threeawn, buffalograss, curlymesquite, and fall witchgrass make up 45 percent. Forbs, such as bushsunflower, bundleflower, orange zexmenia, and halfshrub sundrop, make up 5 percent; and woody shrubs, such as guajillo, skeletonleaf goldeneye, mesquite, vine ephedra, guayacan, ratany, and cenizo, make up 5 percent.

Sideoats grama, plains bristlegrass, and cane bluestem are preferred by livestock and are grazed out under continued heavy grazing. They are replaced by threeawn, slim tridens, fall witchgrass, and woody shrubs. If heavy grazing continues, a dense canopy of cenizo and other mixed brush takes over, with an understory of such plants as red grama, hairy tridens, threeawns, gray coldenia, and annual weeds.

These soils have very poor to fair potential for wildlife habitat because of lack of cover and food.

These soils are poorly suited to most urban uses. The cemented pan, thin surface layer, and corrosivity to uncoated steel are the main limitations. These soils are poorly suited to most recreational uses because of the depth to the cemented pan.

These soils are in capability subclass VIIs. The Zapata soil is in Shallow Ridge (South) range site, and the Vinegarroon soil is in Shallow (South) range site.

ZoD—Zorra-Rock outcrop complex, 1 to 8 percent slopes. This complex consists of a very shallow and shallow, gently sloping to sloping soil and Rock outcrop on ridges on uplands. Slope ranges from 1 to 8 percent but averages about 3 percent. Mapped areas are irregular in shape and range from 20 to 2,000 acres in size.

This complex is about 75 percent Zorra soil, 15 percent Rock outcrop, and 10 percent other soils. Individual areas range from 65 to 90 percent Zorra soil, from 5 to 25 percent Rock outcrop, and from 0 to 15 percent other soils. Areas of the Zorra soil and Rock outcrop are so intricately mixed that separation is not practical at the scale of mapping.

Typically, the Zorra soil has a surface layer of moderately alkaline, dark grayish brown stony loam about 8 inches thick. The next 4 inches is indurated caliche. Below this, 3 inches of fractured limestone with calcium carbonate in cracks and crevices is underlain by coarsely fractured limestone bedrock. About 56 percent of the surface is covered by limestone gravel and cobbles, and about 4 percent is covered by stones.

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

Rock outcrop consists of exposed limestone bedrock and areas with less than 2 inches of soil material over limestone.

Included in mapping are small areas of Acuna, Amistad, Dev, Langtry, Olmos, and Valverde soils. Included soils make up less than 15 percent of any mapped area.

This complex is used mainly for wildlife habitat and range.

The soil is not suited to crops or improved pasture. Very shallow and shallow rooting depth and large stones are the main limitations.

The potential plant community on the Zorra soil consists of a wide variety of grasses, low shrubs, and forbs. Sideoats grama, cane bluestem, and green sprangletop make up 35 percent of the plant cover. Plains bristlegrass, black grama, hairy grama, slim tridens, fall witchgrass, perennial threeawn, Texas wintergrass, Texas cupgrass, plains lovegrass, curlymesquite, and buffalograss make up 45 percent. Forbs, such as bushsunflower, Engelmann-daisy, menodora, Mexican sagewort, and velvet bundleflower, make up 10 percent; and woody plants, such as feather dalea, skeletonleaf goldeneye, agrito, vine ephedra, Texas false-mesquite, hackberry, elbowbush, catclaw acacia, sacahuista, guajillo, cenizo, blackbrush acacia, and cacti, make up 10 percent.

Sideoats grama, green sprangletop, plants lovegrass, cane bluestem, and plains bristlegrass are preferred by livestock and are grazed out under heavy continuous use. They are replaced by fall witchgrass, perennial threeawn, hairy grama, and woody plants. If heavy grazing continues, woody plants native to the site, such as blackbrush and cenizo, increase, along with coyotillo, mescal bean, and leatherstem and such grasses as Hall panicum, hairy tridens, red grama, perennial threeawn, and annuals.

Low rainfall, very low available water capacity, and very shallow and shallow rooting depth limit the amount of forage produced.

This soil has fair potential for wildlife habitat. Deer use the areas for cover and browse.

The Zorra soil is poorly suited to most urban uses. Depth to rock, the cemented pan, thin surface layer, the large stones, and corrosivity to uncoated steel are the main limitations. This soil is poorly suited to most recreational uses. Depth to rock, the cemented pan, small stones, slope, and large stones are the main limitations.

This complex is in capability subclass VIIs. The Zorra soil is in Low Stony Hills (West) range site; Rock outcrop is not placed in a range site.

ZoE—Zorra-Rock outcrop complex, 8 to 15 percent slopes. This complex consists of a very shallow and shallow, strongly sloping to moderately steep soil and Rock outcrop on sides of ridges on uplands. Slope ranges from 8 to 15 percent but averages about 10 percent. About 75 percent of the surface is covered by limestone fragments; they range from gravel to stone in size. Mapped areas are irregular in shape and range from 20 to 1,000 acres in size.

This complex is about 55 percent Zorra soil, 35 percent Rock outcrop, and 10 percent other soils. Individual areas range from 50 to 70 percent Zorra soil, from 30 to 40 percent Rock outcrop, and from 0 to 15 percent other soils. Areas of the Zorra soil and Rock outcrop are so intricately mixed that separation is not practical at the scale of mapping.

Typically, the Zorra soil has a surface layer of moderately alkaline, dark gray very stony loam about 10 inches thick. The next 2 inches is indurated and laminar caliche. Below this, 12 inches of weakly cemented caliche is underlain by coarsely fractured limestone bedrock. About 60 percent of the surface is covered by limestone gravel and cobbles, and about 10 percent is covered by stones.

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

Rock outcrop consists of exposed limestone bedrock and areas with less than 2 inches of soil material over limestone.

Included in mapping are small areas of Acuna, Amistad, Dev, Langtry, Olmos, and Valverde soils. Included soils make up less than 15 percent of any mapped area.

This complex is used mainly for wildlife habitat and range.

The soil is not suited to crops or improved pasture. Slope, very shallow and shallow rooting depth, and large stones are the main limitations.

The potential plant community on this Zorra soil consists of grasses, low shrubs, and forbs. Sideoats grama, cane bluestem, and green sprangletop make up 35 percent of the plant cover. Plains bristlegrass, black grama, hairy grama, slim tridens, fall witchgrass, perennial threeawn, Texas wintergrass, Texas cupgrass, plains lovegrass, curlymesquite, and buffalograss make up 45 percent. Forbs, such as bushsunflower, Engelmann-daisy, menodora, Mexican sagewort, and velvet bundleflower, make up 10 percent; and woody plants, such as feather dalea, skeletonleaf goldeneye, agrito, vine ephedra, Texas false-mesquite, hackberry, elbowbush, catclaw acacia, guajillo, cenizo, blackbrush acacia, and cacti, make up 10 percent.

Sideoats grama, plains lovegrass, green sprangletop, plains bristlegrass and cane bluestem are preferred by livestock and are grazed out under heavy continuous use. They are replaced by fall witchgrass, perennial threeawn, hairy grama, and woody plants. If heavy grazing continues, woody plants native to the site, such as blackbrush and cenizo, continue to increase, along with such plants as coyotillo, mescal bean, and leatherstem and such grasses as Hall panicum, hairy tridens, red grama, perennial threeawn, and annuals.

Low rainfall, very low available water capacity, and very shallow and shallow rooting depth limit the amount of forage produced.

This soil has fair potential for wildlife habitat. Deer use the areas for cover and browse.

The Zorra soil is poorly suited to most urban and recreational uses. Slope, depth to rock, the cemented pan, thin surface layer, large stones, and corrosivity to uncoated steel are the main limitations.

This complex subclass VIIs. The Zorra soil is in Low Stony Hills (West) range site; Rock outcrop is not placed in a range site.

ZRE—Zorra-Rock outcrop association, rolling. This association consists of very shallow and shallow, gently undulating to rolling soils and Rock outcrop on ridges and side slopes on uplands. Slope ranges from 1 to 15 percent but averages about 3 percent. Mapped areas are irregular in shape and range from 20 acres to several thousand acres in size.

This association consists of about 70 percent Zorra soils, 20 percent Rock outcrop, and 10 percent other soils. Individual areas range from 55 to 80 percent Zorra soils, from 10 to 30 percent Rock outcrop, and from 5 to 20 percent other soils. The composition of this association is more variable than that of most map units in the county, but mapping has been controlled well enough for the anticipated use.

A typical Zorra soil has a surface layer of moderately alkaline, dark grayish brown stony clay loam about 5 inches thick. The next 3 inches is indurated caliche. Below this, 4 inches of weakly cemented caliche is underlain by coarsely fractured limestone bedrock. About 55 percent of the surface is covered by limestone gravel and cobbles, and about 5 percent is covered by stones.

These soils are well drained. Surface runoff is medium to rapid. Permeability is moderate, and available water capacity is very low. The rooting zone is very shallow and shallow. The water erosion hazard is moderate to severe.

Rock outcrop consists of exposed limestone bedrock and areas with less than 2 inches of soil material over limestone.

Included in mapping are small areas of Acuna, Amistad, Coahuila, Dev, Langtry, Olmos, Valverde, and Zapata soils. Included soils make up less than 20 percent of any mapped area.

This association is used mainly for wildlife habitat and range.

The soils are not suited to crops or improved pasture. Slope, very shallow and shallow rooting depth, and large stones are the main limitations.

The potential plant community on the Zorra soils consists of grasses, low shrubs, and forbs. Sideoats grama, cane bluestem, and green sprangletop make up 35 percent of the plant cover. Plains bristlegrass, black grama, hairy grama, slim tridens, fall witchgrass, perennial threeawn, Texas wintergrass, Texas cupgrass, plains lovegrass, curlymesquite, and buffalograss make up 45 percent. Forbs, such as bushsunflower, Engelmann-daisy, menodora, Mexican sagewort, and velvet bundleflower, make up 10 percent; and woody plants, such as feather dalea, skeletonleaf goldeneye. agrito, vine ephedra, Texas false-mesquite, hackberry, elbowbush, catclaw acacia, guajillo, cenizo, blackbrush acacia, and cacti, make up 10 percent.

Sideoats grama, plains bristlegrass, green sprangletop, plains lovegrass, and cane bluestem are preferred by livestock and are grazed out under heavy continuous grazing. They are replaced by fall witchgrass, perennial threeawn, hairy grama, and woody plants. If heavy grazing continues, woody plants native to the site, such as blackbrush and cenizo, continue to increase, along with coyotillo, mescal bean, and leatherstem and such grasses as Hall panicum, hairy tridens, red grama, perennial threeawn, and annuals.

Low rainfall, very low available water capacity, and very shallow and shallow rooting depth limit the amount of forage produced.

This soil has fair potential for wildlife habitat. Deer use the areas for cover and browse.

The Zorra soil is poorly suited to most urban and recreational uses. Depth to rock, slope, the cemented pan, thin surface layer, large stones, corrosivity to uncoated steel, and slope are the main limitations.

This association is in capability subclass VIIs. The Zorra soils are in Low Stony Hills (West) range site; Rock outcrop is not placed in a range site.

Prime Farmland

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. The soil quality, growing season, and moisture supply are suitable for economically producing sustained high yields of crops if the land is treated and managed using acceptable farming methods. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment. Prime farmland is of major importance in satisfying the nation's short- and long-term needs for food and fiber. The supply of high quality farmland is limited, and it should be used with wisdom and foresight.

Prime farmland must either be currently used for producing food or fiber or be available for this use. It may be in crops, pasture, timber, grazing, or other uses except urban or built-up land or water areas. Urban or built-up land is any contiguous area 10 acres or more in size that is used for residences, industrial sites, commercial sites, construction sites, institutional sites, public administrative sites, railroad yards, small parks, cemeteries, airports, golf courses, sanitary landfills, sewage treatment plants, water control structures and spillways, shooting ranges, and so forth.

Prime farmland usually has an adequate and dependable supply of moisture from precipitation or irrigation. Temperature and growing season are favorable. It has acceptable reaction and has few or no rocks, and it is permeable to water and air. Prime farmland is not excessively erodible. It is not saturated with water for long periods and is not flooded during the growing season. Slope ranges mainly from 0 to 6 percent.

Some factors necessary for identification of prime farmland, such as irrigation, frequency of flooding, and drainage, may not be evident from the soil survey and will require on-site evaluation to determine if limitations have been overcome by corrective measures.

Val Verde County has no prime farmland in the native state. If irrigated, however, about 117,000 acres (5.6 percent of the county) meets the requirements for prime farmland. The areas are scattered throughout the county, but most are in the southeastern part, mainly in general soil map units 5, 7, and 8.

The soils that are prime farmland when irrigated are listed in this section. This list does not recommend any particular land use. The extent of each listed map unit is shown in table 2. Location is shown on the detailed soil maps in the back of this publication. The soil qualities that affect use and management are described in the section "Detailed soil map units."

The following map units are prime farmland where not used for urban or built-up land and where there is a developed, dependable supply of irrigation water of adequate quality:

AcB—Acuna silty clay, 0 to 3 percent slopes
CoB—Coahuila clay loam, 0 to 3 percent slopes
HdB—Hodgins silt loam, 0 to 3 percent slopes
LaB—Lagloria loam, 0 to 3 percent slopes
Ls—Laredo silty clay loam
Lv—Laredo Variant silty clay loam
Ra—Reynosa silty clay loam
Rd—Rio Diablo silty clay
Rg—Rio Grande silt loam
ToA—Tobosa clay, 0 to 1 percent slopes
VaB—Valverde silty clay loam, 0 to 3 percent slopes

Use and Management of the Soils

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

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

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland; 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, including some not commonly

grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of pasture 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 1,300 acres of Val Verde County was used for crops and pasture in 1967 *(7)*. The crops were primarily irrigated hay and supplemental grazing crops, such as wheat, alfalfa, oats, and forage sorghum. Grain sorghum, cotton, corn, and oats can be grown in the area.

Most of the soils suited to irrigated crops are in the Rio Grande Plain land resource area. The irrigation water comes mostly from San Felipe Springs. A canal system conveys water to the better soils around Del Rio. In some areas, deep wells produce good quality water for irrigation.

About 117,000 acres currently in rangeland and pasture is suitable for irrigated crops. Large scale farming is not feasible in most of these areas, however, because of the small size and narrow or irregular shape of the soil areas.

Irrigated special crops in the county are mostly home-grown vegetables and grapes. Pecan trees are grown commercially for their nuts, and peach trees are well suited to this area. Jojoba is being tested for its adaptability. The deep, well drained Acuna, Coahuila, Lagloria, Laredo, Reynosa, and Rio Diablo soils are well suited to vegetables, small fruits, and pecans. These soils cover about 80,000 acres. Latest information and suggestions for growing special crops can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

All of the soils in Val Verde County have relatively high pH and are mildly alkaline to moderately alkaline. Soil fertility is naturally low in many soils in the survey area; soils on flood plains and terraces are generally higher in plant nutrients. Where the soils have not been fertilized, available potassium is high and available phosphorus and nitrogen are low. All additions of fertilizer should be based on the results of soil tests, on the needs of the crop, and on the desired level of yield. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer to apply.

Most of the land that was used for crops has been converted to improved pasture of such grasses as Coastal and Callie bermudagrass and kleingrass. Pasture is grazed by domestic livestock or cut for hay. The important management practices for pasture include fertilizing, controlling weeds and brush, and stocking at proper rates. Fertilizer requirements are related to kind of soil, plant species, and the desired level of forage production. Added iron helps crops that are sensitive to high levels of calcium. Soil tests should be performed to determine the correct rate of fertilization for desired results. Proper stocking rates balance the number of grazing animals and the productive capacity of the pasture. Weeds and brush, which compete with the desirable vegetation for the available moisture and nutrients, can be controlled by mowing or using herbicides. Weeds are normally a minor problem on well fertilized and properly grazed pasture.

Most of the areas in pasture, and a few areas of range, can be farmed and represent a reserve production capacity. Food production can also be increased considerably by extending the latest crop production technology to all cropland in the county. This soil survey can facilitate the application of such technology.

Soil erosion is a major concern in Val Verde County, especially on cropland. Erosion is a hazard where slope is more than 1 percent. Acuna, Lagloria, and Reynosa soils, for example, have slope of 1 to 3 percent.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost. Second, soil erosion results in

sedimentation of streams. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water for municipal use, for recreation, and for fish and wildlife.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps a plant cover on the soil for extended periods can hold erosion losses to amounts that will not reduce the productive capacity of the soil.

Land leveling and contour tillage reduce water erosion. Land leveling consists of modifying the slope to reduce runoff.

Minimum tillage is desirable because it reduces traffic on the soils. Soils pack easily, especially if plowed or traveled on when moist. Where the soils are packed, the water infiltration rate is reduced and the runoff rate increases. Compacted soils have less air space, and plants have difficulty developing deep root systems. Plants on compacted soils have a shallow root system and suffer the effects of drought when the surface layer dries out.

Information on the design of erosion control practices for each kind of soil is available from local offices of the Soil Conservation Service.

Urban development has been decreasing the acreage of soils that are both well suited to crops and available for planting. In general, the soils that are suited to crops and pasture are well suited to urban uses. This soil survey can help in making land use decisions that will influence the future role of farming and ranching in Val Verde County.

Yields Per Acre

The average yields per acre that can be expected of pasture under a high level of management are shown in table 3. 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, ranchers, 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 pasture depends on the kind of soil and the kind of grass. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding varieties; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop.

For yields of irrigated pasture, it is assumed that the irrigation system is adapted to the soils and to the grass grown and that good quality irrigation water is uniformly applied as needed.

The estimated yields reflect the productive capacity of each soil for pasture. 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.

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 and adapted grasses.

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, woodland, wildlife habitat, or recreation.

Rangeland

Kenneth D. Sparks, area range conservationist, Soil Conservation Service, helped to prepare this section.

Range is land on which the natural potential plant community is composed of grasses, forbs, and shrubs that have value for grazing. The approximately two million acres of native range in Val Verde County is grazed by sheep, cattle, goats, and deer. Over 99 percent of the agricultural income of this county is derived from livestock and livestock products. Most ranches are stocked with a combination of cattle, sheep, and goats. The average size of ranches is 8,000 acres. Some of the small acreage of crops is grown for supplemental feed.

The northern 53 percent of the county is gently undulating to very steep, stony soils that are very shallow or shallow over limestone (general soil map units 1 and 4). In this area live oak and juniper are the main woody plants. Scattered pockets of pinyon pine are in the northern part.

The southwestern 7 percent of the county consists of gently undulating to very steep, gravelly and flaggy soils that are also very shallow and shallow (general soil

map unit 3). Desert shrubs, such as creosotebush, tarbush, and acacia, are the main woody plants in this area.

The central 28 percent of the county consists of gently undulating to very steep, cobbly and stony soils that are very shallow or shallow (general soil map unit 2). The main woody plants in this area are blackbrush, cenizo, guajillo, and acacia.

The southeastern 10 percent of the county is in the Rio Grande Plain land resource area. The nearly level to gently rolling soils are very shallow to deep (general soil map units 5, 6, 7, and 8). Guajillo, cenizo, mesquite, blackbrush acacia, and paloverde are the main woody plants.

The native vegetation varies widely over the county because of differences in elevation and climatic conditions.

The proportion of woody plants has increased above that in the original natural plant community on most soils in the county. Drought and heavy use have reduced the original vegetation on some sites and allowed invading plants to become dominant.

Brush management to control increasing and invading brush is essential to range improvement on some sites. However, many sites will improve if given proper treatment, including frequent rests during the growing season. Rests allow the desirable plant species to reestablish themselves in the range community.

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

Table 4 shows, for each soil, the range site and the total annual production of vegetation in favorable, normal, and unfavorable years. Explanation of the column headings in table 4 follows.

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

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

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

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum

production of vegetation, reduction of undesirable brush species, conservation of water, and control of water erosion and soil blowing. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Recreation

Val Verde County provides areas and facilities for fishing, water skiing, pleasure boating, camping, bird watching, skin diving, hunting, picnicking, and other activities.

The county contains about 37,000 acres of water in Amistad Reservoir (fig. 16), the Rio Grande, and the Pecos and Devils Rivers. The National Park Service has developed many facilities around Amistad National Recreational Area, and more are planned.

Wildlife abounds with white-tailed deer, desert mule deer, scaled quail, bobwhite quail, turkey, white-winged dove, mourning dove, javelina, and numerous other birds and exotic wildlife. Most ranchers lease out white-tailed deer hunting rights.

Many tourists spend a great deal of time at the campgrounds, recreational sites, and points of interest in the county, including San Felipe Springs, Whitehead Memorial Museum, the Judge Roy Bean Visitors' Center, and other historical sites.

The soils of the survey area are rated in table 5 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 by the duration an 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.

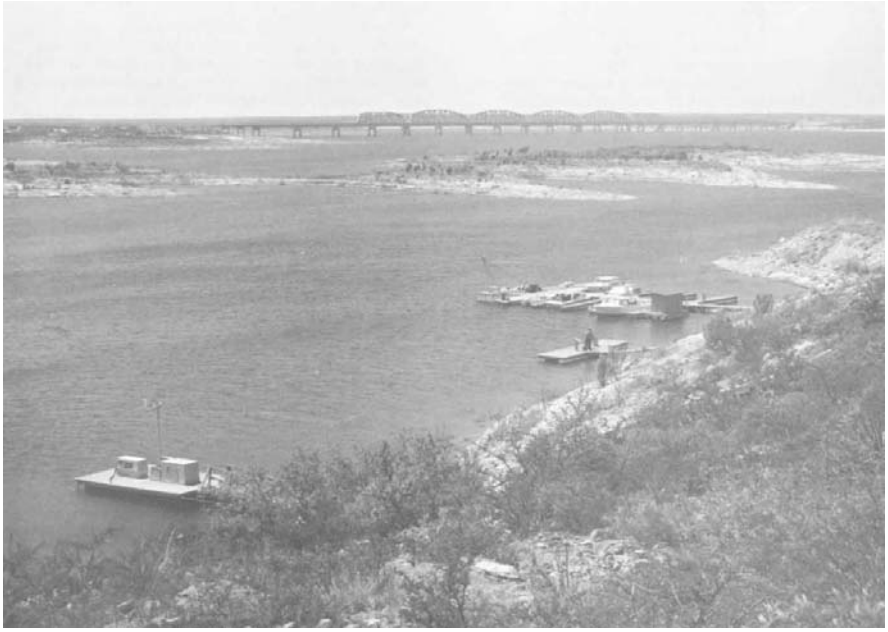


Figure 16.—Boat dock on Amistad Reservoir.

In table 5, 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 5 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 8 and interpretations for dwellings without basements and for local roads and streets in table 7.

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

Richard G. Hungerford. Jr., range conservationist, and Jerry M Turrentine, biologist, Soil Conservation Service, helped to prepare this section.

Val Verde County provides permanent and temporary habitat for many wildlife species. Through management and manipulation of the habitat, man has increased many wildlife species in the survey area.

The major wildlife include white-tailed and desert mule deer, turkey, javelina. bobwhite and scaled quail, and white-winged and mourning dove. Other wildlife include bobcat, coyote, puma (mountain lion), gray and red fox, raccoon, opossum, ringtail, porcupine, armadillo, cottontail and jackrabbit, skunk, fox squirrel, beaver, bat, and badger. Some of these species occur throughout the county while others, such as raccoon, opossum, and squirrel, are found mainly around rivers and creeks. Mule deer are found in general soil map units 2 and 3 west of the Pecos River.

An important sport fishing industry has become established on Amistad Reservoir, Devils and Pecos Rivers, and the Rio Grande. Several kinds of reptile live in the county, as do amphibians in limited areas. Numerous species of songbirds,

water birds, birds of prey, and vultures also inhabit this area or pass through every year.

Evergreen and deciduous trees grow around Del Rio and in areas along rivers, creeks, streams, draws, and tributaries in other parts of the county. They furnish cover and foliage, mast, buds, catkins, twigs, and bark. The growth of trees, shrubs, and ground cover are affected by depth of the rooting zone, available water capacity, and wetness. Examples of evergreen plants are pinyon pine, juniper, evergreen sumac, and live oak. Examples of deciduous plants are Chisos, red Vasey, and shin oaks, sycamore, hackberry, pecan, and greenbriar. White-tailed deer, turkey, woodpecker, squirrel, raccoon, armadillo, and javelina are attracted to these areas.

Water areas include Amistad Reservoir and its tributaries, springs and creeks around Del Rio, and tributaries of the Rio Grande. These areas attract beaver, blue heron, lesser sandhill crane, shorebirds, ducks, and fish. During the migration seasons, waterfowl use the reservoir and rivers for resting and feeding.

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 6, 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, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are kleingrass, blue panicum, johnsongrass, sorghum almum, and alfalfa.

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

also considerations. Examples of wild herbaceous plants are bluestem, Texas wintergrass, perennial croton, bushsunflower, orange zexmenia, plains bristlegrass, green sprangletop, Engelmann-daisy, and sideoats grama.

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 Texas kidneywood, shin oak, guajillo, ephedra, desert yaupon, feather dalea, and Texas false-mesquite.

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, rushes, sedges, and cattail.

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 open and 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 and scaled quail, turkey, meadowlark, roadrunner, cottontail, jackrabbit, fox, and white-winged and mourning dove.

Areas of cropland planted to grain sorghum provide food for doves and quail. Small grain plantings are used by deer if suitable cover is nearby. Crop residue remaining on the surface provides forage for many kinds of wildlife. Small areas of unharvested grain can be left next to good cover. Waterways can be managed to provide cover for small mammals and birds. Fence rows can be allowed to grow up to provide additional cover. Disking field borders greatly improves food supplies in pasture areas. Brush provides food as well as cover. Increasing use of kleingrass is beneficial to birds.

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

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include white-tailed deer, desert mule deer, meadowlark, porcupine, puma, coyote, turkey, bobcat, armadillo, raccoon, javelina, bobwhite, scaled quail, fox, cliff swallows, rattlesnake, golden eagle, woodpeckers, squirrels, and roadrunners.

Proper grazing, planned grazing systems, and deferred grazing allow increased forage production for wildlife, cover for quail and turkey, and fawning areas for deer. Grasses allowed to mature also provide food for dove, quail, and turkey. Brush management is important. Clearing brush in strips and patterns creates a diversity in food sources for various species. Other practices include disking and seeding to multipurpose plants. Development of water facilities aids in distributing livestock and extends habitat for many kinds of wildlife.

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 or a cemented pan, hardness of bedrock or cemented pan 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 7 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, and shrink-swell potential 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, and the available water capacity in the upper 40 inches, affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand or clay, in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 8 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 8 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 effectively filter the effluent. 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 8 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, and large stones.

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. 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 8 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, and soil reaction 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 9 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 9, 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 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 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, and bedrock.

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 or stones, 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 or stones, 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 10 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 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. 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; 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.

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 hazard of wind erosion, 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.

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 and plasticity characteristics. These results are reported in table 15.

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 11 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 a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

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

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

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

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. 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 15.

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 12 shows estimates of some characteristics an(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 *it* 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.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

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 12, the estimated content of organic matter of the plow layer 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 13 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 or by runoff from adjacent slopes. Water standing for short periods after rainfall is not considered flooding.

Table 13 gives the frequency and duration of flooding and the time of year when flooding is most likely.

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

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

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

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 13 are the depth to the seasonal high water table; the kind of water table; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 13.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Only saturated zones within a depth of about 6 feet are indicated.

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 l*ow, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Chemical Analysis of Selected Soils

The results of chemical analysis of several typical pedons in the survey area are given in table 14. The sites of these pedons were carefully selected. Most are typical of the series and are described in the section "Soil series and their morphology." The samples were analyzed by the Texas Agricultural Experiment Station.

Most determinations were made on the soil material smaller than 2 mm in diameter. The methods used are—

Calcium carbonate equivalent—Calculation based on gasimetric determination using the Chittick apparatus *(5)*.
Total carbon—Leco induction furnace.
Inorganic carbon—Carbon dioxide gasimetric technique by the Chittick apparatus *(5)*.
Organic carbon—Calculation of total carbon less inorganic carbon.
Calcite and **dolomite—**Quantitative gasimetric determination by the Chittick apparatus *(5)*.

Engineering Index Test Data

Table 15 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); Shrinkage—T 92 (AASHTO), D 427 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(9)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 16, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

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

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

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquents *(Hapl,* meaning minimal horizonation, plus *aquent,* the suborder of the Entisols that have an aquic moisture regime).

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

name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquents.

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

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

Soil Series and Their Morphology

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

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (8). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (9). Unless otherwise stated, colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Acuna series

The Acuna series consists of deep, well drained soils on stream terraces and low uplands. These soils formed in calcareous, clayey alluvium from limestone hills. Slope ranges from 0 to 3 percent.

Typical pedon of Acuna silty clay, 0 to 3 percent slopes; from the intersection of U.S. Highway 90 and U.S. Highway 277 in Del Rio, 3.3 miles east on U.S. Highway 90 to Ranch Road 2523, 8.3 miles generally northeast on Ranch Road 2523, 0.3 mile west, 75 feet north in rangeland:

A1—0 to 18 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist, the upper 2 inches is grayish brown (10YR 5/2); moderate medium subangular blocky structure parting to moderate medium granular; slightly hard, friable; common fine and medium roots; common fine pores; few fine threads and films of calcium carbonate; few fine concretions of calcium carbonate less than 2 mm in size; calcareous; moderately alkaline; clear wavy boundary.

B21—18 to 30 inches; brown (7.5YR 5/4) clay, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure parting to moderate medium granular; hard, friable; few fine roots; common very fine pores; few thin discontinuous clay films on vertical surfaces of peds; few films and threads of calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

B22ca—30 to 38 inches; pink (7.5YR 7/4) silty clay, brown (7.5YR 5/4) moist; weak fine subangular blocky structure; slightly hard, friable; many very fine pores; about 15 percent by volume films, threads, soft masses, and

concretions of calcium carbonate 2 mm to 2 cm in size; calcareous; moderately alkaline; clear wavy boundary.

B23ca—38 to 60 inches; pink (7.5YR 8/4) silty clay, reddish yellow (7.5YR 7/6) moist; weak fine subangular blocky structure; slightly hard, friable; common very fine pores; about 8 percent by volume films, threads, and soft masses of calcium carbonate 2 mm to 2 cm in size; calcareous; moderately alkaline; gradual wavy boundary.

B24ca—60 to 72 inches; reddish yellow (7.5YR 6/6) silty clay, strong brown (7.5YR 5/6) moist; weak fine subangular blocky structure; slightly hard, friable; about 5 percent by volume soft masses and concretions of calcium carbonate 2 mm to 2 cm in size; calcareous; moderately alkaline.

The solum ranges from 40 to more than 60 inches in thickness. Calcium carbonate equivalent in the 10- to 40-inch control section is 40 to 55 percent. Depth to distinct accumulations of calcium carbonate is 16 to 40 inches; 5 to 30 percent of this is threads, films, soft masses, and concretions. The control section is 35 to 50 percent total clay and 20 to 35 percent noncarbonate clay. Coefficient of linear extensibility ranges from 0.030 to 0.050.

The A horizon is very dark grayish brown, dark grayish brown, grayish brown, dark brown, or brown.

The B horizon is silty clay loam, silty clay, or clay. The B2 horizon is brown, light brown, or pale brown. The B2ca horizon is brown, light brown, pale brown, very pale brown, light yellowish brown, reddish yellow, or pink.

Some pedons have a Cca horizon below a depth of 40 inches with the same colors as the B2ca horizon. Depth to limestone or gravel ranges from 6 to 20 feet.

Amistad series

The Amistad series consists of very flaggy and flaggy loamy soils on ridges and side slopes on uplands. These soils are very shallow and shallow and are well drained. The soils formed in material weathered from flaggy limestone bedrock. Slope ranges from 1 to 15 percent.

Typical pedon of Amistad flaggy clay loam, 1 to 8 percent slopes; from intersection of U.S. Highway 90 and U.S. Highway 277-377 north of Del Rio, 17 miles north on U.S. Highway 277-377, 20 feet east of fence in rangeland:

A1—0 to 6 inches; dark grayish brown (10YR 4/2) flaggy clay loam, very dark grayish brown (10YR 3/2) moist; strong fine granular structure; slightly hard, friable; few fine roots; about 15 percent limestone fragments 2 mm to 15 cm across and 25 percent fragments 15 cm to 3 cm across, fragments are 6 mm to 5 cm thick; some fragments coated with secondary carbonates; calcareous; moderately alkaline; abrupt wavy boundary.

Ccam—6 to 17 inches; white (10YR 8/1) strongly cemented caliche containing a few embedded thin flat limestone fragments; few fine crevices and solution channels filled with dark grayish brown clay loam; clear wavy boundary.

R—17 to 60 inches; flaggy limestone bedrock; flagstones mainly 10 cm to 60 cm long and 5 mm to 15 cm thick.

Solum thickness, or depth to indurated or strongly cemented caliche, ranges from 4 to 20 inches. Limestone fragments and calcium carbonate concretions smaller than 20 mm make up more than 40 percent by weight of the whole soil. Calcium carbonate equivalent in the fine earth fraction is 15 to 35 percent. The fine earth fraction is 22 to 35 percent total clay and 10 to 30 percent noncarbonate clay. Depth to limestone bedrock (R layer) ranges from 8 to 36 inches.

The A horizon is brown, grayish brown, dark grayish brown, or dark brown. It is 35 to 75 percent by volume coarse fragments of limestone and caliche. About 10 to 50 percent of the fragments are channers and 10 to 60 percent are flagstones. The fine earth fraction is loam or clay loam.

The Ccam horizon ranges from 1 inch to more than 15 inches in thickness. It is strongly cemented or indurated. Hardness is 2 or 3 on Mohs' scale. Some pedons have a weakly cemented Cca horizon below the Ccam horizon. It ranges from 4 to 30 inches in thickness.

The R layer in some pedons consists of flaggy limestone interbedded with strata of chalk and marl.

Coahuila series

The Coahuila series consists of deep, well drained soils on old stream terraces and low uplands. These soils formed in calcareous loamy alluvium derived from limestone. Slope ranges from 0 to 3 percent.

Typical pedon of Coahuila clay loam, 0 to 3 percent slopes (fig. 17); from the intersection of U.S. Highway 90 and U.S. Highway 277 in Del Rio, 8.6 miles east and northeast on U.S. Highway 90, 100 feet north of fence in rangeland:

A1—0 to 9 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure parting to weak medium granular; slightly hard, friable; common very fine to medium roots; few fine discontinuous pores; calcareous: moderately alkaline: clear wavy boundary.

B21—9 to 22 inches; pale brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable; few fine and medium roots; few fine discontinuous pores; about 2 percent by volume threads and films of calcium carbonate; few concretions of calcium carbonate 2 to 6 mm in size; calcareous; moderately alkaline; clear wavy boundary.

B22ca—22 to 33 inches; pale brown (10YR 6/3) silty clay loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; slightly hard, friable; few very fine roots; about 8 percent by volume threads, films, soft masses, and concretions of calcium carbonate 2 to 8 mm in size; calcareous; moderately alkaline; clear wavy boundary.

B23ca—33 to 62 inches; very pale brown (10YR 7/4) silty clay, light yellowish brown (10YR 6/4) moist; weak fine and medium subangular blocky structure; slightly hard, friable; few very fine roots; about 18 percent by volume threads, films, soft masses, and concretions of calcium carbonate 2 to 8 mm in size; calcareous; moderately alkaline.

The solum ranges from 60 to more than 80 inches in thickness. Calcium carbonate equivalent in the 10- to 40-inch control section is 40 to 60 percent. The control section is 30 to 50 percent total clay and 18 to 34 percent noncarbonate clay.

The A horizon is grayish brown, light brownish gray, pale brown, or brown. Where value and chroma are less than 3.5 when the soil is moist, the A horizon is less than 7 inches thick.

The B horizon is clay loam, silty clay loam, silty clay, or clay. The B2 horizon is light brownish gray, grayish brown, brown, light brown, light yellowish brown, pale brown, or very pale brown. The Bca horizon is pale brown, very pale brown, light yellowish brown, light gray, pink, or white. The horizon is 5 to 25 percent secondary carbonates in the form of threads, films, soft masses, and concretions.

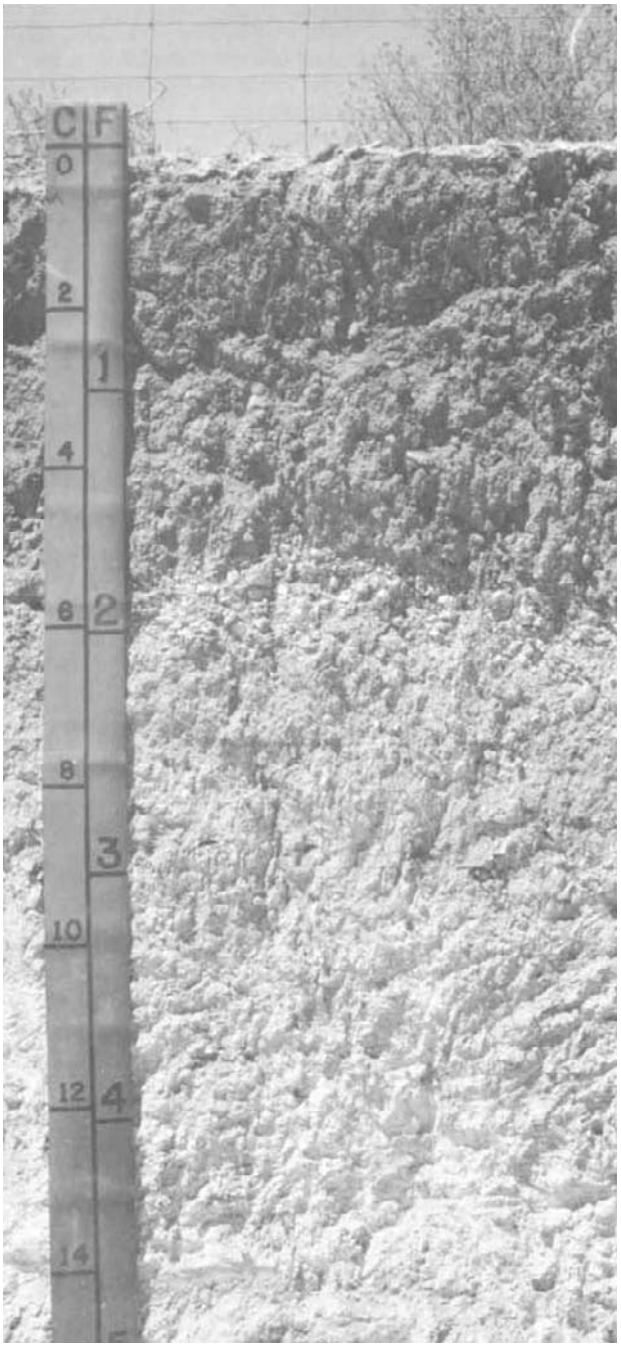


Figure 17.—Profile of Coahuila clay loam, 0 to 3 percent slopes. Horizon of calcium carbonate accumulation begins at a depth of about 22 inches. (Scale "C" is in decimeters; scale "F" is in feet.)

Dev series

The Dev series consists of very gravelly soils on bottom lands. These soils are deep and well drained. They formed in gravelly and loamy alluvium deposited by high-velocity streams that drain limestone hills. Slope ranges from 0 to 3 percent.

Typical pedon of Dev very gravelly clay loam (fig. 18), in an area of Dev soils, frequently flooded; from the intersection of U.S. Highway 90 and Texas Highway 163 in Comstock, 0.2 mile south on street crossing railroad tracks, 0.2 mile west, 0.2 mile south, and 0.05 mile west on streets in Comstock to the extreme southwest corner of the town site, 5.9 miles south. 0.3 mile east, and 0.6 mile southeast on an unpaved ranch road, 400 feet east on the flood plain of Cow Creek in rangeland:

Figure 18.—Profile of a Dev soil. A large part of this soil is waterworn gravel.

A1—0 to 25 inches; dark brown (10YR 4/3) very gravelly clay loam; dark brown (10YR 3/3) moist; weak fine granular structure; hard, friable; few fine roots; about 50 percent by volume limestone gravel 2 mm to 7.5 cm across; few cobbles; calcareous; moderately alkaline; diffuse wavy boundary.

C—25 to 60 inches; pale brown (10YR 6/3) very gravelly clay loam, brown (10YR 513) moist; weak fine granular structure; hard, friable; few fine roots; about 65 percent by volume limestone gravel 2 mm to 7.5 cm across; calcareous: moderately alkaline.

Carbonate accumulations smaller than 20 mm make up 40 to 70 percent by weight of the whole soil. The fine earth fraction of the 10- to 40-inch control section is 18 to 35 percent total clay and 10 to 30 percent noncarbonate clay. All horizons contain 35 to 90 percent by volume limestone gravel 2 mm to 7.5 cm across.

The A horizon is very dark grayish brown, dark grayish brown, grayish brown, dark brown, or brown and is 20 to 30 inches thick. The fine earth fraction is loam or clay loam.

The C horizon is grayish brown, brown, pale brown, yellowish brown, light yellowish brown, light brown, pale brown, or very pale brown. In some pedons, this horizon has discontinuous strata of loam or clay loam that contain few pebbles. These strata range from a few inches to 1 foot or more in thickness. The fine earth fraction is loam or clay loam,

Ector series

The Ector series consists of stony and extremely stony loamy soils on ridges and side slopes on uplands. These soils are very shallow and shallow and are well drained. They formed in material weathered from massive limestone bedrock. Slope ranges from 1 to 40 percent.

Typical pedon of Ector stony loam in an area of Ector-Rock outcrop association, hilly; from the intersection of U.S. Highway 90 and Texas Highway 1024 in Comstock, 27 miles north on Texas Highway 1024 to county road, 6.5 miles west on county road, 100 feet south in rangeland:

A1—0 to 8 inches; grayish brown (10YR 5/2) stony loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure parting to weak fine granular; slightly hard, friable; common very fine and fine roots; about 17 percent by volume limestone fragments 2 mm to 7.5 cm across, about 30 percent fragments 7.5 cm to 25 cm across, and 3 percent fragments 25 cm to 60 cm across; fragments coated with caliche; common pendants of calcium carbonate 1/8 to 3/8 inch thick on lower surfaces of fragments; calcareous; moderately alkaline; clear wavy boundary.

R&Cca—8 to 15 inches; moderately fractured limestone with cracks about 25 cm to 40 cm apart; hardness of about 3 on Mohs' scale; coatings of calcium carbonate up to 5 mm thick on surfaces, cracks and crevices filled and partially sealed with calcium carbonate; clear wavy boundary.

R—15 to 60 inches; indurated coarsely fractured limestone bedrock; few seams of calcium carbonate in cracks and crevices in upper part.

The solum thickness, or depth to limestone bedrock, ranges from 4 to 20 inches. Carbonate accumulations smaller than 20 mm make up more than 40 percent by weight of the whole soil. Calcium carbonate equivalent in the fine earth fraction averages 10 to 30 percent.

The A horizon is grayish brown, dark grayish brown, very dark grayish brown, dark brown, or brown. It is 35 to 80 percent by volume coarse fragments of limestone and caliche. About 15 to 50 percent of the fragments are gravel, 5 to 35 percent are

cobbles, and 1 to 35 percent are stones. The fine earth fraction is loam, clay loam, silty clay loam, or silt loam.

The R layer in most pedons consists of thick beds of indurated limestone, but in some pedons it is interbedded limestone containing strata of chalk and marl.

Felipe series

The Felipe series consists of very gravelly clayey soils on the sides of hills on uplands. These soils are shallow and well drained. They formed in shaly clay. Slope ranges from 8 to 40 percent.

Typical pedon of Felipe very gravelly clay in an area of Felipe and Zorra soils, very rocky, 8 to 40 percent slopes; from the intersection of U.S. Highway 90 and U.S. Highway 277-377 north of Del Rio, 14 miles west on U.S. Highway 90, 6 miles southwest on private road, 700 feet north of road on a hillside in rangeland:

A1—0 to 5 inches; light olive brown (2.5Y 5/4) very gravelly clay, olive brown (2.5Y 4/4) moist; weak medium granular and fine subangular blocky structure; very hard, very firm; few fine roots; few fossil shells; about 45 percent by volume angular limestone fragments 2 mm to 7.5 cm across; few thin flat limestone, ironstone, and siltstone fragments; calcareous; moderately alkaline; clear smooth boundary.

B2—5 to 18 inches; light olive brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) moist; weak fine angular blocky structure; very hard, very firm; few fine roots; few fine gypsum crystals; calcareous; moderately alkaline; gradual smooth boundary.

Cr—18 to 72 inches; olive yellow (2.5Y 6/6) shaly silty clay, light olive brown (2.5Y 5/6) moist; few faint brownish yellow mottles; coarse platy and blocky rock structure; extremely hard, extremely firm; few fine and medium gypsum crystals; few fine black concretions; calcareous; moderately alkaline.

The solum thickness, or depth to shale or shaly silty clay, ranges from 10 to 20 inches. Calcium carbonate equivalent in the control section is 15 to 39 percent. The fine earth fraction of the control section is 40 to 60 percent total clay and 35 to 55 percent noncarbonate clay. Salinity ranges from 1 to 4 mmho/cm in the saturation extract.

The A horizon is grayish brown, light brownish gray, pale brown, light yellowish brown, yellowish brown, light olive brown, or pale olive. It contains 20 to 70 percent by volume angular gravel of limestone, siltstone, and ironstone and fossil shells and iron nodules of gravel size. The fine earth fraction is clay loam, sandy clay loam, silty clay loam, clay, or silty clay.

The B horizon has the same colors as the A horizon. It contains 0 to 10 percent shale and shaly clay fragments. Texture is clay loam, silty clay, or clay.

The Cr horizon is clayey shale, shaly silty clay, or shaly clay. Some pedons contain interbedded layers of marl and thin, calcareous, weakly cemented shaly flagstones. Colors are mainly olive and yellow, but some pedons contain gray and red material.

Hodgins series

The Hodgins series consists of loamy soils on valley fills, old stream terraces, and low uplands. These soils are deep and well drained. They formed in calcareous loamy alluvium derived from limestone. Slope ranges from 0 to 3 percent.

Typical pedon of Hodgins silt loam, 0 to 3 percent slopes; from the intersection of U.S. Highway 90 and Ranch Road 1865 about 14 miles northwest of Langtry, 3 miles

northeast on Ranch Road 1865 to railroad tracks at Pumpville, 5.8 miles north to private road, 1.35 miles east, 50 feet south in rangeland:

A1—0 to 8 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak fine subangular blocky structure parting to weak fine granular; slightly hard, friable; few fine and medium roots; calcareous; moderately alkaline; clear smooth boundary.

B2—8 to 20 inches; light yellowish brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; slightly hard, friable; few fine and medium roots; calcareous; moderately alkaline; clear wavy boundary.

B2ca—20 to 45 inches; light yellowish brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; slightly hard, friable; few fine roots in upper part; few waterworn pebbles in the lower part that are thinly coated with calcium carbonate; about 2 percent by volume threads and films of calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

B3ca—45 to 62 inches; pink (7.5YR 7/4) clay loam, strong brown (7.5YR 5/6) moist; weak fine subangular blocky structure; slightly hard, friable; about 5 percent by volume gravel that is thinly coated with calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 40 to more than 60 inches in thickness. Calcium carbonate equivalent in the 10- to 40-inch control section is 25 to 40 percent. The control section is 30 to 45 percent total clay and 25 to 34 percent noncarbonate clay. Secondary carbonates in the form of threads, films, soft masses, and concretions make up less than 5 percent by volume of any horizon that has its upper boundary within 40 inches of the surface.

The A horizon is pale brown, brown, grayish brown, or light brownish gray. Texture is silt loam or silty clay loam.

The B horizon is pinkish gray, pink, light yellowish brown, light brown, light gray, very pale brown, or pale brown. Texture is silty clay loam, clay loam, or silty clay.

Jimenez series

The Jimenez series consists of very gravelly loamy soils on old stream terraces on uplands. These soils are very shallow and shallow and are excessively drained. They formed in gravelly alluvium over thick beds of caliche. Slope ranges from 1 to 8 percent.

Typical pedon of Jimenez very gravelly loam (fig. 19) in an area of Jimenez-Quemado complex, 1 to 8 percent slopes; from the intersection of U.S. Highway 90 and Texas Highway 163 in Comstock, 0.2 mile south, 0.2 mile west, 0.2 mile south, and 0.05 mile west on city streets to extreme southwest corner of Comstock town site, 5.9 miles south on private road to ranch entrance, 0.6 mile south, 0.25 mile west on ranch road to headquarters, 1.25 miles west on small road, 75 feet north in rangeland:

A1—0 to 10 inches; dark grayish brown (10YR 4/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; about 60 percent by volume waterworn pebbles 2 mm to 5 cm across of quartzite, chert, limestone, sandstone, and igneous rocks; calcareous; moderately alkaline; abrupt wavy boundary.

Ccam—10 to 17 inches; white (10YR 8/2) indurated caliche, laminar in upper part; about 50 percent by volume embedded gravel; diffuse irregular boundary.

Cca—17 to 60 inches; white (10YR 8/2) weakly cemented caliche; about 5 percent by volume embedded gravel.

The solum thickness, or depth to indurated caliche, ranges from 7 to 20 inches. Calcium carbonate equivalent in the control section is less than 40 percent.

The A horizon is dark grayish brown, grayish brown, dark brown, or brown. It is 35 to 80 percent by volume gravel. The fine earth fraction is loam or clay loam.

The Ccam horizon ranges from about 4 to 12 inches in thickness. It is fractured and platy in the upper part in some pedons. The Ccam horizon is strongly cemented or indurated. Gravel content ranges from a little to about 50 percent by volume. The Cca horizon contains from a little to as much as 50 percent by volume embedded gravel.

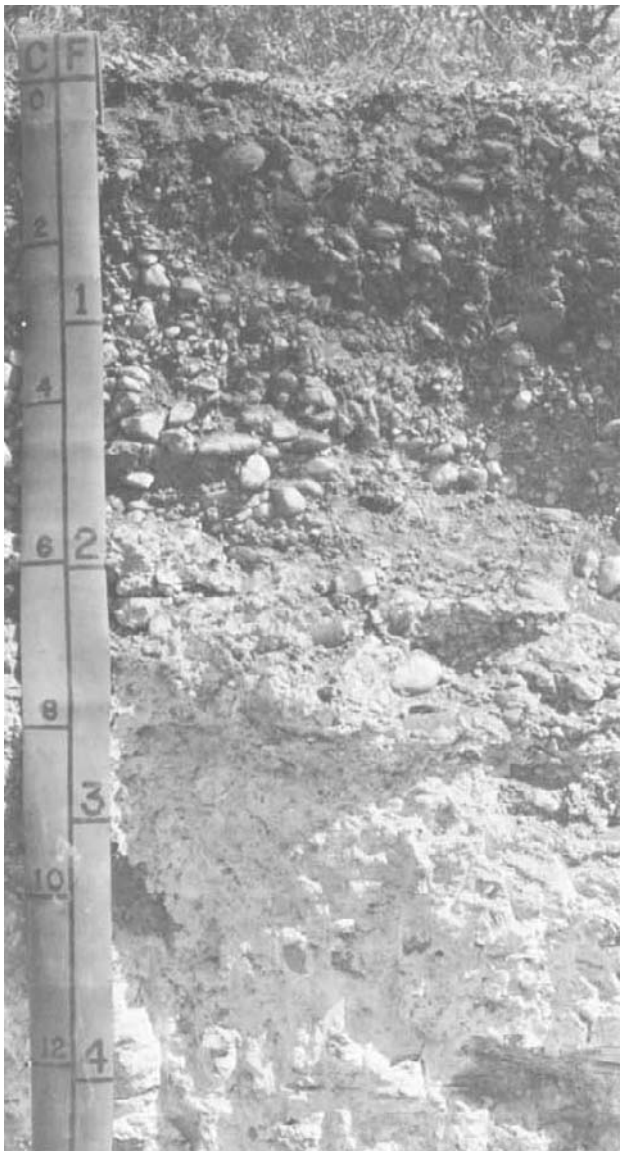


Figure 19.—Profile of Jimenez very gravelly loam. The surface layer rests on a layer of indurated caliche at a depth of about 20 inches. (Scale "C" Is In decimeters; scale "F" is in feet.)

Kavett series

The Kavett series consists of stony and clayey soils on limestone plateaus on uplands. These soils are shallow and well drained. They are underlain by cemented caliche above limestone bedrock. Slope ranges from 0 to 5 percent.

Typical pedon of Kavett stony clay in an area of Kavett-Tarrant association, gently undulating; from the intersection of U.S. Highway 277 and U.S. Highway 377 north of Del Rio 36.6 miles north on U.S. Highway 277, 3.1 miles west on private ranch road, 20 feet south of road in rangeland:

A11—0 to 6 inches; dark grayish brown (10YR 4/2) stony clay, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; hard, firm; common fine roots; about 2 percent by volume angular limestone fragments 25 to 60 cm across, few limestone and caliche pebbles; calcareous; moderately alkaline; clear wavy boundary.

A12—6 to 13 inches; brown (10YR 5/3) stony clay, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; hard, firm; few fine roots; about 8 percent by volume angular limestone and caliche fragments, 6 percent is gravel 2 mm to 25 cm across and 2 percent is stones 25 to 60 cm across; calcareous; moderately alkaline; abrupt wavy boundary.

Ccam—13 to 14 inches; pinkish white (7.5YR 8/2) strongly cemented caliche that has a laminar cap on the upper surface about 1/2 inch thick; clear wavy boundary.

Cca—14 to 23 inches; light brown (7.5YR 6/4) very gravelly clay, brown (7.5YR 5/4) moist; massive; hard, friable; about 50 percent by volume strongly cemented caliche fragments 2 mm to 7.5 cm across; calcareous; moderately alkaline; abrupt wavy boundary.

R—23 to 60 inches; indurated limestone bedrock; cracks and crevices in upper part filled with calcium carbonate.

Solum thickness, or depth to strongly cemented caliche (Ccam horizon), ranges from 10 to 20 inches. Stones cover 0.1 to 3 percent of the surface. Calcium carbonate equivalent in the fine earth fraction of the control section is 5 to 20 percent. The fine earth fraction of the control section is 40 to 60 percent total clay and 35 to 50 percent noncarbonate clay. Depth to bedrock (R layer) is 11 to about 26 inches.

The A horizon is grayish brown, dark grayish brown, dark brown, or brown. Gravel and stones make up 0 to 15 percent of the A horizon. The A horizon is silty clay, clay, clay loam, or silty clay loam.

Some pedons have a B horizon that has color values higher than those of the A horizon.

The Ccam horizon is strongly cemented or indurated. The upper 1/4 to 1 inch is a laminar cap in some pedons. The Cca horizon is absent in some pedons.

The R layer ranges from indurated limestone to interbedded limestone, chalk, and marl.

Lagloria series

The Lagloria series consists of deep, well drained soils on low terraces. These soils formed in loamy calcareous alluvium. Slope ranges from 0 to 3 percent.

Typical pedon of Lagloria loam, 0 to 3 percent slopes; from the intersection of U.S. Highway 277 and U.S. Highway 90 in Del Rio, 0.25 mile south on railroad overpass on U.S. Highway 277, 1.5 miles generally southwest on Spur 239, 0.65 mile south on Spur 239, 100 feet east in rangeland:

Ap—0 to 7 inches; brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard, friable; common fine and

medium roots; common fine discontinuous pores; calcareous; moderately alkaline; abrupt smooth boundary.

A1—7 to 13 inches; brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak fine subangular blocky and weak very fine granular structure; slightly hard, friable; common fine roots; few fine discontinuous pores; calcareous; moderately alkaline; clear wavy boundary.

B21ca—13 to 38 inches; light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; slightly hard, friable; few fine roots; few threads, films, and soft masses of calcium carbonate in lower part; calcareous; moderately alkaline; clear wavy boundary.

B22ca—38 to 56 inches; light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; slightly hard, friable; few discontinuous bedding planes below a depth of 40 inches; few fine roots; few waterworn pebbles; about 6 percent by volume threads, films, soft masses, and concretions of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

Cca—56 to 60 inches; light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable; common bedding planes; about 6 percent by volume threads, films, soft masses, and concretions of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 40 to 60 inches in thickness. The 10- to 40-inch control section is 15 to 25 percent total clay and 8 to 18 percent noncarbonate clay. Calcium carbonate equivalent in the control section is 10 to 25 percent. Some pedons have an Ab horizon at a depth of 20 to 30 inches.

The A horizon is light brownish gray, pale brown, light gray, brown, or very pale brown.

The Bca horizon is light brownish gray, pale brown, light yellowish brown, or very pale brown. Texture is very fine sandy loam, silt loam, or loam.

The Cca horizon is stratified or has bedding planes. Textures and colors are the same as those of the Bca horizon.

Langtry series

The Langtry series consists of cobbly, stony, and very stony loamy soils on lops and sides of ridges on uplands. These soils are very shallow and shallow and are well drained. These soils formed in material weathered from massive limestone bedrock. Slope ranges from 1 to 40 percent.

Typical pedon of Langtry cobbly silt loam, very rocky, 1 to 8 percent slopes (fig. 20); from junction of U.S. Highway 90 and Texas Highway 163 in Comstock, 6.8 miles west on U.S. Highway 90, 100 feet south in rangeland:

A1—0 to 8 inches; dark grayish brown (10YR 4/2) cobbly silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium subangular blocky and granular structure; slightly hard, friable; common fine roots; about 22 percent by volume limestone fragments 2 mm to 7.5 cm across and 23 percent fragments 7.5 cm to 20 cm across; limestone fragments coated with calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

R&Cca—8 to 14 inches; commonly fractured and indurated limestone with reprecipitated calcium carbonate coatings up to 1/4 inch thick; many cracks and crevices filled and partially sealed with calcium carbonate; about 5 to 10 percent by volume thin seams of A1 material 3 mm to 6 mm thick in cracks and crevices; gradual wavy boundary.

R—14 to 30 inches; coarsely fractured massive limestone bedrock; few seams of calcium carbonate in cracks and crevices in upper part.

The solum thickness, or depth to limestone bedrock, ranges from 4 to 20 inches. Carbonate accumulations smaller than 20 mm make up more than 40 percent by weight of the whole soil. Calcium carbonate equivalent in the fine earth fraction is 10 to 30 percent. The fine earth fraction is 10 to 40 percent total clay and 8 to 34 percent noncarbonate clay.

Figure 20.—Profile of Langtry cobbly silt loam, very rocky, 1 to 8 percent slopes. The surface layer is typically 14 inches thick over fractured limestone bedrock.

The A horizon is brown, dark brown, dark grayish brown, or very dark grayish brown. It is 35 to 80 percent by volume coarse fragments of limestone and caliche. About 10 to 30 percent of the fragments are gravel, 20 to 70 percent are cobbles, and 0 to 15 percent are stones. The fine earth fraction is loam, silt loam, or clay loam.

The R layer in most pedons consists of thick beds of indurated limestone, but in some pedons it is interbedded limestone containing strata of chalk and marl.

Laredo series

The Laredo series consists of deep, well drained soils on bottom lands. These soils formed in calcareous silty and loamy alluvium. Slope ranges from 0 to 1 percent.

Typical pedon of Laredo silty clay loam; from intersection of U.S. Highway 277 and U.S. Highway 90 in Del Rio, 2.3 miles generally west on city street to a road that crosses railroad tracks, 0.35 mile southwest to a gate, 175 feet east in pasture:

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak coarse blocky structure parting to weak fine granular; slightly hard, friable; common fine and very fine roots; common fine and medium discontinuous pores; calcareous; moderately alkaline; abrupt smooth boundary.

A1—7 to 13 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure parting to weak fine granular; slightly hard, friable; few fine and very fine roots; few fine discontinuous pores; few concretions of calcium carbonate up to 2 mm in size; calcareous; moderately alkaline; gradual wavy boundary.

B2—13 to 32 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard, friable; few very fine roots; few waterworn siliceous pebbles; few soft masses of calcium carbonate up to 5 mm in size in lower part of horizon; calcareous; moderately alkaline; clear wavy boundary.

B2ca—32 to 42 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; slightly hard, friable; few very fine roots; common krotovinas filled with dark grayish brown (10YR 4/2) silty clay loam in upper part of horizon; about 4 percent by volume threads, films, and soft masses of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

Cca—42 to 60 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; massive; slightly hard, friable; about 10 percent by volume soft masses and concretions of calcium carbonate 4 mm to 2 cm in size; calcareous; moderately alkaline.

The solum ranges from 40 to 56 inches in thickness. Calcium carbonate equivalent in the 10- to 40-inch control section is 25 to 39 percent. The control section is 35 to 40 percent total clay and 25 to 34 percent noncarbonate clay. Secondary carbonates in the form of threads, films, soft masses, and concretions make up less than 5 percent by volume of any horizon having an upper boundary within 40 inches of the surface.

The A horizon is dark grayish brown or brown.

The B2 horizon is grayish brown, light brownish gray, brown, or pale brown.

The Cca horizon is light brownish gray, light gray, very pale brown, or pale brown.

Laredo silty clay loam is a taxadjunct to the Laredo series because it lacks evident stratification above a depth of 50 inches and has a calcic horizon below a depth of 40 inches. These differences do not influence use, management, or behavior of the soil.

Laredo Variant

The Laredo Variant consist of deep, moderately well drained soils on bottom lands. These soils formed in calcareous clayey and loamy alluvium. These soils have a seasonal high water table at a depth of 5 to 6 feet. Slope ranges from 0 to 1 percent.

Typical pedon of Laredo Variant silty clay loam; from intersection of U.S. Highway 90 and U.S. Highway 277 in Del Rio, 0.25 mile south on railroad overpass, 2.25 miles southwest on city street, 300 feet north in pasture:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky and weak fine granular structure; slightly hard, friable; common fine roots; calcareous; moderately alkaline; abrupt smooth boundary.

A1—8 to 12 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure parting to weak fine granular; slightly hard, friable; common fine roots; calcareous; moderately alkaline; gradual wavy boundary.

B21—12 to 28 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; hard, firm; few fine roots; few concretions of calcium carbonate in lower part of horizon; calcareous; moderately alkaline; gradual wavy boundary.

B22ca—28 to 48 inches; pale brown (10YR 6/3) clay, brown (10YR 5/3) moist; few fine distinct dark reddish gray and brown mottles and common fine faint gray mottles below a depth of 30 inches; weak medium subangular blocky structure; hard, firm; few fine roots; about 4 percent by volume fine concretions of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

B23ca—48 to 54 inches; very pale brown (10YR 7/3) clay, pale brown (10YR 6/3) moist; common fine distinct yellowish brown and grayish brown mottles; weak medium subangular blocky structure; hard, firm; few very fine roots; about 8 percent by volume fine concretions of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

Cca—54 to 60 inches; very pale brown (10YR 7/3) clay, pale brown (10YR 6/3) moist; massive; hard, firm; about 10 percent by volume threads, films, soft masses, and concretions of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 40 to 56 inches in thickness. Calcium carbonate equivalent in the 10- to 40-inch control section is 20 to 39 percent. The control section is 35 to 50 percent total clay and 25 to 34 percent noncarbonate clay. Secondary carbonates in the form of threads, films, soft masses, and concretions make up less than 5 percent by volume of any horizon that has its upper boundary within 40 inches of the surface.

The A horizon is dark grayish brown or grayish brown.

The B horizon is brown, pale brown, light brownish gray, very pale brown, or grayish brown. Texture is silty clay loam, silty clay, clay loam, or clay.

The Cca horizon is light gray or very pale brown. Its texture is the same as that of the B horizon. The Cca horizon is absent in some pedons.

Lozier series

The Lozier series consists of very cobbly and very gravelly loamy soils on ridges, side slopes, and low uplands. These soils are very shallow and shallow and are well drained. They formed in material derived from massive limestone bedrock. Slope ranges from 1 to 60 percent.

Typical pedon of Lozier very gravelly loam in an area of Lozier-Shumla association, undulating; from the intersection of U.S. Highway 90 and east end of Loop 25 in Langtry, 0.65 mile southwest on Loop 25, 0.27 mile generally southwest on unpaved road, 100 feet south in rangeland:

A1—0 to 8 inches; light brownish gray (10YR 6/2) very gravelly loam, grayish brown (10YR 5/2) moist; weak fine and medium subangular blocky structure; slightly hard, friable; few fine roots; about 40 percent by volume limestone fragments 2 mm to 7.5 cm across that are coated with caliche; calcareous; moderately alkaline; abrupt wavy boundary.

R&Ca—8 to 14 inches; moderately fractured indurated limestone coated with a layer of reprecipitated calcium carbonate up to 1/2 inch thick; many cracks and crevices filled and partially sealed with calcium carbonate; gradual wavy boundary.

R—14 to 60 inches; coarsely fractured massive limestone bedrock; few seams of calcium carbonate in cracks and crevices in upper part.

The solum thickness, or depth to limestone bedrock, ranges from 4 to 16 inches. Carbonate accumulations smaller than 20 mm make up more than 40 percent by weight of the whole soil. Calcium carbonate equivalent in the fine earth fraction is 35 to 50 percent. The fine earth fraction is 15 to 25 percent total clay and 5 to 15 percent noncarbonate clay.

The A horizon is light brownish gray, pale brown, light yellowish brown, or light gray. It is 35 to 80 percent by volume coarse fragments of limestone and caliche. About 15 to 60 percent of the fragments are gravel and 0 to 50 percent are cobbles. Texture is very gravelly loam or very cobbly loam.

The R layer in most pedons consists of thick beds of indurated limestone, but in some pedons it is interbedded limestone containing strata of chalk and marl.

Mariscal series

The Mariscal series consists of very flaggy and very channery loamy soils on uplands. These soils are very shallow and are well drained. They formed in material derived from flaggy limestone bedrock. Slope ranges from 1 to 60 percent.

Typical pedon of Mariscal very flaggy loam in an area of Mariscal-Lozier association, very steep; from the intersection of U.S. Highway 90 and the west end of Loop 25 in Langtry, 2.8 miles west on U.S. Highway 90, 0.65 mile south on private ranch road, 400 feet west in rangeland:

A1—0 to 7 inches; pale brown (10YR 6/3) very flaggy loam, brown (10YR 5/3) moist; weak fine subangular blocky and weak fine and very fine granular structure; slightly hard, very friable; common fine roots; common fine pores; about 24 percent by volume limestone fragments 2 mm to 15 cm across and 36 percent fragments 15 cm to 45 cm across; limestone fragments coated with calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

R&Cca—7 to 10 inches; fractured flaggy limestone; caliche coatings up to 3 mm thick on surface and partially sealing cracks and crevices; gradual wavy boundary.

R—10 to 60 inches; fractured flaggy limestone bedrock, hardness of 3 on Mohs' scale; few seams of calcium carbonate in cracks and crevices and between flagstones in upper part.

The solum thickness, or depth to limestone bedrock, ranges from 4 to 20 inches. Carbonate accumulations smaller than 20 mm in size make up more than 40 percent by weight of the whole soil. Calcium carbonate equivalent in the fine earth fraction is 30 to 45 percent. The fine earth fraction is 10 to 35 percent total clay and 5 to 30 percent noncarbonate clay.

The A horizon is brown, pale brown, grayish brown, light brownish gray, or very pale brown. Coarse fragments of limestone and caliche make up 35 to 85 percent by volume of the A horizon. Texture of the fine earth fraction is loam, silt loam, or clay loam.

The R layer in most pedons consists of thick beds of flaggy limestone or limestone interbedded with strata of chalk and marl.

Olmos series

The Olmos series consists of very gravelly and loamy soils on uplands. These soils are very shallow and shallow and are well drained. They formed in old outwash sediments over thick beds of caliche. Slope ranges from 1 to 8 percent.

Typical pedon of Olmos very gravelly loam, 1 to 8 percent slopes; from the intersection of U.S. Highway 90 and U.S. Highway 277 north of Del Rio, 16.7 miles north on U.S. Highway 277, 0.25 miles west on ranch road, 30 feet south in rangeland:

A11—0 to 8 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 3/3) moist; moderate fine and medium subangular blocky and moderate medium granular structure; slightly hard, friable; common fine and medium roots; about 35 percent by volume limestone and caliche gravel; calcareous; moderately alkaline; clear wavy boundary.

A12—8 to 18 inches; brown (10YR 5/3) very gravelly clay loam, dark brown (10YR 3/3) moist; moderate fine and medium subangular blocky and moderate medium granular structure; slightly hard, friable; few fine and medium roots; about 50 percent by volume limestone and caliche gravel; calcareous; moderately alkaline; abrupt wavy boundary.

Ccam—18 to 24 inches; pink (7.5YR 7/4) indurated caliche; hardness greater than 3 on Mohs' scale; laminar in upper 1/2 inch; strongly cemented in lower part.

Cca—24 to 60 inches; white to pink weakly cemented caliche that has fractures, solution channels, and embedded gravel.

The solum thickness, or depth to indurated caliche, ranges from 4 to 20 inches. Carbonate accumulations smaller than 20 mm make up more than 40 percent by weight of the whole soil. Calcium carbonate equivalent in the fine earth fraction is 25 to 40 percent. The fine earth fraction is 22 to 35 percent total clay and 10 to 20 percent noncarbonate clay.

The A horizon is very dark grayish brown, dark grayish brown, grayish brown, dark brown, or brown. It contains 35 to 80 percent limestone and caliche fragments. Most of the fragments are in the A12 horizon.

The Ccam horizon ranges from 1 inch to about 20 inches in thickness. The Ccam horizon is strongly cemented or indurated and is laminar in the upper part. Gravel content ranges from a little to 50 percent by volume.

The Cca horizon contains a little to 50 percent by volume limestone gravel.

Pintas series

The Pintas series consists of deep, somewhat poorly drained soils on bottom lands. The soils formed in calcareous clayey alluvium. The water table fluctuates between depths of 1 and 6 feet. Slope ranges from 0 to 1 percent.

Typical pedon of Pintas clay, frequently flooded; from intersection of U.S. Highway 90 and U.S. Highway 277 in Del Rio, 3 miles north on U.S. Highway 90, 1.25 miles west on city street, 0.75 mile southwest on caliche road, 0.5 mile west, 50 feet south in pasture:

Ap—0 to 6 inches; dark gray (10YR 4/1) clay, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; hard, friable; common fine and medium roots; calcareous; moderately alkaline; abrupt smooth boundary.

A1—6 to 11 inches; dark gray (10YR 4/1) clay, black (10YR 2/1) moist; weak medium subangular blocky structure parting to moderate medium granular; hard, friable; common fine and medium roots; calcareous; moderately alkaline; clear wavy boundary.

B2—11 to 23 inches; gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; weak medium subangular blocky structure; hard, friable; few fine roots; about 2 percent by volume hard and pitted concretions of calcium carbonate in lower part of horizon; calcareous; moderately alkaline; abrupt wavy boundary.

C1ca—23 to 42 inches; gray (10YR 6/1) clay, gray (10YR 5/1) moist; massive; extremely hard, firm; few fine roots in upper part; few waterworn limestone pebbles; about 15 percent by volume hard and pitted concretions of calcium carbonate 4 mm to 2 cm across, 5 percent by volume soft masses of calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

C2ca—42 to 62 inches; light gray (10YR 7/2) clay, grayish brown (10YR 5/2) moist; massive; common medium distinct yellowish brown mottles; few waterworn limestone pebbles; about 3 percent by volume soft masses and concretions of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 22 to 40 inches in thickness. Calcium carbonate equivalent in the 10- to 40-inch control section is 40 to 70 percent. The control section is 50 to 70 percent total clay and 35 to 50 percent noncarbonate clay. Secondary carbonates in the form of threads, films, soft masses, and concretions make up less than 5 percent by volume of any horizon that has its upper boundary within 16 inches of the surface.

The A horizon is very dark gray, dark gray, or gray.

The B2 horizon is gray or light gray. Texture is silty clay loam, silty clay, or clay.

The Cca horizon is gray, light gray, or white. Texture is silty clay loam, clay loam, or clay. Some pedons have gravel strata below a depth of 5 feet.

Quemado series

The Quemado series consists of very gravelly soils on old stream terraces on uplands. These soils are shallow and well drained. They formed in gravelly loamy alluvium over thick beds of caliche. Slope ranges from 1 to 8 percent.

Typical pedon of Quemado very gravelly loam in an area of Jimenez-Quemado complex, 1 to 8 percent slopes; from the intersection of U.S. Highway 90 and Texas Highway 163 in Comstock, 0.2 mile mouth. 0.2 mile west, 0.2 mile south, and 0.05 mile west on city streets to extreme southwest corner of Comstock town site, 5.9 miles south on private road to ranch entrance, 0.6 mile south, 0.25 mile west on ranch road to headquarters, 1.1 miles west-southwest, 45 feet south in rangeland:

A1—0 to 5 inches; dark brown (7.5YR 4/4) very gravelly loam, dark brown (7.5YR 3/4) moist; weak fine and medium subangular blocky and granular structure; slightly humid, friable; few fine and medium roots; common fine pores; about 50 percent by volume waterworn quartz, chert, and limestone gravel 2 mm to 7.5 cm across; noncalcareous; mildly alkaline; clear smooth boundary.

B2t—5 to 13 inches; reddish brown (5YR 4/4) very gravelly loam, slightly more clayey than the horizon above, dark reddish brown (5YR 3/4) moist; weak fine and medium subangular blocky and granular structure; slightly hard, friable; few fine and medium roots; common fine pores; about 55 percent by volume waterworn quartz, chert, and limestone gravel 2 mm to 7.5 cm across; noncalcareous; mildly alkaline; abrupt wavy boundary.

Ccam—13 to 18 inches; pinkish white (7.5YR 8/2) indurated caliche; laminar in upper part; 10 percent by volume embedded gravel; diffuse irregular boundary.

Cca—18 to 60 inches; pinkish white (7.5YR 8/2) weakly cemented caliche; 5 percent by volume embedded gravel.

The solum thickness, or depth to indurated caliche, ranges from 10 to 20 inches. Gravel content in the control section ranges from 35 to 80 percent by volume.

The A1 horizon is brown, dark brown, or reddish brown. The fine earth fraction is sandy loam or loam.

The B2t horizon is brown or reddish brown. The fine earth fraction is sandy loam, loam, or sandy clay loam.

The Ccam horizon ranges in thickness from about 4 inches to 10 inches. It is strongly cemented or indurated. It is fractured and platy in the upper part in some pedons. Gravel content ranges from a little to about 50 percent by volume.

The Cca horizon contains a little to as much as 50 percent by volume gravel.

Reynosa series

The Reynosa series consists of deep, well drained soils on old stream terraces. These soils formed in calcareous silty and loamy sediment. Slope ranges from 0 to 2 percent.

Typical pedon of Reynosa silty clay loam; from the intersection of U.S. Highway 90 and U.S. Highway 277 in Del Rio, 0.25 mile south on railroad overpass, 1 block southwest on city street, 1 mile south to historical marker located 40 feet southwest of bend in street, 600 feet southwest on field road, 100 feet northwest of field road, 15 feet northeast in vineyard:

Ap—0 to 8 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; hard, friable; common fine roots; few fine pores; calcareous; moderately alkaline; abrupt smooth boundary.

A11—8 to 12 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate fine and medium subangular blocky and weak fine granular structure; hard, friable; common fine roots; common fine pores; calcareous; moderately alkaline; gradual smooth boundary.

A12—12 to 16 inches; light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate fine and medium subangular blocky and weak fine granular structure; hard, friable; few fine roots; common fine pores; few threads and films of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

B21ca—16 to 24 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate fine and medium subangular blocky structure; hard, firm;

few fine roots; common fine pores; few threads and films of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

B22ca—24 to 40 inches; light yellowish brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; hard, firm; few fine roots; many fine and medium pores; about 5 percent by volume threads, films, soft masses, and concretions of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

B3ca—40 to 58 inches; light yellowish brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; extremely hard, firm; few fine roots; common fine and medium pores; about 15 percent by volume threads, films, soft masses, and concretions of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

Cca—58 to 64 inches; light yellowish brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; extremely hard, firm; common fine and medium pores; about 20 percent by volume threads, films, soft masses, and concretions of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 40 to 60 inches in thickness. Calcium carbonate equivalent in the 10- to 40-inch control section is 40 to 55 percent. The control section is 30 to 40 percent total clay and 20 to 34 percent noncarbonate clay.

The A horizon is light brownish gray, grayish brown, pale brown, or brown. If value is less than 3.5 when the soil is moist, the A horizon is less than 6 inches thick.

The B horizon is brown, light yellowish brown, yellowish brown, pale brown, or very pale brown.

The Cca horizon is light yellowish brown, very pale brown, or light yellowish brown.

Reynosa silty clay loam is a taxadjunct to the Reynosa series because it lacks evident stratification within a depth of 50 inches and it has carbonatic mineralogy. These differences do not significantly affect use and management.

Rio Diablo series

The Rio Diablo series consists of deep, well drained soils on low uplands and stream terraces. These soils formed in calcareous silty and clayey alluvium derived from limestone. Slope ranges from 0 to 2 percent.

Typical pedon of Rio Diablo silty clay; from the intersection of U.S. Highway 90 and Texas Highway 163 in Comstock, 48.7 miles north on Texas Highway 163 to ranch entrance, 2.65 miles east on ranch road, 0.3 miles northeast in rangeland:

A1—0 to 17 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure parting to weak fine granular, weak fine platy structure in upper 1 inch; hard, friable; common fine roots; few fine pores; few limestone pebbles; calcareous; moderately alkaline; clear wavy boundary.

B21—17 to 29 inches; brown (7.5YR 5/4) clay, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; hard, firm; few fine roots; few waterworn limestone pebbles with thin coatings of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

B22ca—29 to 46 inches; light brown (7.5YR 6/4) clay, dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; hard, firm; few fine roots; few waterworn pebbles with thin coatings of calcium carbonate; few threads and films of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

B23ca—46 to 60 inches; light brown (7.5YR 6/4) clay, brown (7.5YR 5/4) moist; weak fine subangular blocky structure; hard, firm; few fine roots in upper part; few waterworn limestone pebbles with thin coatings of calcium carbonate; about 5 percent by volume soft masses and hard concretions of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 40 to more than 60 inches in thickness. Calcium carbonate equivalent in the 10- to 40-inch control section is 20 to 40 percent. The control section is 40 to 55 percent total clay and 35 to 45 percent noncarbonate clay. Secondary carbonates in the form of threads, films, soft masses, and concretions make up less than 5 percent of any horizon that has its upper boundary within 40 inches of the surface. Coefficient of linear extensibility ranges from 0.035 to 0.050. Coarse fragments make up 0 to 15 percent by volume of the soil.

The A horizon is very dark grayish brown, dark grayish brown, grayish brown, dark brown, or brown.

The B horizon is brown, light brown, or pink. Texture is silty clay loam, silty clay, or clay.

A C horizon is present in some pedons. Its color and texture are the same as those of the B horizon. Some pedons have gravelly or cobbly strata below a depth of 40 inches.

Rio Grande series

The Rio Grande series consists of deep, well drained soils on bottom lands. These soils formed in recent loamy and silty alluvium of the Rio Grande. Slope ranges from 0 to 3 percent.

Typical pedon of Rio Grande silt loam; from the intersection of U.S. Highway 90 and U.S. Highway 277 in Del Rio, 0.25 mile south on railroad overpass, 3.0 miles generally southeast on U.S. Highway 277, 2.2 miles generally southwest on ranch road to four concrete silos, 1.0 mile south on ranch road, 150 feet west in rangeland:

A1—0 to 9 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive, upper 1 inch is single grained; slightly hard, very friable; common fine, medium, and coarse roots; common fine and medium discontinuous pores; calcareous; moderately alkaline; abrupt smooth boundary.

C1—9 to 14 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable; common fine and medium roots; common fine pores; few bedding planes; calcareous; moderately alkaline; abrupt smooth boundary.

C2—14 to 51 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable; few fine roots; common bedding planes; calcareous; moderately alkaline; clear smooth boundary.

C3—51 to 64 inches; pale brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; massive; slightly hard, very friable; few fine roots; common bedding planes; calcareous; moderately alkaline.

The control section is 5 to 25 percent total clay and 4 to 18 percent noncarbonate clay. A1 horizons are light brownish gray, grayish brown, light gray, pale brown, or very pale brown. Texture throughout is silt loam, very fine sandy loam, loam, or loamy very fine sand, or the soil is stratified with these textures.

The A horizon is silt loam, very fine sandy loam, loam, or loamy very fine sand. In some pedons the A horizon is absent and the surface layer is a stratified C horizon.

The C horizon contains few to many evident strata that range in texture from loamy fine sand to clay loam.

Sanderson series

The Sanderson series consists of deep, well drained, very gravelly soils on terraces and low uplands. These soils formed in gravelly loamy outwash material from limestone hills. Slope ranges from 0 to 5 percent.

Typical pedon of Sanderson very gravelly loam in an area of Sanderson-Shumla complex, 0 to 5 percent slopes; from the intersection of the west end of Loop 25 and U.S. Highway 90 in Langtry, 2.8 miles west on U.S. Highway 90, 0.9 mile south on private ranch road, 150 feet west in rangeland:

A11—0 to 3 inches; pale brown (10YR 6/3) very gravelly loam, brown (10YR 5/3) moist; weak fine subangular blocky and weak fine granular structure; slightly hard, friable; few fine roots; about 45 percent by volume angular limestone fragments 2 mm to 7.5 cm across; calcareous; moderately alkaline; abrupt smooth boundary.

A12—3 to 8 inches; pale brown (10YR 6/3) very gravelly loam, brown (10YR 5/3) moist; weak fine subangular blocky and weak fine granular structure; slightly hard, friable; few fine roots; about 40 percent by volume angular limestone fragments 2 mm to 7.5 cm across; calcareous; moderately alkaline; clear wavy boundary.

B21ca—8 to 18 inches; light brown (7.5YR 6/4) very gravelly clay loam, brown (7.5YR 5/4) moist; weak fine subangular blocky structure; slightly hard, very friable; few fine roots; about 40 percent by volume angular and rounded limestone fragments 2 mm to 7.5 cm across that are coated with caliche; about 2 percent by volume threads and films of calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

B22ca—18 to 36 inches; light brown (7.5YR 6/4) very gravelly clay loam, brown (7.5YR 5/4) moist; weak fine subangular blocky structure; slightly hard, very friable; few fine roots; about 40 percent by volume angular and rounded limestone fragments 2 mm to 5 cm across that are coated with caliche; about 3 percent by volume threads, films, and coatings of calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

C—36 to 60 inches; pink (7.5YR 7/4) very gravelly clay loam, light brown (7.5YR 6/4) moist; massive; slightly hard, very friable; about 35 percent by volume uncoated angular and rounded limestone fragments 2 mm to 25 mm across; calcareous; moderately alkaline.

The solum ranges from 24 to 45 inches in thickness. Calcium carbonate equivalent in the fine earth fraction of the 10- to 40-inch control section is 40 to 50 percent. The fine earth fraction of the control section is 20 to 35 percent total clay and 5 to 25 percent noncarbonate clay. The fine earth fraction is loam, sandy loam, or clay loam in all horizons. Secondary carbonates in the form of threads, films, soft masses, and concretions make up less than 5 percent by volume of any horizon having an upper boundary within 40 inches of the surface.

The A horizon is light brownish gray, pale brown, pinkish gray, light brown, or grayish brown. It is 15 to 50 percent by volume limestone gravel.

The B2ca horizon is light brownish gray, pale brown, light yellowish brown, light brown, or pink. It is 35 to 80 percent by volume limestone gravel and cobbles.

The C horizon is very pale brown, pink, light yellowish brown, or light brown. It is 35 to 80 percent by volume limestone gravel and cobbles.

Shumla series

The Shumla series consists of very shallow and shallow, well drained soils on terraces and low uplands. These soils formed in calcareous loamy outwash sediment from limestone hills. The sediment overlies caliche. Slope ranges from 0 to 8 percent.

Typical pedon of Shumla loam, 0 to 5 percent slopes; from the intersection of U.S. Highway 90 and Texas Highway 163 in Comstock, 7.5 miles west on U.S. Highway 90, 450 feet north in rangeland:

A1—0 to 3 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; slightly hard, friable; few fine roots; about 5 percent by volume limestone pebbles and caliche fragments 2 mm to 12 mm across; limestone pebbles coated with calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B2—3 to 11 inches; yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 4/4) moist; weak fine and medium subangular blocky structure; slightly hard, friable; common fine roots; common fine and medium pores; about 5 percent by volume limestone pebbles and caliche fragments 2 mm to 12 mm across; limestone pebbles coated with calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

Ccam—11 to 17 inches; white (10YR 8/2) caliche; indurated and laminar in upper part, strongly cemented below; nodules on lower surface; clear smooth boundary.

Cca—17 to 36 inches; very pale brown (10YR 8/3) weakly cemented gravelly loam; few limestone fragments 12 mm to 7.5 cm across coated with calcium carbonate; common strongly cemented imbedded calcium carbonate concretions; calcareous; moderately alkaline; abrupt smooth boundary.

R—36 to 60 inches; fractured limestone bedrock; secondary calcium carbonate coatings on surface and in cracks and crevices in upper part.

The solum thickness, or depth to indurated caliche, ranges from 7 to 20 inches. Calcium carbonate equivalent in the control section is 10 to 39 percent. The control section is 15 to 35 percent total clay and 12 to 30 percent noncarbonate clay. Limestone and caliche fragments make up 0 to 15 percent by volume of the control section. Limestone bedrock is at a depth of 20 to 40 inches.

The A and B horizons are pale brown, brown, pinkish gray, light brownish gray, very pale brown, dark grayish brown, light yellowish brown, yellowish brown, or dark yellowish brown. Texture is silt loam, loam, or clay loam.

The Ccam horizon is 2 to 6 inches thick. It is strongly cemented or indurated and is laminar in the upper part.

Tarrant series

The Tarrant series consists of very stony clayey soils on uplands. These soils are very shallow and shallow and are well drained. They formed in material derived from limestone bedrock. Slope ranges from 0 to 8 percent.

Typical pedon of Tarrant very stony clay in an area of Tarrant association, undulating; from the intersection of U.S. Highway 90 and U.S. Highway 277-377 north of Del Rio, 21 miles north on U.S. Highway 277-377, 6.65 miles east on U.S. Highway 377, 200 feet south in rangeland:

A1—0 to 9 inches; very dark gray (10YR 3/1) very stony clay, black (10YR 2/1) moist; strong fine and medium subangular blocky and granular structure; very hard, firm; common fine roots; about 10 percent of the surface covered by limestone stones; about 40 percent by volume limestone

fragments 7.5 cm to 25 cm across and 5 percent fragments 2 mm to 7.5 cm across; fragments coated with calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

A12ca—9 to 14 inches; very dark grayish brown (10YR 3/2) very cobbly clay, very dark brown (10YR 2/2) moist; moderate fine and medium subangular blocky and granular structure; very hard, firm; few fine roots; about 40 percent by volume limestone fragments 7 to 25 cm across and 30 percent fragments 2 mm to 7 cm across; thin coatings of calcium carbonate on lower surfaces of fragments; calcareous; moderately alkaline; abrupt wavy boundary.

R—14 to 60 inches; white (10YR 8/2) coarsely fractured indurated limestone bedrock; few crevices in upper part filled with very dark grayish brown (10YR 3/2) clay; few roots extend into crevices; thin coatings of calcium carbonate on upper surface of the limestone bedrock and in cracks and crevices.

The solum thickness, or depth to limestone bedrock, ranges form 6 to 20 inches. Calcium carbonate equivalent in the fine earth fraction of the control section ranges from 5 to 20 percent. The fine earth fraction of the control section is 40 to 60 percent total clay and 35 to 55 percent noncarbonate clay.

The A horizon is very dark grayish brown, dark grayish brown, dark brown, dark gray, or very dark gray. The fine earth fraction is clay or silty clay. Coarse fragments make up 35 to 80 percent of the A horizon. About 5 to 35 percent of the fragments are gravel; 35 to 50 percent are cobbles, and 3 to 15 percent are stones.

In some pedons the R layer is interbedded limestone with strata of chalk and marl.

Tobosa series

The Tobosa series consists of clayey soils in narrow drainageways and shallow depressions on uplands. These soils are deep and well drained. They formed in calcareous, clayey alluvium. These soils crack when dry and have gilgai microrelief. Slope ranges from 0 to 1 percent.

Typical pedon of Tobosa clay, 0 to 1 percent slopes; from the intersection of U.S. Highway 277 and U.S. Highway 90 in Del Rio, 4.1 miles east on U.S. Highway 90 to highway crossover, 475 feet north in pasture in the center of a microdepression:

Ap—0 to 7 inches; grayish brown (10YR 5/2) clay, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure parting to moderate fine granular; hard, firm, sticky, plastic; common fine roots; common fine and medium discontinuous pores; few limestone pebbles 2 to 4 mm in size; calcareous; moderately alkaline; abrupt smooth boundary.

A1—7 to 34 inches; grayish brown (10YR 5/2) clay, very dark grayish brown (10YR 3/2) moist; weak fine blocky structure; wedge-shaped peds with long axis tilted 10 to 20 degrees from horizontal in lower part of horizon; hard, firm, sticky, plastic; few fine roots; few fine discontinuous pores; few pressure faces on peds; few limestone pebbles 3 to 10 mm in size; calcareous; moderately alkaline; gradual wavy boundary.

AC—34 to 51 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; weak fine blocky structure forming wedge-shaped peds with long axis tilted 10 to 20 degrees from horizontal; very hard, very firm, sticky, plastic; few fine roots; common cracks between peds filled with grayish brown (10YR 5/2) material from above; few slickensides and pressure faces on peds in upper part; few concretions and soft masses of calcium carbonate 1 to 3 mm in size; calcareous; moderately alkaline; gradual wavy boundary.

Cca—51 to 62 inches; pink (7.5YR 7/4) clay, light brown (7.5YR 6/4) moist; massive; very hard, very firm, sticky, plastic; few cracks in upper part of horizon filled with grayish brown (10YR 5/2) material from above; few soft masses of calcium carbonate 1 to 2 mm in size; calcareous; moderately alkaline.

The solum ranges from 40 to 60 inches in thickness. The fine earth fraction of the control section is 50 to 70 percent total clay and 45 to 60 percent noncarbonate clay. Some pedons contain 5 to 15 percent by volume limestone gravel.

In undisturbed areas, gilgai microrelief consists of microknolls that are 3 to 8 inches higher than the microdepressions. Distance between the microknolls and microdepressions ranges from 12 to 24 feet. When the soil is dry, cracks 0.5 inch to 1.5 inches wide extend from the surface into the AC horizon. Pressure faces on peds begin at a depth of 20 to 30 inches.

The A horizon is grayish brown, dark grayish brown, very dark grayish brown, brown, or dark brown.

The AC horizon is brown, grayish brown, light yellowish brown, pale brown, or light brown. Texture is clay or silty clay.

The Cca horizon is very pale brown, light brown, or pink. In some pedons it has up to 5 percent by volume secondary carbonates. Texture of the Cca horizon is clay or silty clay.

Valverde series

The Valverde series consists of deep, well drained soils on uplands. These soils formed in calcareous loamy outwash sediment over limestone bedrock. Slope ranges from 0 to 3 percent.

Typical pedon of Valverde silty clay loam, 0 to 3 percent slopes; from the intersection of U.S. Highway 90 and U.S. Highway 277 north of Del Rio, 15 miles northwest on U.S. Highway 90, 7.2 miles southwest on private road, 200 feet west of road in rangeland:

A1—0 to 12 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate medium granular structure; slightly hard, friable; gray surface crust about 3 mm thick; few fine roots; few limestone pebbles; calcareous; moderately alkaline; gradual smooth boundary.

B2—12 to 32 inches; light brownish gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) moist; moderate fine and medium granular structure; slightly hard, friable; few fine roots; few limestone pebbles; few fine concretions of calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary.

B2ca—32 to 48 inches; light gray (10YR 7/2) silty clay loam, light brownish gray (10YR 6/2) moist; moderate fine and medium granular structure; slightly hard, friable; few limestone pebbles; about 15 percent by volume fine weakly cemented concretions and soft masses of calcium carbonate; calcareous; moderately alkaline; abrupt smooth boundary.

R—48 to 60 inches; indurated limestone bedrock; coarsely fractured; few crevices filled with light gray silty clay loam.

The solum thickness, or depth to limestone or interbedded limestone, marl, and shale, ranges from 40 to 60 inches. Calcium carbonate equivalent in the 10- to 40-inch control section is 40 to 60 percent. The control section is 30 to 55 percent total clay and 18 to 35 percent noncarbonate clay.

The A horizon is brown, pale brown, grayish brown, light brownish gray, light yellowish brown, or yellowish brown

The B horizon is loam, silt loam, or silty clay loam. Color is brown, light brown, pale brown, very pale brown, light brownish gray, light gray, yellowish brown, or light yellowish brown. Secondary carbonates in the form of threads, films, soft masses, and concretions make up 5 to 50 percent by volume of the Bca horizon. The B horizon in some pedons contains a few limestone, siltstone, caliche, and shale fragments.

The R layer ranges from indurated limestone to interbedded limestone, marl, and shale.

Vinegarroon series

The Vinegarroon series consists of gravelly and loamy soils on uplands. These soils are shallow and well drained. They formed in loamy outwash sediment over thick beds of caliche. Slope ranges from 1 to 5 percent.

Typical pedon of Vinegarroon gravelly loam in an area of Zapata-Vinegarroon complex, 1 to 5 percent slopes; from the intersection of U.S. Highway 90 and U.S. Highway 277 north of Del Rio, 0.1 mile northwest on U.S. Highway 90, 0.25 mile west, 600 feet northwest in rangeland:

A1—0 to 7 inches; light brownish gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; weak fine and medium subangular blocky and weak fine granular structure; hard crust in upper 1 inch; slightly hard, friable; common fine roots; about 15 percent by volume limestone gravel 2 mm to 5 cm across, coated with caliche; few threads and films of calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

B2ca—7 to 17 inches; pale brown (10YR 6/3) gravelly clay loam, dark brown (10YR 4/3) moist; weak medium subangular blocky and weak fine granular structure; slightly hard, friable; common fine roots; about 16 percent by volume limestone gravel 2 mm to 5 cm across, coated with caliche; common films and threads of calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

Ccam—17 to 24 inches; white (10YR 8/2) indurated caliche; laminar in upper part; clear wavy boundary.

Cca—24 to 60 inches; white (10YR 8/2) weakly cemented caliche with a few embedded limestone pebbles.

The solum thickness, or depth to indurated caliche, ranges from 10 to 20 inches. Calcium carbonate equivalent is 40 to 60 percent of the material less than 20 mm in size. The fine earth fraction of the control section is 20 to 40 percent total clay and 5 to 25 percent noncarbonate clay. Coarse fragments make up 0 to 30 percent by volume of the control section. The A and B horizons are loam, clay loam, gravelly loam, or gravelly clay loam.

The A horizon is light brownish gray, pale brown, grayish brown, light gray, or very pale brown. Where color value is less than 5.5 dry and 3.5 moist, the A horizon is less than 6 inches thick.

The B2ca horizon is light brownish gray, pale brown, light gray, and very pale brown.

The Ccam horizon ranges from 1 to 9 inches in thickness. The upper part of the Ccam horizon is indurated or strongly cemented and laminar. The Cca horizon is gravelly in some pedons. Some pedons have limestone below a depth of 48 inches.

Zapata series

The Zapata series consists of gravelly and loamy soils on uplands. These soils are very shallow and well drained. They formed in loamy outwash sediment over thick beds of caliche. Slope ranges from 1 to 5 percent.

Typical pedon of Zapata clay loam in an area of Zapata-Vinegarroon complex, 1 to 5 percent slopes; from the intersection of U.S. Highway 90 and U.S. Highway 277 north of Del Rio, 0.1 mile northwest on U.S. Highway 90, 0.25 mile west, 900 feet northwest in rangeland:

A1—0 to 8 inches; light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; weak fine and medium subangular blocky structure; slightly hard, friable; thin surface crust; common fine roots; few caliche pebbles 25 mm to 75 mm across; few threads and films of calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

Ccam—8 to 13 inches; white (10YR 8/2) strongly cemented caliche that is laminar in the upper part; few embedded limestone pebbles; gradual wavy boundary.

Cca—13 to 60 inches; white (10YR 8/2) weakly cemented caliche; about 10 percent by volume embedded limestone pebbles.

The solum thickness, or depth to indurated or strongly cemented caliche, ranges from 2 to 10 inches. Calcium carbonate equivalent in the fine earth fraction is 40 to 60 percent. The fine earth fraction is 20 to 40 percent total clay and 5 to 25 percent noncarbonate clay.

The A horizon is light brownish gray, grayish brown, or brown. Texture is loam, clay loam, gravelly loam, or gravelly clay loam. Coarse fragments make up 0 to 20 percent of the A horizon.

The Ccam horizon is 1 to 9 inches thick. In some pedons the Ccam horizon is broken and platy in the upper part.

Zorra series

The Zorra series consists of very stony and stony loamy soils on uplands. These soils are very shallow and shallow and are well drained. They are underlain by a thin layer of caliche above limestone bedrock. Slope ranges from 1 to 40 percent.

Typical pedon of Zorra very stony loam in an area of Zorra-Rock outcrop complex, 1 to 8 percent slopes; from the intersection of U.S. Highway 90 and U.S. Highway 277 north of Del Rio, 7.5 miles west on U.S. Highway 90, 0.5 mile north on paved National Park Service road, 0.3 mile east on unpaved National Park Service road, 150 feet north in rangeland:

A1—0 to 8 inches; dark grayish brown (10YR 4/2) stony loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; common fine roots; about 23 percent by volume limestone and caliche fragments 2 mm to 7.5 cm across, 18 percent fragments 7.5 cm to 25 cm across, and 4 percent fragments 25 cm to 60 cm across; limestone fragments coated with calcium carbonate and have pendants on the lower surfaces; calcareous; moderately alkaline; abrupt wavy boundary.

Ccam—8 to 12 inches; white (10YR 8/2) indurated caliche; hardness of about 3 on Mohs' scale; laminar in upper 12 mm; abrupt wavy boundary.

R&Cca—12 to 15 inches; fractured indurated limestone; cracks and crevices filled and partially sealed with secondary carbonates; gradual wavy boundary.

R—15 to 20 inches; fractured limestone bedrock; few seams of secondary calcium carbonate in upper part.

The solum thickness, or depth to indurated caliche, is 4 to 20 inches. Carbonate accumulations smaller than 20 mm make up more than 40 percent by weight of the whole soil. The fine earth fraction of the control section is 15 to 40 percent total clay and 15 to 32 percent noncarbonate clay.

The A horizon is dark grayish brown, very dark grayish brown, very dark gray, brown, or dark brown. Coarse fragments of limestone and caliche make up 35 to 80 percent by volume of the A horizon. About 30 to 50 percent of the fragments are gravel, 10 to 35 percent are cobbles, and 3 to 15 percent are stones. Texture of the fine earth fraction is clay loam or loam.

The Ccam horizon is strongly cemented or indurated and is laminar in the upper part.

The R&Cca horizon is absent in some pedons.

The R layer in most pedons consists of thick beds of indurated limestone, but in some pedons it is interbedded limestone containing thin strata of chalk and marl.

Formation of the Soils

In this section, the factors of soil formation are discussed and related to the formation of soils in Val Verde County, and the processes of soil formation and soil horizon differentiation are explained.

Factors of Soil Formation

Soil is the product of the interaction of five major factors: climate, living organisms, parent material, relief, and time. The kind of soil that develops at any place is determined by these interacting factors.

Climate and plants and animals are the active forces in soil formation. These forces act on the parent material, which has accumulated through the weathering of rock and unconsolidated deposits, and slowly change the material into a natural body that has genetically related horizons. The effects of climate and plants and animals are conditioned by relief, or topography. The parent material itself affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed to change the parent material into a soil. The amount of time can be long or short, but generally a long time is required for distinct horizons to develop.

The interrelationship among the five factors of soil formation is complex, and the effect of any one factor is difficult to isolate. Each factor is discussed separately in the paragraphs that follow, but it is the interaction of all of these factors, rather than their simple sum, that determines the nature of the soil.

Climate

Val Verde County has a semiarid climate with mild, dry winters and hot summers. Rainfall, evaporation rate, temperature, wind, and length of growing season are some of the climatic factors that influence soil formation.

Expansion at high temperatures and contraction at low temperatures cause rocks to fracture. The small fragments become the parent material of soils.

The rainfall pattern causes the soils to be alternately wet and dry. When a clayey soil such as Tobosa clay dries, it becomes severely cracked. During rains, the cracks fill with water, wetting the soil thoroughly. Then the soil swells and the cracks close. This alternate shrinking and swelling causes the soil to churn and mix and prevents accumulation of clay in the subsoil.

Water moving through the soil carries clay particles downward from the surface layer and deposits them as the water slows. As clay accumulates, permeability

decreases, the water moves even slower, and deposition of clay accelerates. Quemado soils have an accumulation of clay in the lower layers. Eventually the lower layers may become clayey in texture.

Rainfall also leaches minerals from the upper layers and deposits them in lower layers. As a result, Acuna, Coahuila, Olmos, Vinegarroon, and many other soils in this county have a layer in which calcium carbonate has accumulated.

Living Organisms

Plants, man, bacteria, fungi, insects, worms, and other animals are important in the formation of soils. Gains or losses of organic matter, nitrogen, and plant nutrients and changes in structure and porosity are caused by living organisms.

Plants have played a major role in soil development in Val Verde County. The fibrous root system of grasses contributes large amounts of organic matter to the soils. Roots of grasses, shrubs, and trees decay and leave holes and pores that carry air and water.

Earthworms, insects, rodents, and other animals have worked and mixed the soil to some degree. Worms and insects hasten the decay of organic matter, and their tunnels improve soil structure and aid movement of air and water through the soil. Bacteria and fungi help in the decay of organic matter, improving fertility and tilth.

Man has also influenced soil formation. He has changed the character of the plant community by grazing sheep, goats, and cattle. He has changed soil structure by plowing and planting crops, and he has altered soil development by construction and excavation.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. It determines the limits of the chemical and mineralogical composition of the soil.

The soils of Val Verde County formed in parent materials derived from three geologic systems: the Cretaceous, the Tertiary, and the Quaternary. The geology of Val Verde County is discussed in more detail in the "Geology" section. However, the soils derived from the three systems are listed here.

Materials of the Cretaceous System influence the soils of nearly all of the county except the southeastern part. These materials are mainly interbedded limestone and marl and are many feet thick. Ector, Langtry, Tarrant, Zorra, Kavett, Lozier, Mariscal, and Amistad soils formed in material derived from the limestone of this system. Felipe soils formed in the interbedded shaly marl.

Materials of the Tertiary System influence the soils of the southeastern part of the county. These materials are mainly thick beds of caliche and gravel with a cemented caliche layer. Olmos, Quemado, Jimenez, Zapata, Vinegarroon, and Shumla soils formed in materials from this system.

Materials of the Quaternary System also influence the soils of the southeastern part of the county. These materials are mainly older alluvial deposits on old high stream terraces and have more distinct horizons. Lagloria, Laredo, Reynosa, Hodgins, Rio Diablo, Pintas, Acuna, and Coahuila soils formed in materials from this system.

The soils on the flood plains of rivers and drainageways formed in recent deposits of alluvium. Many of these deposits have been reworked from time to time by wind and water, and new sediments have been deposited. Dev and Rio Grande soils formed in this material.

Relief

Relief, or topography, affects soil formation through its effect on drainage, runoff, erosion, plant cover, and soil temperature. The relief in Val Verde County ranges

from nearly level in the southeastern part and along streams and valleys to very steep on escarpments scattered throughout the county.

Profile development depends on the amount and depth of penetration of moisture. Soils that are sloping to very steep absorb less moisture and normally have less developed profiles than nearly level soils. Many of the more sloping soils erode almost as fast as they form.

Some of the deepest soils in the county are the nearly level Lagloria, Rio Diablo, Coahuila, Acuna, and Reynosa soils. Shallow and very shallow Ector, Langtry, Amistad, Felipe, and Zorra soils are on the steeper side slopes and ridges. These soils range from well developed to almost not developed at all.

Time

Time is required for soil formation, and many characteristics of a soil are determined by the length of time that the soil forming processes have had to act. The length of time that the parent material has been in place is generally reflected by the degree of development of the soil profile.

The soils of Val Verde County range from young to old. Young soils have very little profile development. Older soils have well expressed horizons. Rio Grande and Dev soils are examples of young, deep soils that lack development. Ector, Langtry, and Tarrant soils are young, shallow and very shallow soils. Erosion removes material from Chair surface as feet as new material is weathered from bedrock. Lagloria, Reynosa, Laredo, and Hodgins soils are slightly older and show a little more development.

Some older soils have a calcic horizon in the lower part of the profile. As time passes, water leaches calcium carbonate downward and deposits it in the form of soft masses or concretions in the lower horizons. Acuna, Coahuila, and Valverde soils have calcium carbonate in the lower horizons. Some soils have calcium carbonate concretions that have become cemented or indurated. Indurated, or petrocalcic, horizons require a long time to develop. Olmos, Jimenez, Quemado, Zapata, Vinegarroon, and Shumla soils are examples of soils that have a petrocalcic horizon.

Soil Horizons

The soil-forming factors produce a succession of layers, or horizons, in the soil profile. The horizons differ in one or more properties, such as thickness, color, texture, structure, consistence, porosity, or reaction.

Most profiles contain three major horizons: A, B, and C. The B horizon has not developed in some young soils. Several processes are involved in the formation of the A, B, and C horizons. In Val Verde County, the main processes are leaching of calcium carbonate and bases, accumulation of organic matter, and formation and translocation of silicate clay minerals. In most soils, more than one of these processes have been active in the development of the horizons.

The A horizon is the surface layer. It is the horizon of maximum accumulation of organic matter. The soils of Val Verde County range from low to medium in organic matter content. Various dissolved or suspended materials, such as calcium carbonate, iron, or clay, may have been leached out of the A horizon down into the B horizon.

The B horizon lies immediately below the A horizon. It is the horizon of maximum accumulation of dissolved or suspended materials, or it is an altered horizon that shows distinct structure but little evidence of clay translocation or accumulation. The Bca horizon is usually a layer of accumulation of carbonates, commonly calcium carbonate. Subsoil layers that have distinct structure and little evidence of accumulation of these materials are called just "B". Acuna and Coahuila soils have a distinct Bca horizon; Lagloria soils have a B horizon.

The C horizon is relatively little affected by soil-forming processes, but it can have been modified by weathering. A Ccam horizon has been irreversibly cemented with carbonates.

The Cr horizon is unconsolidated underlying material, such as soft shale.

The R layer is consolidated bedrock, such as limestone.

Geology

L. E. Garner, geologist, University of Texas at Austin, Bureau of Economic Geology, helped to prepare this section. *(4, 6)*

Val Verde County is on the Edwards Plateau, except for the southeastern corner, which is on the Rio Grande Plain. The Edwards Plateau is part of the Great Plains, and the Rio Grande Plain is part of the Gulf Coastal Plain.

Most of the Edwards Plateau is underlain by hard limestone that is highly resistant to erosion. A small part is underlain by more easily eroded soft limestone, marl, and shale. The altitude of the plateau ranges from 1,150 to 2,350 feet. Numerous rivers and streams and their tributaries have formed ridges, hills, and deep narrow valleys and have cut canyons several hundred feet deep. The terrain is generally rough and the soils are mostly very shallow and shallow.

The Rio Grande Plain is nearly level to gently undulating. The altitude ranges from about 840 to 1,150 feet. The soils are thin on the ridges and thick on the plains and in the valleys.

The surface geology of Val Verde County consists of sedimentary rock derived from deposits of three geologic periods. The rocks dating from the Cretaceous Period are 75 to 135 million years old and were deposited under marine conditions. The materials from the Tertiary and Quaternary Periods are less than 3 million years old and were laid down by fresh water.

At the end of the Jurassic Period, the North American continent was mostly dry land. Then the Cretaceous seas advanced into the interior of the western part of the continent. Cretaceous history is largely a record of the deposits of this last great invasion of the sea into North America. In Val Verde County, the dominant bedrock material is Cretaceous and is divided into the older Comanche Series (Lower Cretaceous) and the more recent Gulf Series (Upper Cretaceous).

The Comanche Series consists of the Fredericksburg, and Washita Groups, which are further divided into formations.

The formations of the Fredericksburg Group that crop out in this county are Salmon Peak Limestone, Devils River Limestone, and Edwards Limestone, which are equivalent to the Edwards Formation in Central Texas. Where these formations are at the surface, the topography is gently sloping and gently undulating to very steep. The layers of limestone vary in resistance to erosion, resulting in a stair-step topography on the dissected uplands. There are many small drainageways, a few rivers and streams are deeply incised, and flood plains are well developed.

Salmon Peak Limestone crops out along the southern edge of the Edwards Plateau. The layers of limestone and mudstone are up to 310 feet thick. In the southern part of the area occupied by this formation, Zorra and Langtry soils formed in material derived form the rocks; in the northern part, Ector soils developed.

Devils River Limestone crops out in the southern part of the Edwards Plateau. It is laterally equivalent to Salmon Peak Limestone and McKnight Formation. The layers of limestone, mudstone, and dolomite are as much as about 700 feet thick. Ector and Tarrant soils formed in material derived from the rocks of this formation in the eastern part of its area, and Langtry soils formed in the material in the western part.

Edwards Limestone is represented in this area by the Segovia Member. It crops out in the northern half of Val Verde County and is equivalent to the upper part of

Devils River Limestone. The layers of limestone, dolomite, and marl are up to 380 feet thick and are thickest in the southern part of their area. Rolling to steep Ector soils and nearly level to gently undulating Tarrant and Kavett soils formed in material derived from this formation.

The outcroppings of the Washita Group in Val Verde County consist of Del Rio Clay and Buda Limestone.

Del Rio Clay crops out in the southern part of the county on narrow, steep side slopes. It lies unconformably over Edwards Limestone or Devils River Limestone. The rock is up to 200 feet thick and feathers out toward the northwest. The layers of shale and siltstone turn yellow after weathering and develop into Felipe soils. Vegetation is sparse. These areas are sometimes called "badlands." The material of this formation is easily eroded where not protected by overlying Buda Limestone.

Buda Limestone crops out in scattered areas throughout the southern part of the county. The fine-grained, massive limestone and marl is up to 100 feet thick and is thickest to the east. It lies unconformably over Del Rio Clay or Devils River Limestone. The Buda Limestone caps are generally resistant to weathering and form a landscape of gently undulating to rolling hills. Langtry and Zorra soils formed in material derived from this formation.

The Gulf Series consists of Eagle Ford and Austin Groups. Eagle Ford Group and Boquillas Flags are laterally equivalent; both lie unconformably over Buda Limestone.

Eagle Ford Group generally crops out southeast of the Pecos River. The topography is gently sloping and gently undulating to rolling. The rock consists of flaggy shale, siltstone, and limestone. It is up to 200 feet thick and thins out northeastward. Amistad soils formed in material derived from this formation.

Boquillas Flags generally crops out southwest of the Pecos River. Topography varies from nearly level areas to very steep hills. The formation consists of interbedded limestone, siltstone, silty limestone, and shale and is up to 220 feet thick. Mariscal, Lozier, and Shumla soils formed in material derived from this formation.

Austin Chalk crops out in the southwestern part of the county and lies unconformably over Eagle Ford Group and Boquillas Flags. Topography is gently sloping and gently undulating to very steep. The rock ranges from hard lime mudstone to soft chalk. It is up to 580 feet thick in the eastern part and thickens southwestward. Langtry, Lozier, and Shumla soils formed in material derived from this formation.

The only Tertiary deposit in Val Verde County is Uvalde Gravel, which is of Pliocene age.

Uvalde Gravel consists of loose gravel embedded in caliche. This formation mantles Cretaceous rocks and forms high, gently undulating plains not associated with present drainage patterns. During the Tertiary Period, Cretaceous sediments were exposed to weathering and erosion. Then the Balcones fault uplifted the Edwards Plateau to its present level about 100 to 1,500 feet above the Rio Grande Plain. This uplift increased the gradient of streams in the area, and the faster-flowing water could carry more sediment. Large quantities of material were washed from the Edwards Plateau and deposited on the Rio Grande Plain. These deposits were subsequently eroded, leaving only gravel-capped divides of Uvalde Gravel. In some areas parallel to the Rio Grande, the gravel is mainly igneous. Uvalde material developed into Olmos, Jimenez, Quemado, Zapata, and Vinegarroon soils.

The Quaternary material in Val Verde County is river-deposited sediment, or alluvium, of Pleistocene and Recent times.

The Pleistocene (ice age) material forms fluvial terrace deposits, alluvial fans, and colluvium. This material is moderately thick to thick beds of calcareous gravel, sand, silt, and clay. Beds of caliche are in some areas. Alluvial fan deposits and colluvium are very minor. Most of the fluvial deposits are on narrow, flat terraces between areas

of Uvalde Gravel and the present flood plain. These materials developed mainly into Acuna, Valverde, Laredo, Reynosa, Rio Diablo, and Olmos soils.

Recent flood plain deposits are in the narrow, flat areas adjacent to major streams and rivers, such as the Rio Grande, Sycamore Creek, Red Bluff Creek, Devils River, Dry Devils River, Dolan Creek, San Felipe Creek, Langtry Creek, Howards Creek, Pecos River, and Johnson Draw. These sediments are unconsolidated mixed gravel, sand, silt, and clay. Also included is bedrock, which is found in stream channels in places. These alluvial deposits are the parent material of Rio Grande, Dev, Hodgins, Lagloria, and Pintas soils. These soils are subject to periodic floods, except for the Lagloria soils, which are on high terraces above the Rio Grande.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Badland. Steep or very steep, commonly nonstony, barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a fragment.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Erosion pavement. A layer of gravel or stones that remains on the surface after fine particles are removed by sheet or rill erosion.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 37.5 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gilgai. Commonly a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of Vertisols—clayey soils having a high coefficient of expansion and contraction with changes in moisture content.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows:

O horizon.—*An* organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net

irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Montmorillonite. A fine, platy alumino-silicate clay mineral that expands and contracts with absorption and loss of water. It has a high cation-exchange capacity and is plastic and sticky when wet.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive

terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 20 inch
Rapid	6.0 to 20 inches
very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil, (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or

more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. Alluvium deposited by heavily loaded streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

The tables in this soil survey contain information that affects land use planning in this survey area. More current data tables may be available from the Web Soil Survey at the Tabular Data tab.

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