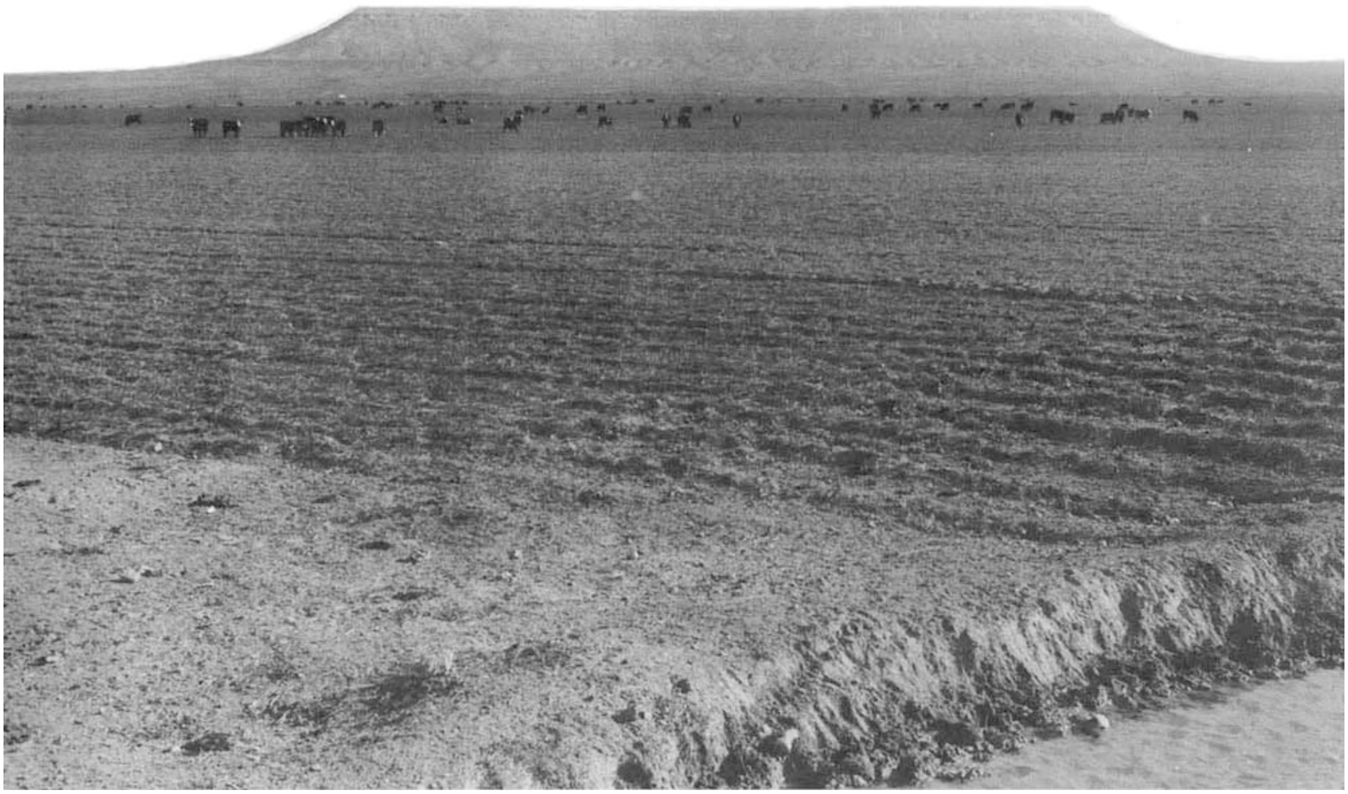
SOIL SURVEY OF
PECOS COUNTY, TEXAS

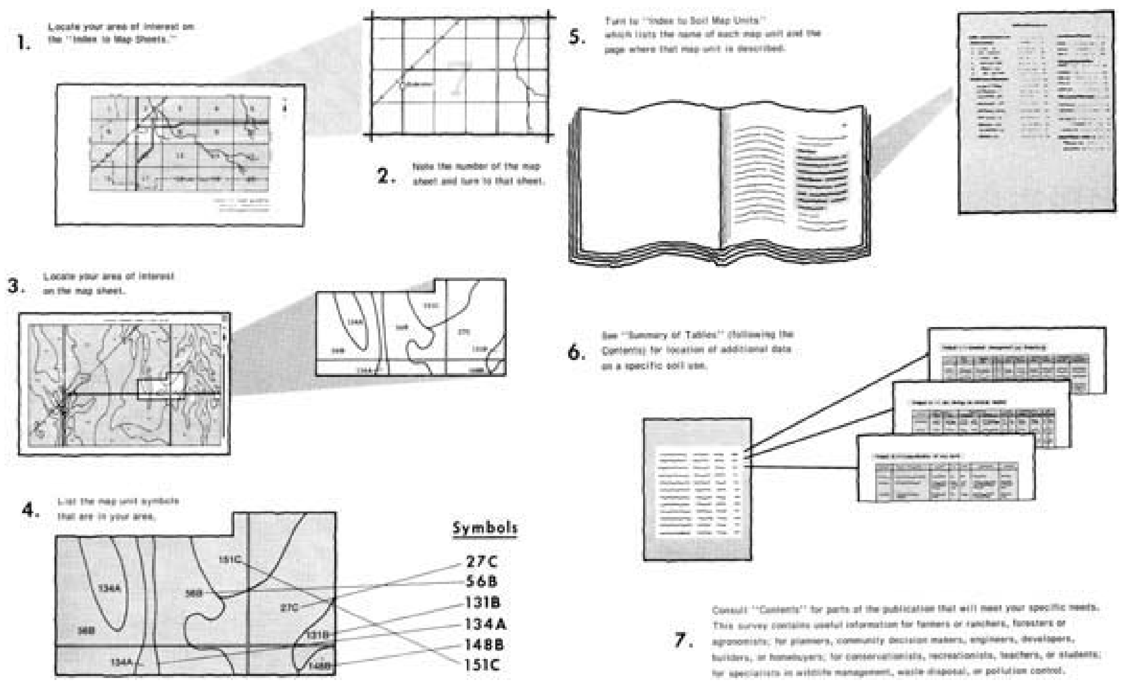


ELECTRONIC VERSION

This soil survey is an electronic version of the original printed copy, dated May 1980. 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.

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

HOW TO USE THIS SOIL SURVEY



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 completed in the period 1967-77. Soil names and descriptions were approved in 1977. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1977. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Rio-Grande-Pecos River, Toyah-Limpia, Trans Pecos, and Upper Pecos Soil and Water Conservation District.

Cover: Area of Reagan-Hodgins association, nearly level. The 12-mile Mesa has an area of Lozier-Rock outcrop association, steep.

Contents

Index to map units vi
Summary of tables vii
General nature of the survey area 1
Farming and ranching 1
Natural resources 2
Climate 2
How this survey was made 3
General soil map for broad land use planning 3
Descriptions of map units 4
1. Ector-Sanderson-Rock outcrop 4
2. Lozier-Rock outcrop 5
3. Brewster-Limpia 6
4. Reakor-Upton-Delnorte 7
5. Reagan-Hodgins-Iraan 8
6. Dalby-Reakor 9
7. Monahans-Orla-Hoban 10
8. Balmorhea-Reeves 11
9. Pecos-Patrole-Arno 11
Broad land use considerations 13
Soil maps for detailed planning 13
Soil descriptions 14
Use and management of the soils 36
Crops and pasture 37
Irrigation and salinity 38
Yields per acre 38
Land capability classification 39
Rangeland 40
Recreation 41
Wildlife habitat 42
Engineering 44
Building site development 45
Sanitary facilities 46
Construction materials 47
Water management 48
Soil properties 50
Engineering properties 50
Physical and chemical properties 51
Soil and water features 53
Engineering test data 55
Classification of the soils 55
Soil series and morphology 56
Arno series 56
Balmorhea series 57
Bigetty series 57
Brewster series 58
Coyanosa series 58
Dalby series 59
Delnorte series 60
Dev series 60
Ector series 61
Hoban series 62
Hodgins series 62
Iraan series 63
Limpia series 64
Lozier series 65

Monahans series ... 65
Orla series ... 66
Pajarito series ... 67
Patrole series ... 67
Pecos series ... 68
Reagan series ... 69
Reakor series ... 70
Reeves series ... 70
Rockhouse series ... 71
Sanderson series ... 72
Upton series ... 73
Formation of the soils ... 73
Factors of soil formation ... 73
Parent material ... 74
Climate ... 74
Plant and animal life ... 74
Relief ... 75
Time ... 75
References ... 75
Glossary ... 76
Tables ... 85

Issued May 1980

Index to map units

Page
1—Balmorhea association 14
2—Bigetty-Rockhouse association 15
3—Brewster-Rock outcrop association, hilly 16
4—Coyanosa-Rock outcrop association, hilly 17
5—Dalby clay, 0 to 1 percent slopes 17
6—Delnorte association, gently undulating 17
7—Dev-Iraan association, frequently flooded 18
8—Ector association, hilly 19
9—Ector-Rock outcrop association, steep 20
10—Ector-Upton association, gently undulating 21
11—Hoban silty clay loam, 0 to 1 percent slopes 22
12—Iraan silty clay loam, occasionally flooded 22
13—Limpia association, gently sloping 23
14—Lozier association, hilly 24
15—Lozier-Rock outcrop association, steep 24
16—Monahans loam, 0 to 1 percent slopes 25
17—Monahans-Pajarito association, nearly level 26
18—Orla association, nearly level 26
19—Pecos-Patrole-Arno association 27
20—Reagan silty clay loam, saline 29
21—Reagan-Hodgins association, nearly level 29
22—Reakor silty clay loam, 0 to 1 percent slopes 32
23—Reakor association, nearly level 32
24—Reeves clay loam, 0 to 1 percent slopes 33
25—Reeves-Hoban association, nearly level 34
26—Sanderson association, gently undulating 34
27—Upton gravelly loam, 0 to 1 percent slopes 35
28—Upton association, gently sloping 36

Summary of tables

Note 1: The tables listed below have been formatted to accommodate file size and accessibility. The original tables along with the manuscript and maps are available on CD and paper copy. A copy can be obtained by contacting the Field office.

Note 2: The Soil Data Mart may provide more up-to-date tables for this survey area.

Temperature and precipitation (table 1) 85
Freeze dates in spring and fall (table 2) 86
Probability. Temperature.
Growing season (table 3) 86
Probability. Daily minimum temperature.
Potentials and limitations of map units on the general soil map (table 4) 87
Extent of area. Irrigated crops. Specialty crops. Rangeland. Urban uses. Recreation areas.
Acreage and proportionate extent of the soils (table 5) 88
Acres. Percent.
General salt tolerance ratings of various crops (table 6) 88
Kind of crop. Sensitive. Moderately tolerant. Tolerant Highly tolerant.
Yields per acre of crops and pasture (table 7) 89
Cotton lint. Grain sorghum. Alfalfa hay. Barley.
Capability classes and subclasses (table 8) 91
Total acreage. Major management concerns (Subclass).
Rangeland productivity and characteristic plant communities (table 9).......... 92
Range site. Total production. Characteristic vegetation. Composition.
Recreational development (table 10) 98
Camp areas. Picnic areas. Playgrounds. Paths and trails.
Wildlife habitat potentials (table 11) 101
Potential for habitat elements. Potential as habitat for— Openland wildlife, Wetland wildlife, Rangeland wildlife.
Building site development (table 12) 103
Shallow excavations. Dwellings without basements. Dwellings with basements. Small commercial buildings. Local roads and streets.
Sanitary facilities (table 13) 106
Septic tank absorption fields. Sewage lagoon areas. Trench sanitary landfill. Area sanitary landfill. Daily cover for landfill.
Construction materials (table 14) 109
Roadfill. Sand. Gravel. Topsoil.
Water management (table 15) 112
Pond reservoir areas; Embankments, dikes, and levees; Drainage, Irrigation, Terraces and diversions, Grassed waterways.

Summary of tables-Continued

Page

Engineering properties and classifications (table 16) 114
Depth. USDA texture. Classification—Unified, AASHTO.
Fragments greater than 3 inches.
Percentage passing sieve—4, 10, 40, 200.
Liquid limit. Plasticity index.

Physical and chemical properties of soils (table 17) 118
Depth. Permeability. Available water capacity.
Soil reaction. Salinity. Shrink-swell potential.
Erosion factors. Wind erodibility group.

Soil and water features (table 18) 121
Hydrologic group. Flooding. High water table.
Bedrock. Cemented pan. Risk of corrosion.

Engineering test data (table 19) 123
Classification. Grain-size distribution. Liquid limit.
Plasticity index. Particle density. Shrinkage.

Classification of the soils (table 20) 125
Family or higher taxonomic class.

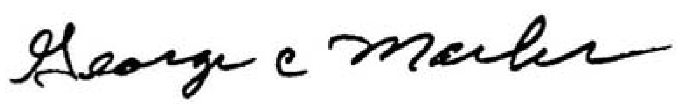
Foreword

This soil survey contains information that can be used in land-planning programs in Pecos County, Texas. 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.

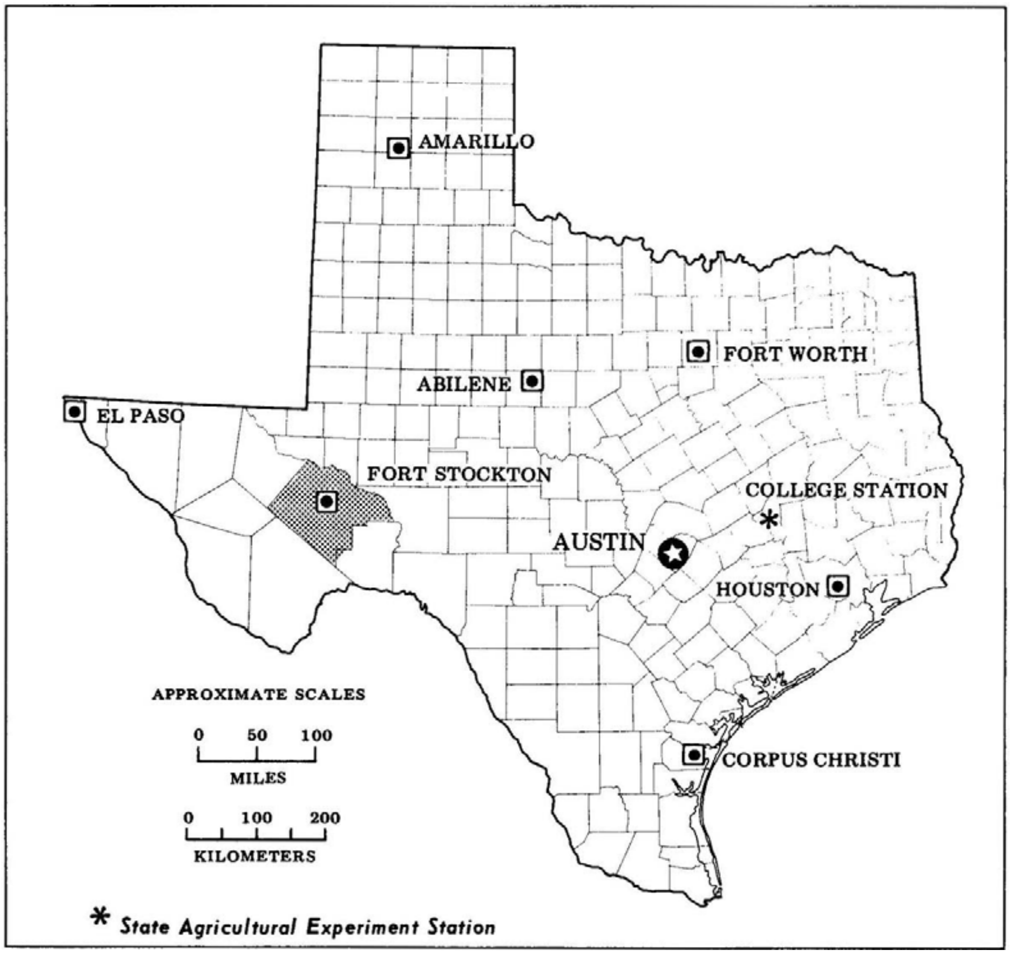
This soil survey is designed for many different users. Farmers, ranchers, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey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

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

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



George C. Marks
State Conservationist
Soil Conservation Service



Location of Pecos County in Texas.

Soil Survey of
Pecos County, Texas

By Jerry L. Rives,
Soil Conservation Service

Soils Surveyed by Plinio H. Flores and Ervin Blum
Soil Conservation Service

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

Pecos County is in the far western part of Texas. It is in the Trans-Pecos and Edwards Plateau Land Resource Areas.

Pecos County, the second largest county in Texas, is about 88 miles from north to south and about 108 miles from east to west. The total area is 3,035,520 acres, or 4,743 square miles. The surface is nearly level to gently undulating in the northern half of the county and hilly to mountainous in the southern half. Elevation ranges from about 2,200 feet near the Pecos River to about 5,200 feet in the mountains. All the drainage flows into the Pecos River.

Ranching and irrigated farming are the main enterprises in the county. According to the Conservation Needs Inventory *(3)* in 1967, about 67,674 acres was irrigated cropland, 2,759,563 acres was rangeland, 1,920 acres was water, and 12,119 acres was urban and built-up areas. Irrigation has declined the last few years. Now only about 25,000 acres is irrigated. Beef cattle and sheep are the principal ranching stock in the county. Cotton, grain sorghum, barley, and alfalfa are the main cultivated crops. Vegetable crops, such as cantaloup, onions, peppers, and cabbage, are also grown.

Oil and gas production and exploration, automotive testing grounds, and sulfur production are important to the economy of the county. Pecos County is the site of one of the world's largest producing gas well.

General nature of the survey area

Pecos County was created in 1871 from a part of Presidio County. It was named for the Pecos River, which is the county line on the northeast.

Fort Stockton, the county seat, was founded in 1845 and was converted to a fort in 1854. The fort served as a refuge for travelers on the Old Spanish Trail. Comanche Springs, which flowed 60 million gallons of water per day, was the main incentive for the location of Fort Stockton. It ceased flowing in 1952 because of extensive pumping of irrigation water. The Diamond Y Springs, about 10 miles north of Fort Stockton, is widely known as a habitat for pupfish *(Cyprinodon boyinus)*, which had been believed extinct.

In 1975 the population of Pecos County was 15,810. The city of Fort Stockton had a population of 9,525.

Farming and ranching

Livestock is the major agricultural enterprise in Pecos County. Approximately 90 percent of the land area is rangeland. Livestock enterprises are mainly cow-calf but also include steer and sheep.

Irrigated farming is another important enterprise to the economy of Pecos County. The major irrigated crops are cotton, grain sorghum, barley, alfalfa, and vegetables. The acreage planted to these crops has declined because of the high cost of producing irrigated crops in the county. Only about 25,000 acres is now irrigated. This acreage is mainly for the production of grain and forage crops used locally.

Natural resources

Underground water is an important natural resource in the county. Irrigation wells supply water for the irrigated acreage that has been developed.

The discovery of oil, natural gas, and minerals, such as sand, gravel, and sulfur, in recent years is an important source of livelihood for people who are employed by companies that explore and develop these resources in the county.

Wildlife is another important natural resource in Pecos County. Species include mule deer, antelope, javelina, scaled quail, mourning dove, white-winged dove, and coyote.

Climate

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

Table 1 gives data on temperature and precipitation for the survey area as recorded at Fort Stockton in the period 1955 to 1975. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 47 degrees F, and the average daily minimum temperature is 32 degrees. The lowest temperature on record, which occurred at Fort Stockton on January 5, 1972, is 4 degrees. In summer the average temperature is 80 degrees, and the average daily maximum temperature is 94 degrees. The highest recorded temperature, which occurred at Fort Stockton on June 22, 1969, is 110 degrees.

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

The average annual precipitation is 12 inches. Of this, 8 inches, or 65 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 6 inches. The heaviest 1-day rainfall during the period of record was 3.38 inches at Fort Stockton on May 27, 1957. Thunderstorms occur on about 40 days each year, and most occur in summer.

Snowfall is rare. In 50 percent of the winters, there is no measurable snowfall. In 25 percent, the snowfall, usually of short duration, is more than 3 inches. The heaviest 1-day snowfall on record was more than 4 inches.

The average relative humidity in midafternoon is about 40 percent. Humidity is higher at night, and the average at dawn is about 70 percent. The sun shines 80 percent of the time possible in summer and 75 percent in winter. The prevailing wind is from the south-southeast. Average windspeed is highest, 13 miles per hour, in April.

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 nation-wide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

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

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

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

General soil map for broad land use planning

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each 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.

The soils in the survey area vary widely in their potential for major land uses. Table 4 shows the extent of the map units shown on the general soil map. It lists the potential of each, in relation to that of the other map units, for major land uses and shows soil properties that limit use. Soil potential ratings are based on the practices commonly used in the survey area to overcome soil limitations. These ratings reflect the ease of overcoming the limitations. They also reflect the problems that will persist even if such practices are used.

Each map unit is rated for *irrigated crops, specialty crops, rangeland, urban uses,* and *recreation uses*. Irrigated crops are those grown extensively in the survey area. Specialty crops are the vegetables and fruits that generally require intensive management. Rangeland refers to land producing grasses and forbs native to the area. Urban uses include residential, commercial, and industrial developments. Recreation uses are campsites, picnic areas, ballfields, and other areas that are subject to heavy foot traffic.

Descriptions of map units

Soils dominantly on hills and mountains

This group of map units makes up about 48 percent of the county. The major soils are of the Brewster, Ector, Limpia, and Sanderson series, all of which are gravelly or stony. Also in this group are extensive areas of Rock outcrop.

Brewster soils are shallow to very shallow over igneous rock. Ector and Lozier soils are shallow to very shallow over limestone. Limpia soils are deep and clayey. Sanderson soils are deep and loamy. Most of these soils are moderately alkaline.

All the acreage is rangeland. The native vegetation is black grama, sideoats grama, blue grama, bush muhly, slim tridens, and cane bluestem. Woody plants, such as creosotebush, mesquite, and juniper, have encroached in most areas.

Most of the soils have low potential for irrigated crops and for urban and recreation uses because they are shallow to very shallow and also because of the slope and the high content of gravel and stones.

1. Ector-Sanderson-Rock outcrop

Very shallow to shallow and deep, gently sloping to steep gravelly soils; and Rock outcrop; on limestone hills and in valleys

This unit (fig. 1) makes up about 36 percent of the county. It is about 48 percent Ector soils, 16 percent Sanderson soils, 16 percent Rock outcrop, and 20 percent Coyanosa, Dev, Hodgins, Iraan, Lozier, Reagan, and Upton soils. The slope range is 1 to 45 percent.

The gently sloping to steep Ector soils are on limestone hills and mesa tops. They have a dark grayish brown very gravelly clay loam surface layer about 10 inches thick. This layer rests abruptly on fractured limestone bedrock.

The gently sloping Sanderson soils are on uplands and also on foot slopes and in valley fills at the base of limestone hills. The surface layer is moderately alkaline, grayish brown gravelly clay loam about 10 inches thick. Below this is moderately alkaline, light yellowish brown very gravelly clay loam that extends to a depth of more than 60 inches.

Limestone crops out on the almost vertical barren escarpments and other rolling to steep areas of the hills and mountains.

The very shallow, sloping to steep very gravelly Coyanosa soils are on sandstone hills. The deep, nearly level to gently sloping very gravelly Dev soils are on flood plains along small drainageways. The deep, nearly level to gently sloping loamy Reagan and Hodgins soils are on flood plains. The very shallow to shallow, rolling to steep very gravelly Lozier soils are on limestone hills and mountains. The gently sloping to sloping, shallow gravelly Upton soils are on uplands.

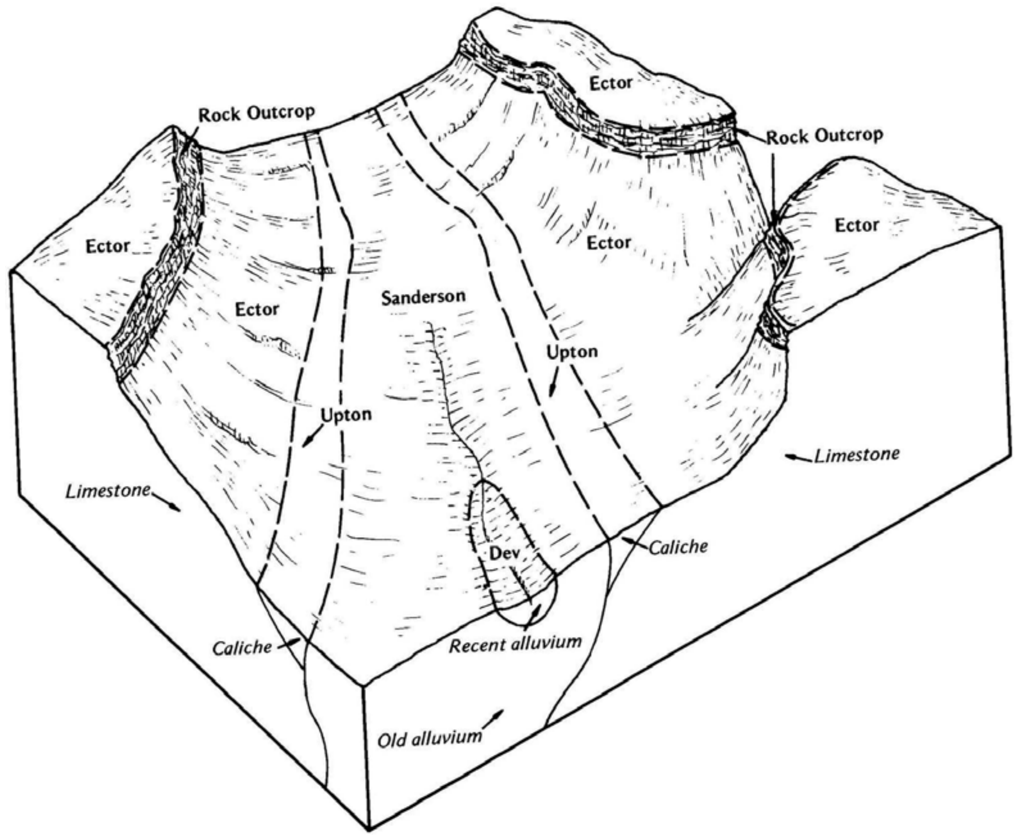


Figure 1.—Pattern of soils and underlying material in the Ector-Sanderson-Rock outcrop map unit.

This area is used as rangeland. Ector soils are not suited to irrigated crops or specialty crops because of the shallowness over bedrock, the slope, and the high content of gravel. Sanderson soils have a low potential for irrigated crops because they are gravelly throughout and have low available water capacity.

The potential is medium for rangeland because of low rainfall and low available water capacity. The potential is low for wildlife habitat.

The potential is low for most urban uses because of the shallowness over bedrock, the slope, and the small stones on the surface. The potential is also low for most recreation uses because of small stones on the surface, the shallowness over rock, and the slope.

2. Lozier-Rock outcrop

Very shallow to shallow, rolling to steep very gravelly and stony soils; and Rock outcrop; on limestone hills

This unit makes up about 11 percent of the county. It is about 71 percent Lozier soils; 14 percent Rock outcrop; and 15 percent Delnorte, Hodgins, Reakor, and Upton soils. The slope range is 5 to 45 percent.

The rolling to steep Lozier soils are on limestone hills. The slope range is 5 to 45 percent. The surface layer is light brownish gray very gravelly loam about 6 inches thick. It rests abruptly on fractured, caliche coated limestone bedrock.

Limestone crops out on the almost vertical barren escarpments and hillsides.

The shallow, gently sloping to sloping gravelly Delnorte and Upton soils are on foot slopes at the base of limestone hills. The deep, nearly level to gently sloping loamy Hodgins and Reakor soils are in valleys and drainageways.

This area is used as rangeland. It is not suited to irrigated crops or specialty crops. Shallowness over bedrock, the slopes, and small and large stones are the limiting factors.

The potential is low for native range plants. Rainfall is low, and available water capacity is very low. The potential is low for wildlife habitat.

The potential is low for most urban and recreation uses. Slope, shallowness over bedrock, and small and large stones are the most limiting factors.

3. Brewster-Limpia

Very shallow to shallow and deep, undulating to steep very cobbly soils; on igneous hills and mountains

This unit makes up about 1 percent of the county. It is about 33 percent Brewster soils; 30 percent Limpia soils; and 37 percent Bigetty soils and Rock outcrop. The slope range is 1 to 40 percent.

Brewster soils are on hills and mountains. The slope range is 5 to 40 percent. The surface layer is neutral, brown very cobbly loam about 8 inches thick. This layer rests abruptly on fractured igneous bedrock.

The undulating Limpia soils are on foot slopes and fans at the base of the hills and mountains. The slope range is 1 to 3 percent. The surface layer is neutral, reddish gray very cobbly loam about 8 inches thick. From 8 to 36 inches is neutral, reddish brown very cobbly clay. Below this is a moderately alkaline, pink very gravelly clay.

The deep, nearly level loamy Bigetty soils are on flood plains along intermittent streams. Rock outcrop occurs as almost vertical escarpments and bare rock areas on the hills and mountains.

Also in this unit are soils that are similar to Brewster soils but are more than 20 inches to bedrock and soils that have a loamy, not cobbly, surface layer.

This area is used as rangeland. It is not suited to irrigated crops or specialty crops. Depth to bedrock, the slope, and coarse fragments are the most limiting factors.

The potential for rangeland is medium. Low rainfall, rapid runoff, and low available water capacity are the main limiting factors.

Brewster soils have a low potential for most urban uses because of shallowness over bedrock, the slope, and large and small stones. Limpia soils have a medium potential for most urban uses. Moderate shrink-swell potential, clayey texture, and small stones are the limiting factors.

The potential for recreation use is low because of small stones on the surface, the slope, and shallowness over bedrock.

Soils dominantly on uplands

This group of map units makes up about 49 percent of the county. The major soils are of the Dalby, Delnorte, Hoban, Hodgins, Iraan, Monahans, Orla, Reagan, Reakor, and Upton series. These are nearly level to gently sloping and gently undulating soils on uplands.

Dalby soils are clayey throughout. Delnorte and Upton soils have a gravelly surface layer and are underlain by indurated caliche within 20 inches of the surface. Hoban, Monahans, and Orla soils have gypsiferous layers within 60 inches of the surface. Hodgins, Iraan, Reagan, and Reakor soils are deep and loamy throughout. All soils in this group are moderately alkaline.

Most of the irrigated cropland is on the deep soils in this group. Delnorte and Orla soils are not suited to irrigation because the surface layer is less than 10 inches thick. Cotton, grain sorghum, barley, and alfalfa are the major crops. The native vegetation on rangeland is blue grama, black grama, sideoats grama, tobosa, burrograss, alkali sacaton, and cane bluestem. Creosotebush, mesquite, yucca, and fourwing saltbush have encroached in some areas.

Most of the soils have medium potential for urban and recreation uses. The main problems are low strength, the clayey texture, shrink-swell potential, the dusty surface layer, and the flooding in some areas.

4. Reakor-Upton-Delnorte

Deep and very shallow to shallow, nearly level to gently undulating very gravelly and loamy soils; on uplands

This unit (fig. 2) makes up about 19 percent of the county. It is about 41 percent Reakor soils; 30 percent Upton soils; 10 percent Delnorte soils; and 19 percent Hoban, Hodgins, Reeves, and Sanderson soils. The slope range is 0 to 5 percent.

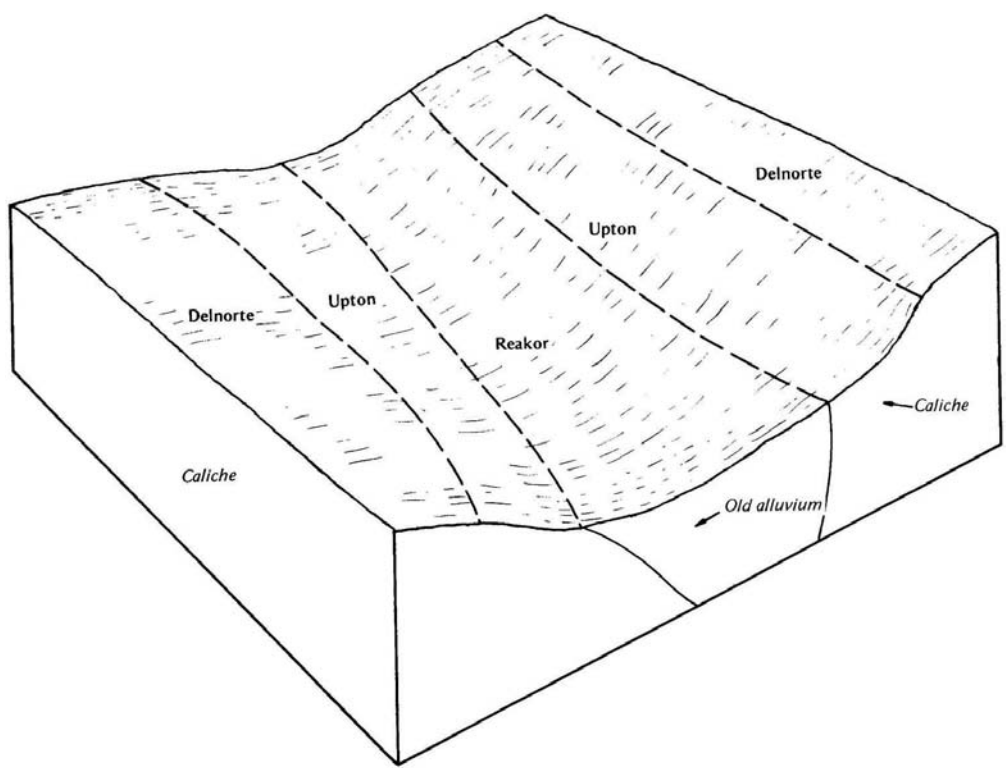


Figure 2.—Pattern of soils and underlying material in the Reakor-Upton-Delnorte map unit.

The nearly level to gently sloping Reakor soils are on uplands. They have a surface layer of very pale brown silty clay loam about 34 inches thick. From 34 to 62 inches is pink to pinkish white silty clay loam that is about 20 percent soft powdery masses of calcium carbonate.

The nearly level to gently sloping Upton soils are on uplands. They have a moderately alkaline, yellowish brown gravelly clay loam surface layer about 3 inches thick. From 3 to 14 inches is a moderately alkaline, light yellowish brown gravelly clay loam. From 14 to about 60 inches is white to pink caliche that is undurated in the upper part.

The nearly level to gently undulating Delnorte soils are on uplands. The surface layer is brown very gravelly loam about 5 inches thick. From 5 to 9 inches is yellowish brown very gravelly loam. Below this is white indurated caliche.

The deep, nearly level to gently sloping loamy Hoban soils, the deep, nearly level Reeves soils, and the deep, gently sloping very gravelly Sanderson soils are on uplands. The deep, nearly level loamy Hodgins soils are in drainageways and on terraces.

This area is used mainly as rangeland. Small areas of the Reakor soils are used for irrigated crops.

Reakor soils have high potential for irrigated crops and specialty crops if enough good quality water is available. Upton soils have low potential for irrigated crops because they are shallow over indurated caliche. Delnorte soils are not suited to irrigated crops because of the high content of gravel and the shallowness over indurated caliche.

The potential for rangeland is low because of the shallow soil and very low rainfall.

The soils in this unit have medium potential for most urban use. Shallowness over hard caliche, the risk of corrosion to uncoated steel, the small stones, and the medium shrink-swell potential of Reakor soils are the main limiting factors. The potential for recreation use is medium because of the large amount of gravel on the surface of Delnorte soils and the dusty surface of Reakor and Upton soils.

5. Reagan-Hodgins-Iraan

Deep, nearly level loamy soils; on uplands and flood plains

This unit (fig. 3) makes up about 18 percent of the county. It is about 42 percent Reagan soils; 20 percent Hodgins soils; 13 percent Iraan soils; and 25 percent Dalby, Dev, Sanderson, and Upton soils. The slope range is 1 to 4 percent.

The nearly level Reagan soils are on uplands. They have a brown silty clay loam surface layer about 8 inches thick. From 8 to 32 inches is yellowish brown silty clay loam. From 32 to 60 inches is very pale brown silty clay loam that contains common to many soft masses of calcium carbonate.

The nearly level Hodgins soils are on uplands. They have a light brownish gray silty clay loam surface layer about 3 inches thick. From about 3 to 24 inches is light brown silty clay loam. From 24 to 44 inches is moderately alkaline, pink silty clay loam. From 44 to 66 inches is moderately alkaline, reddish yellow silty clay loam.

The nearly level Iraan soils are on flood plains along intermittent streams. They have a dark grayish brown silty clay loam surface layer about 28 inches thick. From 28 to 60 inches is brown silty clay loam.

The deep, nearly level clayey Dalby soils are on uplands and flats. The deep, nearly level to gently sloping very gravelly Dev soils are on flood plains along small drainageways. The deep, gently sloping very gravelly Sanderson soils and the nearly level to gently sloping, shallow to very shallow gravelly Upton soils are on uplands.

This area is used for irrigated crops and rangeland.

The potential for irrigated crops and specialty crops is high on Reagan and Hodgins soils if enough good quality water is available and the soils are not subject to flooding. Iraan soils have low potential for irrigated crops because of the flood hazard. Irrigated cotton, grain sorghum, alfalfa, and barley are the main crops.

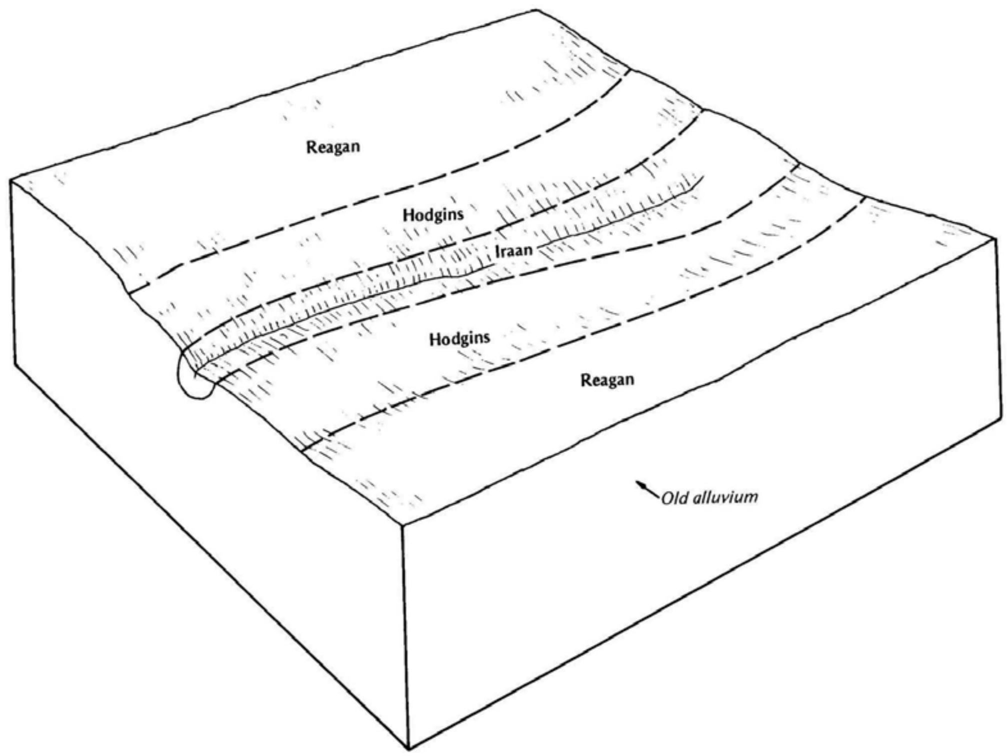


Figure 3.—Pattern of soils and underlying material in the Reagan-Hodgins-Iraan map unit.

The potential for native range plants is high. Low rainfall and high dry winds are the most limiting factors for forage production.

The potential is medium for most urban and recreation uses because of the moderate shrink-swell potential, the flood hazard, and the dusty surface.

6. Dalby-Reakor

Deep, nearly level clayey and loamy soils; on uplands and outwash plains

This unit makes up about 7 percent of the county. It is about 68 percent Dalby soils; 24 percent Reakor soils; and 8 percent Bigetty and Rockhouse soils. The slope range is 0 to 3 percent.

The nearly level Dalby soils are on uplands and flats. They have a reddish brown clay surface layer about 36 inches thick. To a depth of 60 inches or more is light reddish brown clay.

The nearly level Reakor soils are on uplands. They have a very pale brown silty clay loam surface layer about 34 inches thick. From 34 to 62 inches is pink to pinkish white silty clay loam that has common soft powdery masses of calcium carbonate.

The deep loamy Bigetty soils and the deep very cobbly Rockhouse soils are on flood plains along intermittent streams. All are nearly level.

This area is used for irrigated crops and rangeland.

The potential for irrigated crops and specialty crops is high but depends on the quantity and quality of the irrigation water. Cotton, alfalfa, and grain sorghum are the main crops.

The potential for rangeland is high. Low rainfall and slow intake are the limiting factors. Dalby soils usually receive extra runoff from higher elevations.

The potential is low for most urban and recreation uses. Shrink-swell potential, slow permeability, and the clay surface texture are the main limitations. This unit is subject to flooding during periods of heavy rainfall.

7. Monahans-Orla-Hoban

Deep and shallow, nearly level loamy soils; on uplands

This unit makes up about 5 percent of the county. It is about 21 percent Monahans soils; 18 percent Orla soils; 18 percent Hobans soils; and 43 percent Balmorhea, Hodgins, Pajarito, Reakor, Reeves, Sanderson, and Upton soils. The slope range is 0 to 2 percent.

The nearly level Monahans soils are on upland terraces near the Pecos River. These saline soils have a light yellowish brown loam surface layer about 8 inches thick. From 8 to 26 inches is light brown loam. From 26 to 60 inches is pink to light brown loam that contains common gypsum crystals and concretions of calcium carbonate.

The nearly level Orla soils formed in saline, gypsiferous material on uplands. They are saline throughout. They have a surface layer of very pale brown loam about 6 inches thick. From 6 to 60 inches is white to very pale brown loam that is about 40 to 80 percent gypsum and calcium carbonate.

The nearly level Hoban soils are on uplands. The surface layer is pale brown to light brown silty clay loam about 18 inches thick. From 18 to about 72 inches is pink clay loam that contains common to many masses of calcium carbonate and gypsum.

The deep, nearly level loamy Balmorhea soils are on bottom lands. The deep, nearly level loamy Hodgins soils are along drainageways and on stream terraces. The deep loamy Pajarito soils, the deep loamy Reakor and Reeves soils, and the shallow to very shallow gravelly Upton soils are on uplands. All are nearly level to gently sloping. Also on uplands are the deep, gently sloping very gravelly Sanderson soils.

This unit is used for irrigated crops, rangeland, and specialty crops. The overall potential is medium for irrigated crops. Hoban soils have high potential, Monahans soils medium potential, and Orla soils low potential.

This unit has medium potential for native range plants because of low rainfall and soil salinity.

The potential is medium for most urban and recreation uses. Moderate shrink-swell potential, seepage, risk of corrosion to uncoated steel, and the dusty surface layer are the limiting factors. Some areas are flooded during periods of heavy rainfall.

Soils dominantly on flood plains

This group of map units makes up about 3 percent of the county. The major soils are of the Arno, Balmorhea, Patrole, Pecos, and Reeves series. These nearly level soils are on flood plains, terraces, and the lower uplands. They are loamy or clayey throughout and are well drained to somewhat poorly drained. All are moderately alkaline. In some areas they are subject to flooding.

These soils are used for range and irrigated crops. The soils along the Pecos River are moderately to extremely saline. Cotton, grain sorghum, barley, and alfalfa are the major crops. Native vegetation is alkali sacaton, vine-mesquite, giant sacaton, twoflower trichloris, tobosa, and cane bluestem. Fourwing saltbush, mesquite, and tamarisk (saltcedar) are the major woody plants.

This unit has low potential for most urban and recreation uses. The flood hazard, low strength, high shrink-swell potential, and the dusty surface layer are the most limiting factors.

8. Balmorhea-Reeves

Deep and moderately deep, nearly level loamy soils; on flood plains and uplands

This unit makes up about 2 percent of the county. It is about 51 percent Balmorhea soils; 27 percent Reeves soils; and 22 percent Hoban, Hodgins, Orla, and Reakor soils. The slope range is 0 to 2 percent.

The nearly level Balmorhea soils occupy depressional areas in flood plains. These areas are, or were formerly, spring fed marshes. The surface layer is gray silt loam about 24 inches thick. From 24 to 38 inches is dark gray silty clay loam. Below this to 60 inches or more is light gray silty clay loam that contains many concretions of calcium carbonate.

The nearly level Reeves soils are on uplands. These slightly to moderately saline soils have a pale brown loam surface layer about 6 inches thick. From 6 to 28 inches is pink clay loam. From 28 to 60 inches is pink loam that has many masses of calcium carbonate and gypsum.

The deep, nearly level to gently sloping loamy Hoban and Reakor soils are on uplands. The deep, nearly level loamy Hodgins soils occupy drainageways and terraces. The shallow, nearly level gypsiferous Orla soils are on uplands. They formed in saline material.

This unit is used for irrigated crops and range.

The potential for irrigated crops, such as cotton, grain sorghum, and alfalfa and specialty crops, is high. It depends on the quantity and quality of the irrigation water.

These soils have high potential for native range plants, but low rainfall and lack of runoff from higher areas are limitations.

The potential is low for most urban use. The flood hazard, moderate shrink-swell potential, seepage, and the risk of corrosion to uncoated steel are the most limiting factors. Some areas are flooded during periods of heavy rainfall.

The potential is medium for most recreation uses because the surface is dusty and flooding is likely.

9. Pecos-Patrole-Arno

Deep, nearly level, saline clayey and loamy soils; on flood plains of the Pecos River

This unit (fig. 4) makes up about 1 percent of the county. It is about 45 percent Pecos soils; 25 percent Patrole soils; 20 percent Arno soils; and 10 percent Orla soils and a soil in seep areas that is loamy and very high in salts. The slope range is 0 to 1 percent.

The nearly level Pecos soils are on flood plains. These saline soils have a surface layer of grayish brown silty clay about 20 inches thick. From 20 to 34 inches is grayish brown clay. From 34 to 60 inches is silty clay loam that is light brownish gray in the upper part and reddish brown in the lower part.

The nearly level Patrole soils are near the stream channels. These saline soils have a light reddish brown very fine sandy loam surface layer about 15 inches thick. From 15 to 30 inches is light reddish brown very fine sandy loam. From 30 to 60 inches is reddish brown clay.

The nearly level Arno soils are on flood plains away from the stream channels. They are reddish brown saline clays that extend to a depth of more than 60 inches.

The shallow, saline, nearly level to gently sloping loamy Orla soils formed in gypsiferous material. They are on uplands.

This unit is used mainly as rangeland.

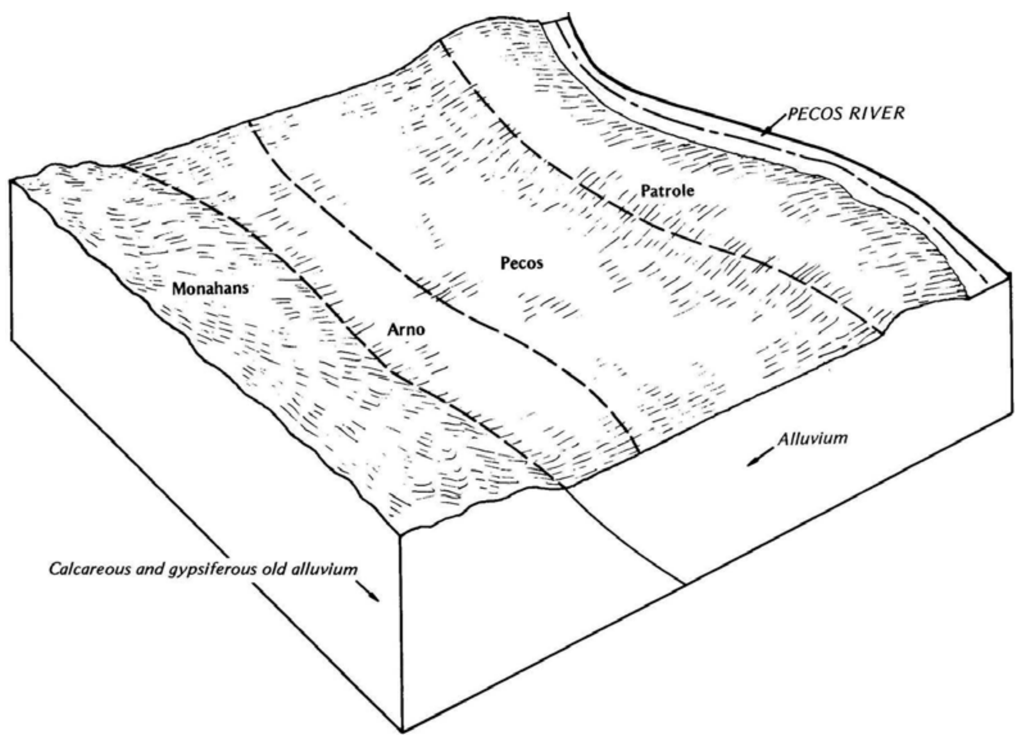


Figure 4.—Pattern of soils and underlying material in the Pecos-Patrole-Arno map unit.

The potential for irrigated crops is medium because of salinity, the flood hazard, and the slow intake. The potential for specialty crops is low because of salinity and the flood hazard.

The potential for native range plants is medium because of low rainfall, very slow permeability, and soil salinity.

The potential is low for most urban and recreation uses. The risk of corrosion to uncoated steel, the flood hazard, high shrink-swell potential, the dusty surface, and the clayey texture are the limiting factors.

Broad land use considerations

The map units in Pecos County vary widely in their potential for major land use, as indicated in table 4. Indicated for each land use are general ratings of the potential of each map unit as related to the potential of the other map units. Also indicated are major soil limitations. Not considered is the location as related to existing transportation systems or other facilities.

Land uses considered are irrigated farm crops, specialty crops, rangeland, urban, and recreation. Irrigated farm crops grown in Pecos County include cotton, grain sorghum, barley, and alfalfa. Specialty crops include vegetables and pecans, which are grown on limited acreages and require intensive management. Rangeland refers to land in native range plants. Urban tracts are farmsteads and residential, commercial, and industrial sites. Recreation areas include paths and trails, picnic areas, camp areas, and playgrounds.

In general, the kind of soil, the low rainfall, the quantity and quality of irrigation water, the salinity, and the high cost of producing irrigated crops are the most important factors that influence land use in Pecos County.

About 1 percent of the county is irrigated cropland. The rest is dominantly expansive areas of rangeland and small acreages of pasture, urban land, and water areas. According to table 4, about 27 percent of the county has high potential for rangeland, about 43 percent has medium potential, and about 30 percent has low potential. Table 4 also indicates that about 27 percent of the county has high potential for irrigated farm crops, 6 percent has medium potential, and 67 percent has low potential. Thus, about 23 percent of the county could be converted from rangeland to irrigated farmland if sufficient quantity and quality irrigation water were available.

The trend in recent years has been a decrease in the number of acres used for irrigated crops and an increase in the acreage of idle cropland, as cost of producing irrigated crops has increased.

In general, the Reagan-Hodgins-Iraan, Balmorhea-Reeves, and Dalby-Reakor map units have high potential for irrigated crops. Most of the acreage of irrigated crops is in these units. These are deep loamy and clayey soils that are well suited to irrigated crops. The major problem is the availability of irrigation water. Salinity in the irrigation water is also a major limitation. Electrical conductivity ranges from about 2 millimhos per centimeter to 8 millimhos per centimeter.

Good irrigation water management is needed, such as leaching, timely application, and proper length of irrigation runs. Crop residue on the surface, timely and limited tillage, crop rotations, and fertilization are important.

The information in this section and more detailed soil information in the following sections can be used as a guide in planning an orderly growth and development of the county.

Soil maps for detailed planning

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

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

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

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

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

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

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. Bigetty-Rockhouse association is an example.

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

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop 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 5 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

1—Balmorhea association. These nearly level soils are on flood plains that were formerly spring fed marshes. They are rarely flooded because most of the springs that once fed these areas have ceased to flow. In periods of heavy rainfall, however, short duration flooding is likely. The slope range is 0 to 2 percent. The surface is plane to concave. Areas are generally rectangular and range from 20 to several thousand acres.

This map unit is about 60 percent Balmorhea soils and 40 percent other soils. Most areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

Balmorhea soils typically have a moderately alkaline surface layer about 38 inches thick. The upper 24 inches is gray silt loam. The lower 14 inches is dark gray silty clay loam. From 38 to 60 inches is moderately alkaline, light gray silty clay loam that has many fine concretions of calcium carbonate.

These soils are somewhat poorly drained. Surface runoff is slow. Permeability is moderately slow. The available water capacity is high. The root zone is deep. The hazard of water erosion is slight, and the hazard of soil blowing is moderate.

Included in mapping are small areas of Hodgins, Orla, Reakor, and Reeves soils and areas of a soil that is more than 35 percent clay but is otherwise similar to the Balmorhea soil. Also included are soils that are deep, have a dark surface layer, and contain accumulations of calcium carbonate. These included soils, in slightly higher positions, make up about 40 percent of most mapped areas. Tufa, a porous rock of calcium carbonate, crops out in some areas.

These Balmorhea soils are mainly rangeland. They are not suited to nonirrigated crops, pasture, or hay because of the very low rainfall. The potential is high for irrigated cotton, grain sorghum, alfalfa, and barley. Salinity and poor drainage are problems.

The potential is high for native range plants. The very low rainfall and frequency of flooding are limiting factors, but yields of highly salt tolerant plants are good during favorable years. The potential is low for openland and rangeland wildlife habitat.

The potential is low for most urban uses because of flooding, low strength, and moderate shrink-swell potential. The potential is medium for most recreation uses because of the flood hazard and dusty surface layer. This soil is slippery and sticky when wet.

The capability subclass is VIs nonirrigated. The range site is Draw.

2—Bigetty-Rockhouse association. This association consists of deep, nearly level soils on flood plains along drainageways that drain igneous and limestone hills. The soils are subject to rare flooding during intense rainstorms and are sometimes inundated for a few hours. The slope range is 0 to 2 percent. Areas are long and narrow and range from a few hundred to several thousand acres.

This map unit is about 55 percent Bigetty soil, 25 percent Rockhouse soil, and 20 percent other soils. The Bigetty soil is in long, narrow irregular areas on the middle and outer edges of the flood plains. The Rockhouse soil is near the channels of the draws or in old channels of the flood plain. The surface of both soils is generally plane, but in a few areas it is concave. Areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

The surface layer of the Bigetty soil is typically moderately alkaline, dark grayish brown loam in the upper 20 inches and moderately alkaline, dark grayish brown silty clay loam in the lower 16 inches. From 36 to 48 inches is moderately alkaline, brown silty clay loam.

The Bigetty soil is well drained. Surface runoff is medium to slow, and permeability is moderately slow. The available water capacity is high. Flooding is rare. The hazard of water erosion is severe, and soil blowing moderate.

The Rockhouse soil typically has a moderately alkaline, dark grayish brown loam surface layer about 11 inches thick. Between 11 and 60 inches is moderately alkaline, yellowish brown very cobbly loamy sand that is about 55 percent by volume igneous fragments.

The Rockhouse soil is well drained. Surface runoff is slow to medium, and permeability is rapid. The available water capacity is low. The soil is subject to flooding. The hazards of water erosion and soil blowing are slight.

Included in mapping are small areas of Reakor and Upton soils, areas of a dark soil that is more than 35 percent clay, areas of riverwash in stream channels, and areas of soils that are more than 15 percent gravel but are otherwise similar to this Bigetty soil. These included soils make up about 20 percent of any one mapped area.

This association is used for range. The Bigetty soil is suited to irrigated cotton, grain sorghum, barley, and alfalfa in areas protected from flooding where good quality water is available. The Rockhouse soil is not suited to irrigated crops because of the low available water capacity and the high cobble content. The soils are not suitable for nonirrigated farming because of the very low rainfall. They have a high potential for native range plants because they receive runoff from the hills. The native vegetation is sideoats grama, cane bluestem, tobosa, burrograss, and vine-mesquite. The potential is medium for rangeland wildlife habitat. It is low for openland wildlife habitat in nonirrigated areas.

The potential is low for most urban and recreation uses. Flooding is the limiting factor.

The capability subclass is VIIe nonirrigated for the Bigetty soil and VIs nonirrigated for the Rockhouse soil. The range site is Draw.

3—Brewster-Rock outcrop association, hilly. This association consists of very shallow to shallow soils on uplands. The slope range is 5 to 40 percent. Areas are oval to irregular in shape and range from 160 to several thousand acres.

This map unit is about 70 percent Brewster soil, 15 percent Rock outcrop, and 15 percent other soils. Areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

The Brewster soil typically has a surface layer of neutral, brown very cobbly loam about 8 inches thick. This layer rests abruptly on coarsely fractured igneous bedrock.

This Brewster soil is well drained. Surface runoff is rapid. Permeability is moderate, and the available water capacity is very low. The hazards of water erosion and soil blowing are slight.

Included in mapping are areas of a deep gravelly soil in narrow draws and areas of a soil that is similar to this Brewster soil but is more than 20 inches deep over bedrock. Also included are spots of Brewster soils where slopes are 5 to 10 percent and others where they are 30 to 40 percent. These included soils make up about 15 percent of any one mapped area.

The soils in this association are not suitable for cultivation because of the slope, the very shallow to shallow root zone, and the coarse fragments. They are used for range. The Brewster soil has medium potential for native range plants. The very low rainfall, the rapid runoff, and the very low available water capacity are the main limiting factors. Because of the stones and Rock outcrop, these soils receive extra runoff and produce more forage than soils that do not receive extra runoff. The potential is low for openland wildlife habitat and medium for rangeland habitat.

This unit has low potential for urban and recreation uses. The slope, the depth to bedrock, and the small and large stones are the most limiting factors.

The capability subclass is VIIs for Brewster soil. The range site is Igneous Hill and Mountain. Rock outcrop is not assigned to a capability subclass or range site.

4—Coyanosa-Rock outcrop association, hilly. This association consists of shallow and very shallow very gravelly soils on sandstone hills. The slope range is 15 to 30 percent. Areas are oval to irregular in shape and range from 50 to 1,000 acres.

This map unit is about 60 percent Coyanosa soil, 35 percent Rock outcrop, and 5 percent other soils. The Coyanosa soil is on the hilltops and side slopes. The sandstone outcrop is along sharp breaks and escarpments. Most areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

The Coyanosa soil typically has a neutral, dark yellowish brown very gravelly loam surface layer about 4 inches thick. From 4 to 10 inches is moderately alkaline, dark yellowish brown very gravelly loam. This layer rests abruptly on strongly cemented sandstone bedrock.

This Coyanosa soil is well drained. Surface runoff is rapid, and permeability is moderate. The available water capacity is very low. The hazards of water erosion and soil blowing are slight.

Included in mapping are areas of a soil that is similar to the Coyanosa soil but is darker, more clayey, and less than 35 percent coarse fragments. Included on foot slopes and in narrow valleys and drainageways between the hills are Upton, Reagan, Hodgins, and Iraan soils.

The Coyanosa soil is used for range. It is not suited to irrigated crops, hay, pasture, or orchards. The depth to bedrock and the slope are the limiting features. The potential is medium for native range plants. It is low for rangeland and openland wildlife habitat.

The potential is low for most urban and recreation uses. The slope, the depth to bedrock, and the small stones are the most limiting features.

The Coyanosa soil is in capability subclass VIIs and the Sandstone Hills range site. Rock outcrop is not assigned to a capability subclass or range site.

5—Dalby clay, 0 to 1 percent slopes. This deep, nearly level soil occupies valleys and outwash plains of uplands. It has a plane to concave surface and gilgai microrelief of microknolls and microdepressions. It is subject to rare flooding of short duration in periods of heavy rainfall. Areas are long and irregular in shape and range from 5 to several thousand acres.

Typically, the surface layer is a moderately alkaline, reddish brown clay about 36 inches thick. The next layer is moderately alkaline, light reddish brown clay that extends to a depth of more than 60 inches.

This soil is well drained. Surface runoff is very slow. Permeability is very slow, and the available water capacity is medium. The soil has poor tilth and is difficult for deep rooted plants to penetrate when moisture is low. The hazards of water erosion and soil blowing are moderate.

Included in mapping are small areas of Hodgins, Reakor, Reeves, and Delnorte soils. These soils are at slightly higher levels than this Dalby clay. They make up less than 15 percent of any mapped area.

This Dalby soil is used mainly for irrigated crops and for rangeland. The major crops are cotton, alfalfa, rye, oats, barley, wheat, grain sorghum, cantaloupe, watermelon, peppers, onions, cabbage, and carrots. The soil is also suited to irrigated pasture. It is not suited to nonirrigated farming. Rainfall is very low.

The potential is high for irrigated cotton, grain sorghum, barley, and alfalfa, but it depends on the quantity and quality of the irrigation water. The major problems are soil tilth and salinity. A well designed irrigation system and proper application of irrigation water are important. Both surface and sprinkler irrigation can be used. In areas where irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation is not advisable because of possible leaf burn.

Crop residue on the surface, timely and limited tillage, and crop rotations conserve moisture and help to control soil blowing and water erosion. Crop residue also helps to maintain soil productivity and reduces the amount of salts coming to the surface through the evaporation of water. A leaching program should be planned based on the salt tolerance of the crop and the salinity of the irrigation water.

The potential is high for native plants. Low rainfall is the limiting factor. Most areas receive runoff from other areas. Native range plants are tobosa, vine-mesquite, blue grama, and cane bluestem. The potential is medium for irrigated openland and rangeland wildlife habitat. The potential is low for nonirrigated openland and rangeland habitat.

This Dalby soil has low potential for most urban and recreation uses. The most limiting factors are the very slow permeability, the flood hazard, the clay surface layer, and the shrink-swell potential.

The capability subclass is IIs irrigated and VIs nonirrigated. The range site is Clay Flat.

6—Delnorte association, gently undulating. This association consists of very gravelly loamy soils on uplands. The soils are very shallow to shallow over a cemented pan. The slope range is 1 to 5 percent. Areas range from 20 to several thousand acres and are oblong and irregular in shape.

This map unit is about 75 percent Delnorte soils and 25 percent other soils. Areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

Delnorte soils typically have a moderately alkaline, brown very gravelly loam surface layer about 5 inches thick. The next layer is moderately alkaline, yellowish brown very gravelly loam about 4 inches thick. At a depth of 9 inches is a strongly cemented caliche layer that has many igneous fragments.

The soils in this association are excessively drained. Surface runoff is rapid. Permeability is moderate, and the available water capacity is very low. The hazards of water erosion and soil blowing are slight.

Included in mapping are small areas of Upton soils and areas of a deep very gravelly soil with accumulations of calcium carbonate within 40 inches of the surface. Upton soils are on convex hills and are less than 35 percent limestone fragments.

These Delnorte soils are not suited to irrigated crops because of the very low available water capacity, the limited root zone, and the large amount of gravel. They are used mainly for range, but the potential for native range plants is low. Low rainfall, very low available water capacity, and lack of runoff from other areas limit the amount of forage produced. The potential for openland and rangeland wildlife habitat is low.

These soils have a medium potential for most urban uses. The depth to caliche and the risk of corrosion to uncoated steel are the most limiting factors. The potential for recreation use is low because of the large amount of gravel on the surface.

The capability subclass is VIIs. The range site is Gravelly.

7—Dev-Iraan association, frequently flooded. This association consists of deep, nearly level soils on flood plains of draws that drain limestone hills and mountains. These soils are subject to frequent flooding for brief to very brief periods because they receive rapid surface runoff from mountainous areas. The slope is less than 1 percent. Areas are long and narrow and range from a few hundred to several thousand acres.

This map unit is about 50 percent Dev soil, 35 percent Iraan soil, and 15 percent other soils. These soils are intermixed along the valley floors. Areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

The Dev soil typically has a moderately alkaline, dark grayish brown very gravelly clay loam surface layer about 16 inches thick. From 16 to 34 inches is moderately alkaline, dark brown very gravelly clay loam.

The Iraan soil typically has a moderately alkaline, dark grayish brown silty clay loam surface layer about 28 inches thick. From 28 to 43 inches is moderately alkaline, brown silty clay loam. From 43 to 60 inches is moderately alkaline, brown gravelly silty clay loam.

The soils in this association are well drained. Surface runoff is slow to medium. Permeability is moderately rapid in the Dev soil and moderate in the Iraan soil. The available water capacity is low in the Dev soil because of the high gravel content. It is high in Iraan soil. The hazard of water erosion is severe on the Dev soil and moderate on the Iraan soil. The hazard of soil blowing is slight on both soils.

Included in mapping are small areas of Hodgins, Reagan, and Sanderson soils. All are at slightly higher elevations than the Dev and Iraan soils.

The soils in this association are not suited to irrigated crops because of the flood hazard. They are used for range. The potential is high for native range plants. Low rainfall, high dry winds, and brush infestation limit the amount of forage produced. The potential is medium for openland and rangeland wildlife habitat.

The potential is low for most urban and recreation uses because of the flood hazard.

The capability subclass is VIw nonirrigated. The range site is Draw.

8—Ector association, hilly. This association consists of shallow to very shallow, hilly soils on uplands. The slope range is 10 to 30 percent. Areas are irregular in shape and range from 200 to several thousand acres.

This map unit is about 75 percent Ector soil, 10 percent Rock outcrop, and 15 percent other soils. Areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

Ector soils typically have a moderately alkaline, dark grayish brown very gravelly clay loam surface layer about 10 inches thick. The underlying layer is fractured limestone bedrock that has caliche coatings in the upper 7 inches.

These soils are well drained. Permeability is moderate, and surface runoff is rapid. The available water capacity is very low. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

About 15 percent of this map unit is included areas of Dev, Hodgins, Reagan, and Upton soils. Reagan, Hodgins, and Dev soils are in the narrow valleys and drainageways. Upton soils are on foot slopes. Also included are small areas where rock crops out on the steeper escarpments. Rock outcrop makes up about 10 percent of any one mapped area.

The soils in this association are not suited to crops because of the shallow root zone, the very low available water capacity, and the large amount of gravel, cobbles, and stones. All the acreage is range, but potential for native range plants is medium. The very low rainfall and the very low available water capacity limit the amount of forage produced. The potential is low for openland wildlife habitat and medium for rangeland habitat.

These soils have low potential for most urban uses. The slope, depth to bedrock, and small stones are the most limiting features. The potential for most recreation uses is medium. The slope and depth to bedrock are the most limiting factors.

The capability subclass is VIIs. The range site is Limestone Hill and Mountain.

9—Ector-Rock outcrop association, steep. This association consists of very shallow stony soils on lime-stone hills and mountains. The slope range is 20 to 45 percent. In some areas almost vertical escarpments of limestone crop out. Areas are 40 to several thousand acres and are irregular in shape.

This map unit is about 60 percent Ector soil, 30 percent Rock outcrop, and 10 percent other soils. Ector soils are on limestone hillsides and mountaintops (fig. 5). Scattered areas of Rock outcrop occur as ledges and escarpments on the sides and on eroded tops. Most areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

The Ector soil typically has a moderately alkaline, dark grayish brown stony clay loam surface layer that is about 11 inches thick and 75 percent by volume limestone fragments 4 to 24 inches across. Below this is fractured limestone that is coated with calcium carbonate in the upper part.

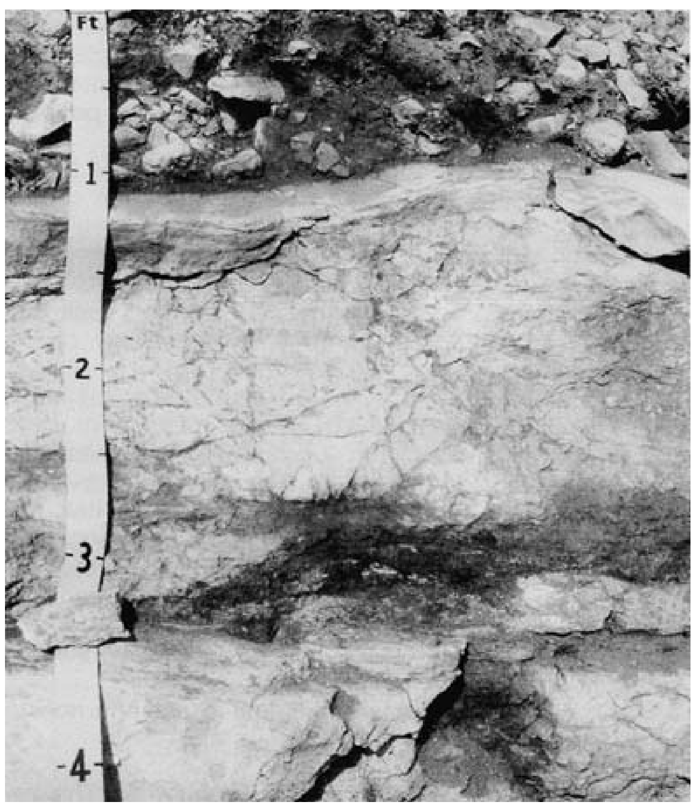


Figure 5.—Profile of Ector very stony clay loam in an area of Ector-Rock outcrop association, steep.

The Ector soil is well drained. Surface runoff is rapid. Permeability is moderate, and the available water capacity is very low. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

Included in mapping are small areas of Dev, Hodgins, Reagan, Sanderson, and Upton soils. Dev, Hodgins, and Reagan soils are in the narrow valleys and drainageways between the hills and mountains. Sanderson and Upton soils are at the base of the hills on foot slopes. These included soils make up about 10 percent of any one mapped area.

The soils in this association are not suited to irrigated crops, hay, pasture, or orchards because of the very shallow root zone, the very low available water capacity, the high volume of stones and gravel, and the steep slopes. They are used mainly for range. The potential for native range plants is medium. Low rainfall, low available water capacity, and rapid runoff limit the amount of forage produced. The potential is medium for rangeland wildlife habitat and low for openland wildlife habitat.

This association has low potential for most urban and recreation uses because of the steep slopes, the depth to limestone bedrock, and the large amount of gravel and stones.

The capability subclass is VIIs for Ector soil. The range site is Limestone Hill and Mountain. Rock outcrop is not assigned to a range site or capability subclass.

10—Ector-Upton association, gently undulating. This association consists of soils that are shallow and very shallow over bedrock or a cemented pan. It is on limestone plateaus and mesa tops. The slope range is 1 to 4 percent. Areas range from 40 to 10,000 acres and are oblong or irregular in shape.

This map unit is about 50 percent Ector soil, 40 percent Upton soil, and 10 percent other soils. A few areas are dominantly the Upton soil. The Ector soil is in areas bordering the escarpments of large mesas. The Upton soil is in the inner, or center, areas. The tops of the smaller mesas are dominantly the Ector soil. Most areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

The Ector soil typically has a moderately alkaline, dark grayish brown very gravelly clay loam surface layer that is about 8 inches thick and is about 70 percent coarse limestone fragments up to 10 inches across. This layer rests abruptly on fractured limestone bedrock.

The Upton soil typically has a moderately alkaline, brown gravelly clay loam surface layer about 5 inches thick. From 5 to 18 inches is moderately alkaline, yellowish brown gravelly clay loam about 13 inches thick. From 18 to 24 inches is indurated caliche. From 24 to 40 inches is weakly cemented caliche.

The soils in this association are well drained. Surface runoff is medium to rapid. Permeability is moderate, and the available water capacity is very low. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

Included in mapping are small areas of Lozier, Iraan, and Dalby soils. Lozier soils border escarpments similar to those bordering the Ector soils. Iraan soils are in drainageways along the plateaus and mesa tops. Dalby soils are in rounded and subrounded shallow lakebeds of 10 to 50 acres.

The soils in this association are not suited to irrigated crops because of the very low available water capacity, the shallow root zone, and the high content of coarse fragments. They are mainly rangeland. The potential for native range plants is low. Low rainfall, very low available water capacity, and lack of runoff from other areas limit the amount of forage produced. The potential is low for openland and rangeland wildlife habitat.

The potential is low for most urban uses. The shallowness over indurated caliche or limestone bedrock and the high content of small stones are the most limiting factors. The potential for recreation uses is medium. The large amount of small stones on the surface, the steep slopes, and the depth to bedrock or indurated caliche are the most limiting factors.

The capability subclass is VIIs nonirrigated. The Ector soil is in the Limestone Hill and Mountain range site. The Upton soil is in the Gravelly range site.

11—Hoban silty clay loam, 0 to 1 percent slopes. This deep, nearly level soil is on uplands. Areas range from about 10 to 2,500 acres and are irregular in shape.

The surface layer is typically a moderately alkaline, pale brown silty clay loam about 5 inches thick. From 5 to 20 inches is moderately alkaline, light brown silty clay loam. From 20 to 60 inches is moderately alkaline, pink clay loam that has many soft masses of calcium carbonate.

This soil is well drained. Surface runoff is slow. Permeability is moderate, and the available water capacity is high. The hazard of water erosion is severe, and the hazard of soil blowing is slight.

Included in mapping are small areas of Reeves, Orla, Monahans, and Upton soils. The included soils make up less than 20 percent of any one mapped area.

This Hoban soil is used for irrigated crops, mainly cotton, alfalfa, barley, and grain sorghum. Because of the very low rainfall, nonirrigated farming is not advisable.

The potential for irrigated cotton, grain sorghum, barley, and alfalfa is high, but it depends on the quantity and quality of the irrigation water. The major problems are soil tilth and salinity. A well designed irrigation system and proper application of irrigation water are important. Both surface and sprinkler irrigation can be used. Where irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation is not advisable because of possible leaf burn.

Crop residue on the surface when crops are not grown, timely and limited tillage, and crop rotations conserve moisture and help to control soil blowing and water erosion. Crop residue also helps to maintain soil productivity and reduce the amount of salt coming to the surface by evaporation of water. A leaching program should be planned based on the salt tolerance of the crop and the salinity of the irrigation water.

The potential for native range plants is high. The very low rainfall and lack of runoff are the limiting factors. Runoff has been reduced because of the roads and irrigation ditches. The potential is high for openland and rangeland wildlife habitat in irrigated areas.

The potential is medium for most urban uses, mainly because of the moderate shrink-swell potential of the soil. The potential for most recreation use is low because of a dusty surface.

The capability class is I irrigated and VIIc nonirrigated. The range site is Loamy.

12—Iraan silty clay loam, occasionally flooded. This deep, nearly level soil is in draws and drainageways that drain limestone hills and mountains. The slope range is 0 to 1 percent. Flooding of very brief duration occurs about once in 2 years, usually in July through October. It is caused by excess runoff from limestone hills and mountains during heavy rains. Areas range from 20 to 500 acres and are long or irregular in shape.

The surface layer is typically a moderately alkaline, dark grayish brown silty clay loam about 28 inches thick.

Between 28 to 60 inches is moderately alkaline, brown silty clay loam that contains a few rounded pebbles.

This Iraan soil is well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is high. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

Included in this map unit are small areas of Hodgins and Reagan soils.

Hodgins soils are in the same position on the valley floors. Reagan soils are at slightly higher elevations.

Most of the acreage is irrigated cropland, pastureland, hayland, or pecan orchards. The major crops are alfalfa, cotton, and grain sorghum. Some areas are idle cropland, and some have been returned to native rangeland.

The potential is high for irrigated cotton, grain sorghum, barley, and alfalfa in areas protected from flooding, but it depends on the quantity and quality of the irrigation water. Because of occasional flooding, diversions are needed to avoid flood damage to crops. Crop residue on the surface, timely and limited tillage, and crop rotations are important. A well designed irrigation system, proper application of irrigation water, and salinity control are essential. Surface and sprinkler irrigation can be used, but when the salinity of the water exceeds 4 millimhos per centimeter, sprinkler irrigation is not advisable because of possible leaf burn.

The potential for rangeland is high. The potential for openland and rangeland wildlife habitat is medium.

This soil has low potential for most urban uses. Flooding is a hazard for community development. The potential is medium for most recreation uses. The most limiting factor is the flood hazard. The soil is also slippery and sticky when wet and slow to dry.

The capability subclass is IIw irrigated and VIw nonirrigated. The subclass of an irrigated soil actually depends on the electrical conductivity of the irrigation water. The range site is Draw.

13—Limpia association, gently sloping. This association consists of deep, gently sloping very gravelly and very cobbly soils on uplands. These soils are on alluvial fans, terraces, and outwash plains of igneous hills and mountains. The slope range is 1 to 3 percent. Areas are oblong and irregular in shape and range from a few hundred to several thousand acres.

This map unit is about 60 percent Limpia soil and 40 percent other soils. Areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

Limpia soils have a neutral, reddish gray very cobbly loam surface layer about 8 inches thick. From 8 to 36 inches is neutral to mildly alkaline, reddish brown very cobbly clay. Between 22 and 36 inches is mildly alkaline, reddish brown very cobbly clay. Below this to more than 60 inches is moderately alkaline, pink very gravelly clay.

Limpia soils are well drained. Surface runoff is medium, and permeability is slow. The available water capacity is low because of the many igneous fragments. The hazards of water erosion and soil blowing are slight.

Included in mapping are small areas of Bigetty, Brewster, and other soils, which do not have large accumulations of fragments in the upper part. Bigetty soils are on flood plains. Brewster soils are in the same position as Limpia soils. These included soils make up about 40 percent of any one mapped area.

The soils in this unit are not suitable for cultivation because of the amount of gravel and cobbles and the low available water capacity. They are mainly rangeland. The potential for native range plants is high. Low rainfall and low available water capacity limit the amount of forage produced. The potential is low for openland wildlife habitat and medium for rangeland habitat.

The potential is medium for most urban uses. The soils expand when wet and shrink when dry and have a high content of small stones. These are the most limiting factors. The potential for recreation use is low because of the large amount of gravel and cobbles on the surface.

The capability subclass is VIs. The range site is Foothill Slope.

14—Lozier association, hilly. This association consists of very shallow to shallow stony and gravelly soils on limestone hills. The slope range is 10 to 25 percent. Areas are oblong or irregular in shape and range from 60 to several thousand acres.

This map unit is about 80 percent Lozier soils, 10 percent Rock outcrop, and 10 percent other soils. Limestone crops out along the few sharp ledges or escarpments. Most areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

Lozier soils typically have a moderately alkaline, light brownish gray very gravelly loam surface layer that is about 6 inches thick and about 78 percent by volume limestone fragments. This layer rests abruptly on fractured limestone bedrock.

The soils in this association are well drained. Surface runoff is medium to rapid. Permeability is moderate, and the available water capacity is very low. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

Included in mapping are small areas of Delnorte, Hodgins, Reakor, and Upton soils and spots of Lozier soils that have slopes of 2 to 10 percent. Delnorte and Upton soils are at the base of hills. Hodgins and Reakor soils are in the narrow valleys and drainageways between the hills. These included soils make up about 10 percent of any one mapped area.

Lozier soils are used as rangeland. They are not suited to irrigated crops, hay, pasture, or orchards. The depth to bedrock, the slope, and the high content of small stones are limitations. The potential is low for native range plants because the very low rainfall and the very low available water capacity limit the amount of forage. The potential is low for openland and rangeland wildlife habitat.

These soils have low potential for most urban and recreation uses. The slope, the shallowness to bedrock, and the large amount of small stones are the most limiting factors.

The capability subclass is VIIs. The range site is Limestone Hill and Mountain.

15—Lozier-Rock outcrop association, steep. This association consists of very shallow stony soils on limestone hills and mountains. The slope range is 20 to 45 percent. Areas are irregular in shape and are 55 to 500 acres.

This unit is about 45 percent Lozier soil, 40 percent Rock outcrop, and 15 percent other soils. Lozier soils are on the crests and side slopes. Limestone crops out along the sharp breaks and escarpments. Areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

Lozier soils typically have a light brownish gray stony loam surface layer that is about 4 inches thick and about 60 percent by volume limestone fragments. This layer rests abruptly on fractured, caliche coated limestone bedrock.

The soils in this association are well drained. Surface runoff is medium to rapid. Permeability is moderate, and the available water capacity is very low. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

Included in some areas are areas of Hodgins, Reakor, and Upton soils and soils that are similar to the Lozier soil but are less than 4 inches deep over limestone. Upton soils are on foot slopes. Hodgins and Reakor soils are in the narrow valleys and drainageways between the hills. Lozier soils, which have slopes of 5 to 20 percent, occur in some areas. Included soils make up about 15 percent of any one mapped area.

Lozier soils are used as rangeland. They are not suited to irrigated crops, hay, pasture, or orchards. The shallowness over bedrock, the slope, and the high content of small stones are the limiting factors. The potential is low for native range plants because of the very low rainfall and the very low available water capacity. Also, the potential is low for openland and rangeland wildlife habitat.

These soils have low potential for most urban and recreation uses. The slope, the depth to bedrock, and the high content of small stones are the most limiting factors.

The capability subclass is VIIs for the Lozier soil and VIIIs for Rock outcrop. The Lozier soil is in Limestone Hill and Mountain range site.

16—Monahans loam, 0 to 1 percent slopes. This deep, nearly level soil is on uplands. Areas are irregular in shape and range from 20 to 400 acres.

The surface layer is typically about 9 inches of moderately alkaline, light yellowish brown loam. From 9 to 42 inches is moderately alkaline light brown loam. From 42 to 62 inches is moderately alkaline, pink loam. It is about 30 percent by volume soft masses and crystals of gypsum and concretions of calcium carbonate.

This soil is well drained. Permeability is moderate. Surface runoff is slow to very slow, and the available water capacity is medium. The hazard of water erosion is slight, and the hazard of soil blowing is moderate.

Included in mapping are small areas of Hoban, Hodgins, Orla, Pajarito, and Upton soils. Hoban, Hodgins, Pajarito, and Orla soils occupy the same position as the Monahans soil, but Upton soils are in slightly higher positions. These included soils make up 5 to 15 percent of any one mapped area.

This Monahans soil is used for irrigated crops or is idle cropland. The major crops are cotton, grain sorghum, and alfalfa. Because of the very low rainfall, nonirrigated farming is not advisable.

The potential for irrigated cotton, grain sorghum, and alfalfa is medium but depends on the quantity and quality of the water used. The major problem is salinity. A well designed irrigation system and proper application of irrigation water are major concerns. Both surface and sprinkler irrigation can be used. If the irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation is not advisable because of possible leaf burn.

Crop residue on the surface, timely and limited tillage, and crop rotations conserve moisture and help to control soil blowing and water erosion. Crop residue also helps to maintain soil productivity and reduces the amount of salt coming to the surface by evaporation of water. A leaching program should be planned based on the salt tolerance of the crop and the salinity of the irrigation water.

The potential for native range plants is medium. The very low rainfall and lack of runoff from areas above are the limiting factors. The potential is low for openland and rangeland wildlife habitat.

The potential is high for most urban uses. Recreational uses have a medium potential because of a dusty surface layer.

The capability subclass is IIe irrigated and VIIe nonirrigated. The range site is Sandy Loam.

17—Monahans-Pajarito association, nearly level. This association consists of deep, nearly level soils on upland terraces near the Pecos River. Slopes are 0 to 3 percent. Areas are typically irregular in shape and range from 200 to several thousand acres.

This map unit is about 60 percent Monahans soil, 30 percent Pajarito soil, and 10 percent other soils. The Monahans soil is in the higher areas. The Pajarito soil is in low areas near the Pecos River flood plain. Areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

The surface layer of the Monahans soil is moderately alkaline, light yellowish brown loam about 8 inches thick. From 8 to 60 inches is moderately alkaline, light brown to pink loam that is about 20 to 30 percent calcium sulfate.

The Pajarito soil typically has a moderately alkaline, brown fine sandy loam surface layer about 9 inches thick. From 9 to 36 inches is moderately alkaline, light brown fine sandy loam. Between 36 and 62 inches is moderately alkaline, pink fine sandy loam that is about 5 percent calcium carbonate.

The soils in this association are well drained. Surface runoff is slow to very slow. Permeability is moderate to moderately rapid. The available water capacity is medium.

Included in mapping are small areas of Hoban, Reakor, Reeves, and Upton soils. Hoban and Reeves soils are in saline drainageways that dissect the areas. Reakor and Upton soils are in the more sloping convex positions. These soils make up about 10 percent of any one mapped area.

All this association is rangeland, but it is suited to irrigated crops, pasture, hay, and orchards. If good quantity and quality irrigation water is available, the potential for irrigated crops is medium to high. The potential for native range plants is medium. Low rainfall, lack of runoff from other areas, and possible salinity limit the amount of forage produced. The potential is low for openland and rangeland wildlife habitat.

The potential is high for most urban uses and medium for most recreation uses because of the dusty surface layer.

The capability subclass is VIIe nonirrigated and IIe irrigated. The range site is Sandy Loam.

18—Orla association, nearly level. This association consists of soils that are shallow over gypsiferous earth. The slope range is 0 to 2 percent. Areas are irregular or oval in shape and range from several hundred to several thousand acres.

This map unit is about 80 percent Orla soils and 20 percent other soils. Areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

Orla soils typically have a surface layer of moderately alkaline, pale brown loam about 2 inches thick. From 2 to 6 inches is very friable, moderately alkaline, very pale brown loam. This layer rests abruptly on a layer of white, gypsiferous earth.

The soils in this association are well drained. Surface runoff is medium. Permeability is moderate, and the available water capacity is low. The hazards of water erosion and soil blowing are moderate.

Included in mapping are areas of Hoban, Reakor, Reeves, and Sanderson soils. These included soils make up less than 20 percent of any one mapped area.

Most of the acreage is range. The soils are not suited to irrigated crops. The shallowness of the soils and the salinity in some places are the limiting factors.

The potential for native range plants is medium. The very low rainfall and the salinity are the limiting factors.

The native vegetation is mainly salt tolerant plants, such as alkali sacaton, fourwing saltbush, and twoflower trichloris. The potential is low for openland and rangeland wildlife habitat.

The potential is medium for most urban uses. Orla soils have moderate shrink-swell potential and are highly corrosive to foundations. They have a medium potential for most recreation uses because of a dusty surface layer.

The capability subclass is VIIs nonirrigated. The range site is Salty.

19—Pecos-Patrole-Arno association. This association consists of deep, nearly level saline soils on the Pecos River flood plain (fig. 6). The slope range is 0 to 1 percent. Areas are mostly long and range from 100 acres to more than a thousand acres. Flooding, which is rare, is mainly near the outlets of small watersheds. Large floods have been controlled by large dams and reservoirs upstream on the Pecos River.

Figure 6.—Landscape of Pecos-Patrole-Arno association along the Pecos River. The range site is Salty Bottomland.

This unit is about 45 percent Pecos soil, 25 percent Patrole soil, 20 percent Arno soil, and 10 percent other soils. Patrole soils are near the stream channels. Pecos and Arno soils are farther away from the channel. Areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

The Pecos soil has a saline, moderately alkaline, grayish brown silty clay surface layer about 20 inches thick. From 20 to 34 inches is saline, moderately alkaline, grayish brown clay. Between 34 and 40 inches is saline, moderately alkaline, light brownish gray silty clay loam. To a depth of 60 inches is saline, moderately alkaline, reddish brown silty clay.

The Patrole soil typically has a saline, moderately alkaline, light reddish brown to reddish brown very fine sandy loam surface layer about 15 inches thick (fig. 7). From 15 to 30 inches is saline, moderately alkaline, light reddish brown very fine sandy loam. Below this, to a depth of 60 inches or more, is saline, moderately alkaline, reddish brown clay.

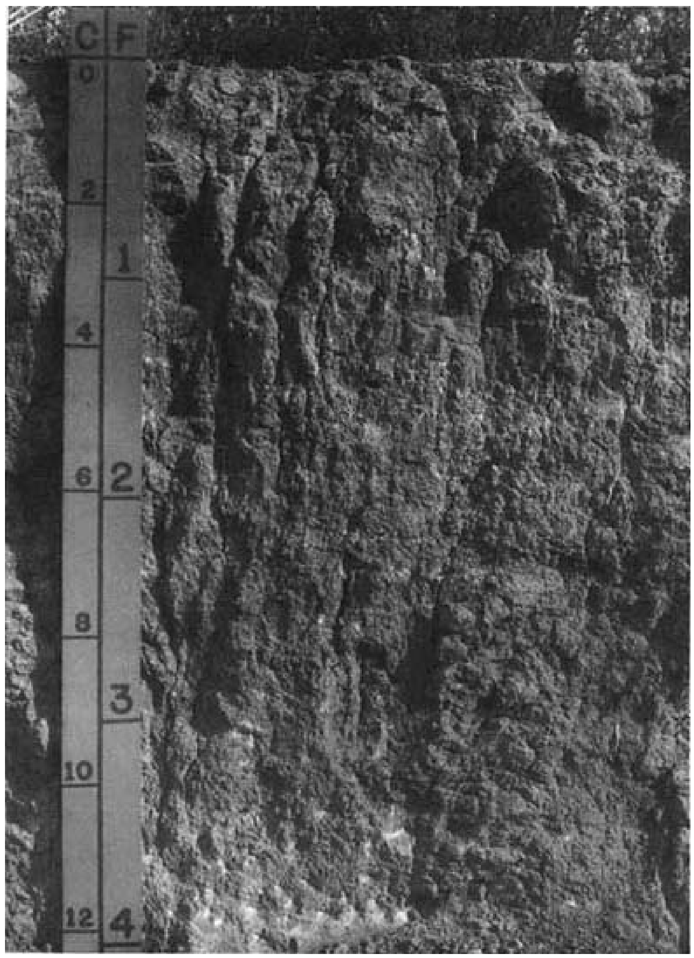


Figure 7.—Profile of Patrole very fine sandy loam, showing accumulations of salts, in an area of Pecos-Patrole-Arno association. Depths are shown in centimeters (c) and feet (f). Multiply the figure on the left by 10 to determine the depth in centimeters.

The Arno soil typically has a saline, moderately alkaline, reddish brown clay surface layer about 6 inches thick. Between depths of 6 and 60 inches is saline, moderately alkaline reddish brown clay that has common threads and masses of gypsum salts.

The soils in this association are moderately well drained. Surface runoff is slow. Permeability is very slow. The available water capacity is low to medium depending on the soil salinity. The hazards of water erosion and soil blowing are moderate.

Included in mapping are small areas of Orla soils. Also included are small areas of a soil that is loamy throughout and a few seep areas, very high in salts, that support very little vegetation. These included soils make up about 10 percent of any one mapped area.

This association is mainly rangeland. Some areas are also idle cropland. The potential is medium for irrigated cotton, barley, and alfalfa because of the salinity problems. The potential is also medium for native range plants because of the very low rainfall, the very slow permeability, and the soil salinity. The native vegetation is alkali sacaton, fourwing saltbush, twoflower trichloris, and giant sacaton. The potential for openland and rangeland wildlife habitat is low.

The potential for most urban and recreation uses is low. Flooding is a hazard. The soils expand when wet and shrink when dry. In addition, they are slippery and sticky when wet and are slow to dry.

The capability subclass is VIIs nonirrigated. The range site is Salty Bottomland.

20—Reagan silty clay loam, saline. This deep, nearly level soil is in old drainageways that carry saline spring water into the Pecos River. Most areas are near the Pecos River. They are rarely flooded for very brief periods during peak rainfall. The slope range is 0 to 1 percent. Areas range from 100 to several thousand acres and are mostly long and narrow. The soil is moderately saline.

The Reagan soil has a surface layer of saline, moderately alkaline, light brownish gray silty clay loam that is about 5 inches thick. From 5 to 18 inches is a saline, moderately alkaline, pale brown silty clay loam. Between depths of 18 and 26 inches is also saline, moderately alkaline, pale brown silty clay loam. To a depth of 60 inches is saline, moderately alkaline, very pale brown silty clay loam.

This soil is well drained. Surface runoff is slow. Permeability is moderate, and the available water capacity is medium. The soil has good tilth and a deep root zone, but the salinity is harmful to salt sensitive plants. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

Included in mapping are small areas of Reeves and Balmorhea soils. These soils generally make up less than 10 percent of any one mapped area. Reeves soils are at the higher elevations. Balmorhea soils are in the same position as this Reagan soil.

Most of the acreage is rangeland, but a few areas are abandoned cropland. Saltcedar and alkali sacaton typify the native vegetation. The potential is medium for native range plants. The most limiting factors are soil salinity and limited rainfall.

This soil is not suited to irrigated crops because of the soil salinity and the flood hazard. The potential is low for openland and rangeland wildlife habitat.

This soil has low potential for most urban uses. Flooding and the moderate shrink-swell potential are the main limiting factors. The potential is medium for most recreation use because of the flood hazard and the dusty surface. The soil is slippery and sticky when wet and is slow to dry.

The capability subclass is VIIs nonirrigated. The range site is Salty.

21—Reagan-Hodgins association, nearly level. This association consists of deep soils of valleys and plains. The slope range is 0 to 1 percent. Areas are irregular in shape and range from 160 to several thousand acres.

This unit is about 50 percent Reagan soil, 25 percent Hodgins soil, and 25 percent other soils. Some areas are dominantly Hodgins soil. Both soils are nearly level, but the Hodgins soil is generally in the slightly lower areas. Areas generally are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

The Reagan soil typically has a friable, moderately alkaline, brown silty clay loam surface layer about 8 inches thick (fig. 8). From 8 to 32 inches is moderately alkaline, yellowish brown silty clay loam. Between 32 and 60 inches is very pale brown silty clay loam that is moderately alkaline and about 35 percent by volume soft masses of calcium carbonate.

Figure 8.—Profile of Reagan silty clay loam, showing the wavy upper boundary of the calcic horizon, in an area of Reagan-Hodgins association, nearly level. Multiply the figure on the left by 10 to determine the depth in centimeters.

The Hodgins soil typically has a very friable, moderately alkaline silty clay loam surface layer about 24 inches thick. This layer is light brownish gray in the upper part and light brown below. From 24 to 44 inches is moderately alkaline, pink silty clay loam. From 44 to 66 inches is moderately alkaline, reddish yellow silty clay loam (fig. 9).

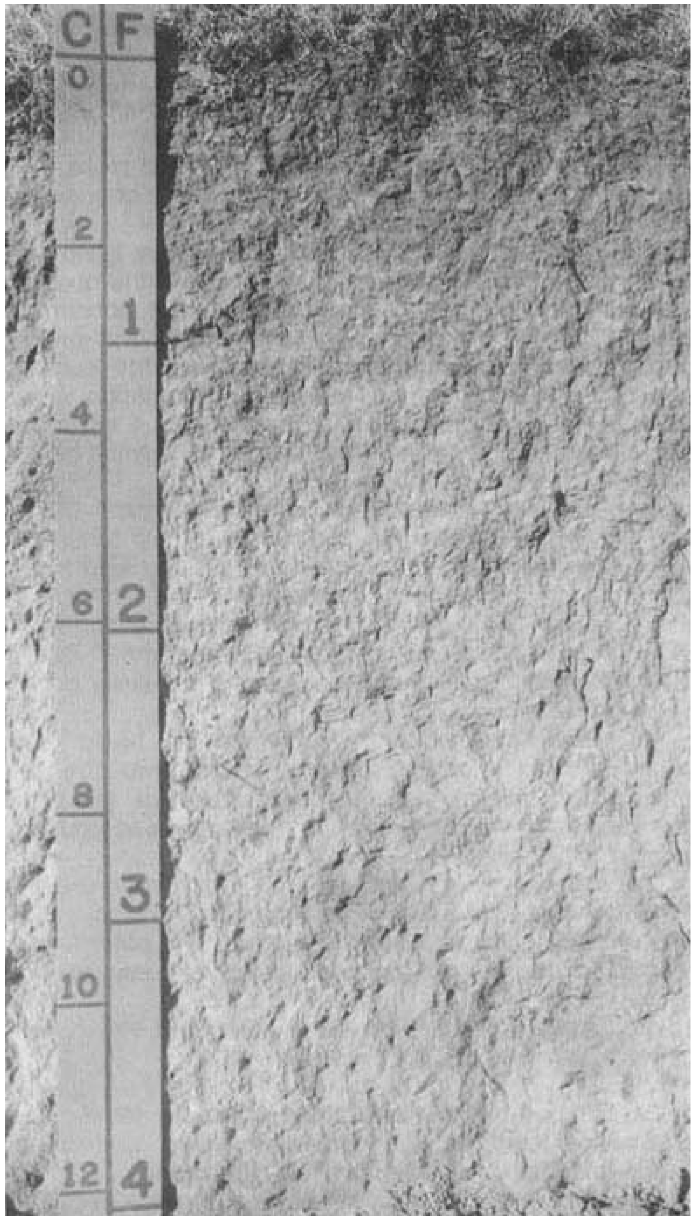


Figure 9.—Profile of Hodgins silty clay loam in an area of Reagan-Hodgins association, nearly level. Multiply the figure on the left by 10 to determine the depth in centimeters.

The soils in this association are well drained. Surface runoff is slow, and permeability is moderate. The available water capacity is medium for the Reagan soil and high for the Hodgins soil. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

Included in this association are small areas of Dalby, Iraan, and Upton soils. Dalby and Iraan soils are adjacent to small drainageways. Upton soils are in slightly convex areas or on alluvial fans of limestone hills that join this association. These soils make up as much as 25 percent of any one mapped area.

This association is used as rangeland. The potential is high for irrigated cotton, grain sorghum, and alfalfa if a sufficient quantity of good quality irrigation water is available. The soils are not suited to nonirrigated farming because of limited rainfall. The potential is high for native range plants. Low rainfall, high dry winds, and brush infestation limit the amount of forage produced. The potential is low for openland wildlife habitat and medium for rangeland habitat.

The potential is medium for most urban and recreation use. These soils expand when wet and shrink when dry. In addition, they are slippery and sticky when wet and slow to dry. They have a dusty surface.

The nonirrigated capability subclass is VIc for Reagan soil and VIw for Hodgins soil. The range site is Loamy.

22—Reakor silty clay loam, 0 to 1 percent slopes. This deep, nearly level soil is on irrigated uplands. Areas are irregular in shape and range from 6 to 1,700 acres.

The surface layer is moderately alkaline, brown silty clay loam about 7 inches thick. From 7 to 27 inches is moderately alkaline, brown silty clay loam. Between 27 and 60 inches is moderately alkaline, pink to light brown silty clay loam that is 15 to 35 percent soft masses of calcium carbonate.

This soil is well drained. Permeability is moderate to moderately slow. Surface runoff is slow, and available water capacity is high. The hazard of water erosion is severe, and the hazard of soil blowing is moderate.

Included in mapping are small areas of Hodgins and Upton soils, which make up about 10 percent of any one mapped area.

This soil is used for irrigated crops, hay, and pasture. The major crops are cotton, alfalfa, grain sorghum, wheat, and barley. Nonirrigated farming is not advisable because of the very low rainfall.

The potential is high for irrigated cotton, grain sorghum, barley, and alfalfa in areas where a sufficient quantity of good quality irrigation water is available. The major problem is salinity. A well designed irrigation system and proper application of irrigation water are needed. Both surface and sprinkler irrigation can be used. If the irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation is not advisable because of possible leaf burn.

Crop residue on the surface, timely and limited tillage, and crop rotations conserve soil moisture and help to control soil blowing and water erosion. Crop residue also helps maintain soil productivity and reduces the amount of salts coming to the surface through evaporation of water. A leaching program should be planned based on the salt tolerance of the crop grown and the salinity of the irrigation water.

The potential is low for reestablishing native range because of the very low rainfall.

This soil has a medium potential for most urban uses because it shrinks when dry and swells when wet. It is corrosive to uncoated steel. The potential is low for most recreation uses because of a dusty surface layer.

The capability class is I irrigated and VIIc nonirrigated. The range site is Loamy.

23—Reakor association, nearly level. This association consists of deep, nearly level soils on outwash plains and in basins. The slope range is 0 to 3 percent. Areas are irregular in shape and range from 35 to several thousand acres.

About 75 percent of this map unit is Reakor silty clay loam, and 25 percent other soils. Most areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

Reakor soils have a surface layer of moderately alkaline, very pale brown silty clay loam about 9 inches thick. From 9 to 34 inches is moderately alkaline, very pale brown silty clay loam. From 34 to 55 inches is moderately alkaline, pink silty clay loam that has many soft powdery masses and threads of calcium carbonate. From 55 to 62 inches is moderately alkaline, pinkish white silty clay loam that contains common soft powdery masses and threads of calcium carbonate.

Reakor soils are well drained. Surface runoff is moderately slow. Permeability is moderate to moderately slow, and available water capacity is high. The hazard of water erosion is severe, and the hazard of soil blowing is moderate.

Included in this association are small areas of Delnorte, Sanderson, and Upton soils. These soils are at higher elevations on oval shaped gravelly hills 10 to 30 acres in size. They make up less than 25 percent of any one mapped area.

This association is used for range and community development. It is suited to irrigated crops where good quality water of sufficient quantity is available. It has high potential for this use. It is not suited to nonirrigated crops, pasture, or hay because of very low rainfall. The potential is medium for native range plants because of very low rainfall.

Reakor soils have medium potential for most urban uses because they shrink when dry and swell when wet. They are also corrosive to uncoated steel. The potential is medium for recreation because of the dusty surface.

The capability class is I irrigated. The capability subclass is VIIc nonirrigated. The range site is Loamy.

24—Reeves clay loam, 0 to 1 percent slopes. This deep, nearly level soil is on uplands. Areas are irregular in shape and range from 10 to 1,600 acres.

This soil typically has a moderately alkaline, light brown clay loam surface layer about 10 inches thick. From 10 to 22 inches is moderately alkaline, light brown clay loam. From 22 to 34 inches is moderately alkaline, pink clay loam. From 34 to 62 inches is moderately alkaline, pink loam that has many soft masses of gypsum and calcium carbonate.

This soil is well drained. Surface runoff is medium. Permeability is moderate above the gypsum layer and variable in the gypsum layer. Available water capacity is high. The hazard of water erosion is severe, and the hazard of soil blowing is moderate.

Included in some areas are small areas of Reeves soils where the surface layer is loam or silty clay loam. Also included are small areas of Hoban, Orla, and Reakor soils. Included soils make up less than 20 percent of any one mapped area.

This Reeves soil is used mainly for irrigated crops. It is not suitable for nonirrigated farming because of very low rainfall. A few areas are rangeland.

The potential is medium for irrigated cotton, grain sorghum, barley, and alfalfa, but it depends on the quantity and quality of the irrigation water. The major concern is salinity. A well designed irrigation system and proper application of irrigation water are essential. Both surface and sprinkler irrigation can be used. If irrigation water has an electrical conductivity of more than 4 millimhos per centimeter, sprinkler irrigation is not advisable because of possible leaf burn.

Crop residue on the surface, timely and limited tillage, and crop rotations conserve moisture and help to control soil blowing and water erosion. Crop residue also helps maintain soil productivity and reduces the amount of soluble salts coming to the surface through evaporation of water. A leaching program should be planned based on the salt tolerance of the crop and the salinity of the irrigation water.

The potential is medium for native plants. The very low rainfall and lack of runoff from higher areas are the limiting factors. The potential is medium for openland and rangeland wildlife habitat in irrigated areas and low in nonirrigated areas.

This soil has medium potential for most urban uses. It expands when wet and shrinks when dry. This shrinking and swelling is its most limiting feature. The potential for recreation use is medium because of a dusty surface layer.

The capability subclass is IIIs irrigated and VIIs nonirrigated. The range site is Loamy.

25—Reeves-Hoban association, nearly level. This association consists of moderately deep and deep, nearly level soils on uplands. The slope range is 0 to 1 percent. Areas are irregular in shape and range from 120 to several thousand acres.

About 50 percent of this map unit is Reeves soil, 30 percent Hoban soil, and 20 percent other soils. Areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

The Reeves soil typically has a moderately alkaline, pale brown loam surface layer about 6 inches thick. From 6 to 22 inches is moderately alkaline, pink clay loam. Between 28 and 60 inches is moderately alkaline, pink loam that has soft masses and crystals of gypsum and calcium carbonate.

The Hoban soil typically has a moderately alkaline, pale brown silty clay loam surface layer about 9 inches thick. From 9 to 18 inches is moderately alkaline, light brown silty clay loam. From 18 to 72 inches is moderately alkaline, pink silty clay loam that has common soft masses of calcium carbonate and gypsum in the upper part increasing to many masses in the lower part.

The soils in this association are well drained. Surface runoff is slow to medium. Permeability is moderate. The available water capacity is high. The hazard of water erosion is severe, and the hazard of soil blowing is moderate.

Included in mapping are small areas of Monahans, Orla, Reakor, and Upton soils. Monahans soils are on mounds near drainageways. Orla soils are in positions similar to those of Reeves and Hoban soils. Reakor soils are in the valleys of small drainageways. Upton soils are at the high elevations on slightly convex knolls.

This association is suited to irrigated crops in areas where a sufficient quantity of good quality irrigation water is available. It is not suited to nonirrigated farming because of the low rainfall. The soils are used for range. The potential is medium to high for native range plants. Low rainfall, high dry winds, and brush infestation limit the amount of forage produced. The potential is low for openland and rangeland wildlife habitat.

The potential is medium for most urban uses because the soils have inadequate strength to support loads and because of the risk of corrosion to metals and concrete. The potential is medium for recreation use because the soil has a dusty surface that is slippery and sticky when wet and is slow to dry.

The nonirrigated capability subclass is VIIs for the Reeves soil and VIIc for the Hoban soil. The range site is Loamy.

26—Sanderson association, gently undulating. This association consists of deep gravelly soils on uplands. The slope range is 1 to 5 percent. Areas are irregular in shape and range from 50 to 800 acres.

About 75 percent of this map unit is Sanderson soils and 25 percent other soils. Most areas are large and vary in composition. The detail of mapping is adequate, however, for planning use and management of the soils.

Sanderson soils typically have a moderately alkaline, grayish brown gravelly clay loam surface layer about 10 inches thick. From 10 to about 60 inches is moderately alkaline, light yellowish brown very gravelly clay loam.

The soils in this association are well drained. Surface runoff is medium, and permeability is moderate. The available water capacity is low. The hazards of water erosion and soil blowing are slight.

Included in mapping are small areas of Delnorte, Hodgins, Reagan, Reakor, and Upton soils. Hodgins, Reagan, and Reakor soils are in the lower positions along drainageways. Delnorte and Upton soils are in higher positions similar to those of Sanderson soil.

This association is used for range. The potential is low for irrigated crops because of the low available water capacity, the high content of limestone fragments, and the slope. In addition, irrigation water is generally unavailable. The potential for native range plants is low because of low rainfall and low available water capacity. The native vegetation is black grama, bush muhly, slim tridens, and Wright threeawn. The potential is low for openland wildlife habitat and medium for rangeland habitat.

The potential is high for most urban uses. Sanderson soils have medium potential for most recreation use because of the amount of small stones on the surface.

The capability subclass is VIs. The range site is Gravelly.

27—Upton gravelly loam, 0 to 1 percent slopes. This nearly level soil is on uplands. It is very shallow to shallow over a cemented pan. Areas are oval or irregular in shape and range from 50 to several thousand acres.

This soil has a moderately alkaline, pinkish gray gravelly loam surface layer about 8 inches thick. From 8 to 16 inches is moderately alkaline, light brown gravelly loam about 8 inches thick. This layer rests abruptly on pink indurated caliche about 8 inches thick. From 24 to 60 inches is pink caliche material.

Upton soils are well drained. Surface runoff is medium, and permeability is moderate. The available water capacity is very low. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

Included in this map unit are areas of Delnorte and Reakor soils. Delnorte soils are on small oval shaped gravelly hills at slightly higher elevations. Reakor soils are in slightly lower areas. These soils make up 20 to 30 percent of any one mapped area.

This soil is used for irrigated crops and range. Cotton, alfalfa, and barley are the major crops.

This soil has low potential for irrigated cotton, barley, and alfalfa because of the very low available water capacity and the shallow root zone. The cultivated areas are small areas included in large fields, and it is not practical to leave them idle. Crop residue on the surface, timely and limited tillage, and crop rotations are major concerns. A well designed irrigation system, proper application of irrigation water, and salinity control are also important. Surface and sprinkler irrigation can be used. If the salinity of the water exceeds 4 millimhos per centimeter, sprinkler irrigation is not advisable because of possible leaf burn.

The potential is low for reestablishing native range. The very low rainfall and very low available water capacity are the limiting features. The potential is low for both openland and rangeland wildlife habitat.

The potential is low for most urban uses because of the shallowness over indurated caliche. The potential is medium for most recreation uses. Upton soils have a dusty surface and a large amount of small stones on the surface.

The capability subclass is IVs irrigated and VIIs nonirrigated. The range site is Gravelly.

28—Upton association, gently sloping. This association consists of gravelly soils on uplands. The soils are very shallow to shallow over a cemented pan. The slope range is 1 to 3 percent. Areas are irregular or oblong and range from 50 to a few thousand acres.

About 75 percent of this association is Upton soils and about 25 percent other soils.

Upton soils have a moderately alkaline, yellowish brown to light yellowish brown gravelly clay loam surface layer about 14 inches thick. Below this is indurated caliche about 4 inches thick. From 18 to 60 inches is weakly cemented caliche that is about 40 percent by volume limestone fragments.

The soils in this association are well drained. Surface runoff is medium, and permeability is moderate. The available water capacity is very low because of the shallowness and gravel content. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

Included in mapping are small areas of Hodgins, Reagan, and Sanderson soils and areas of a shallow to very shallow soil where the surface layer is less than 15 percent gravel. Hodgins and Reagan soils are in lower areas near narrow drains. Sanderson soils are on alluvial fans of limestone hills.

This association is used for range. It is not suited to irrigated crops because of the shallowness over indurated caliche, the high gravel content, and lack of a supply of irrigation water. The potential for native range plants is low because of low rainfall and very low available water capacity.

The potential is low for most urban uses. The most limiting feature is the shallowness over indurated caliche. The potential for most recreation use is medium because of the dusty surface and the large amount of small stones on the surface.

The capability subclass is VIIs dryland. The range site is Gravelly.

Use and management of the soils

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

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

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

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

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

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

Crops and pasture

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

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

In 1967, about 67,674 acres in Pecos County was irrigated cropland, according to the Conservation Needs Inventory *(3).* In 1977, only about 25,000 acres was irrigated.

All cropland and pastureland is irrigated. The rainfall is too low for nonirrigated farming. The most restrictive factors for irrigated cropland or pastureland are soil salinity and availability of suitable irrigation water. Another factor, not soil related, is the high cost of producing irrigated crops. This factor has caused several thousands of acres of irrigated land to be idle. Other management concerns are the hazard of soil blowing, soil tilth, and irrigation water management.

Soil blowing is a moderate hazard on the clayey Arno, Dalby, and Pecos soils and on the loamy Balmorhea, Bigetty, Monahans, Orla, Pajarito, Reakor, and Reeves soils. Maintaining a plant cover or a rough soil surface through proper tillage reduces soil blowing.

Loss of the surface layer through soil blowing is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Second, soil blowing not only results in crop damage but also pollutes the air during duststorms, causing health hazards and safety hazards on highways and roads.

A conservation cropping system that keeps plant cover on the soil for extended periods can hold soil losses to amounts that will not reduce the productivity of the soil. Leaving crop residue on the surface reduces the hazard of soil blowing.

Soil tilth is an important factor in germination of seed, emergence of seedlings, and movement of water and air in the soil. Clayey soils, such as Dalby, Arno, and Pecos soils, become very hard and compacted and restrict movement of roots, water, and air in the soil. Hoban, Hodgins, Reagan, Reakor, and Reeves soils contain large amounts of silt and calcium carbonates, which cause the formation of a hard crust on the surface, restricting seedling emergence and entrance of air and water into the soil. Crop residue, stubble mulching, cover crops, and minimum tillage improve and preserve good tilth.

Additions of fertilizer are needed to obtain the best yields from irrigated crops. The irrigated soils in the county respond well to fertilizer. Additions should be based on the results of soil tests, on the needs of the crop, and on the expected level of yields. No lime is needed. The Cooperative Extension Service can help in determining the kind and amount of fertilizer to be applied.

Water management is highly important in irrigated farming in order to conserve water and obtain the most economical yields. Concrete lined ditches or underground pipelines are used to prevent loss of water from the well to the field. Proper row length provides an even distribution of water down the row and prevents water from running out at the end of the row. Water should be applied according to the needs of the crop and the stages of plant growth. It should be applied before plants go into stress. In some areas extra water is needed to leach salts below the root zone.

Information on irrigation water management and leaching practices for each kind of soil is available in local field offices of the Soil Conservation Service.

Field crops suited to the soils and climate of Pecos County are cotton, grain sorghum, barley, and alfalfa. Special crops are cantaloupe, peppers, cabbage, and onions.

The latest information and suggestions on growing field crops or special crops can be obtained from the local offices of the Soil Conservation Service and the Cooperative Extension Service.

Irrigation and salinity

All cultivated cropland, pastureland, and hayland in the county is irrigated. The annual rainfall is too low for nonirrigated crops. Most of the land irrigated is from wells that have depths of 250 to 600 feet. Most of the irrigation done with water from the Pecos River is now abandoned. The amount and quality of water available is too variable and unpredictable for good management.

The major salinity problem is in the areas irrigated by the wells. The electrical conductivity (EC) of these wells ranges from 2.0 to about 8.0 millimhos per centimeter (EC x 1,000 at 25 degrees C.). Most of the wells have an electrical conductivity of 2.0 to 4.5 millimhos per centimeter.

Unless irrigated soils are leached, even when water of low salinity is used, the soil eventually becomes too saline for most crops. The annual rainfall is usually not enough to leach the salts out of the root zone.

Selecting crops that are best suited to the predicted electrical conductivity of the soil is important. Table 6 shows the salt tolerance of some of the crops that can be grown in the county *(5).*

The amount of water needed for leaching depends on the salt tolerance of the crop, the amount and salinity of water supplied by irrigation, and the efficiency of the irrigation system. This amount could be as much as 10 to 50 percent of the water applied. More detailed information on soil and water management can be obtained from the local offices of the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 7. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

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

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

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

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

Crops other than those shown in table 7 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

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, or for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit *(6).* 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.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-6.

The acreage of soils in each capability class and subclass is shown in table 8. The capability classification of each map unit is given in the section "Soil maps for detailed planning."

Rangeland

Winfred R. Bauer, area range conservationist, Soil Conservation Service, assisted in preparing this section.

Most of Pecos County is range. Major parts of the farm income are derived from livestock, mainly cattle, sheep, and goats. Cow-calf-yearling operations are dominant in the northern and western parts of the county. Cow-calf and sheep operations and some goats are common in the eastern part. The average size ranch is about 17,000 acres.

In winter native forage is often supplemented with protein concentrate or hay. Creep feeding of calves and lambs is practiced on some ranches.

The native vegetation on most of the survey area has been greatly depleted by continued excessive use. About 80 percent of once open grassland is now infested with brush, weeds, and other low quality forage plants. The amount of forage grown on some ranches is less than half the forage originally produced. Productivity of the ranch can be increased by using management that is effective for specific kinds of soil and range sites.

Most of the soils in the northern part of the county are deep loamy and shallow gravelly loams. These soils support drought tolerant short grasses and some mid grasses. The potential productivity is low because of insufficient rainfall. In the southern part of the county, the soils are shallow clay loams and loams underlain by limestone. These soils support a plant community of mid and short grasses in about equal amounts with woody shrubs. The potential productivity is low because of the shallow root zone and insufficient rainfall.

On most of the rangeland, the major management concern is control of grazing so that the kinds and amounts of plants that make up the potential plant community are reestablished. Controlling brush, reseeding deteriorated rangeland, and livestock water are also important management concerns. If sound range management based on the soil survey information and rangeland inventories is applied, the potential is high for increasing the productivity of range in the area.

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 9 shows, for each soil in the survey area, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as or are suited to rangeland are listed. Explanation of the column headings in table 9 follows.

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

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

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

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

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

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

Recreation

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

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

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

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.

Wildlife habitat

Willard Richter, biologist, Soil Conservation Service, helped prepare this section.

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

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

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

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

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 mountain mahogany, bitterbrush, snowberry, and big sagebrush.

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

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

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

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

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

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants.

The major wildlife species in the county are mule deer, antelope, and javelina. Bird species are scaled quail, mourning dove, roadrunner, and numerous songbirds. Smaller mammals are jackrabbit and cottontail rabbit. The mountain lion and coyote are the major predators. There are numerous raptors in the county, for example, the peregrine falcon, which is a threatened and endangered species.

Some irrigated areas in the county have a good potential for openland habitat. The economics of irrigating these areas should be considered, however, before establishing these habitats.

Engineering

Claude Thompson, Jr., area engineer, Soil Conservation Service, helped prepare this section.

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, and natural soil structure or aggregation. 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 12 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and with-out basements, small commercial buildings, local roads and streets, and lawns. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary facilities

Table 13 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 13 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 13 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bed-rock, 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 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 13 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction materials

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

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts and are naturally fertile or respond well to fertilizer.

Soils rated *fair* are sandy soils, loamy soils that have a relativity high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water management

Table 15 gives information on the soil properties and site features that affect water management. The kinds of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. If the limitations are slight or insignificant, the soil is shown as *favorable*. Otherwise, the most significant limitations are shown.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A 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, plasticity, and compaction characteristics. These results are reported in table 19.

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 properties

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

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

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

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

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

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

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. 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 19.

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.

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

Physical and chemical properties

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

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of irrigation 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 0.10 to 0.49. 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.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Soil and water features

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

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

The four hydrologic soil groups are:

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

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

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

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

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

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

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

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

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

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

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

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

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

Cemented pans are hard subsurface layers, within a depth of 5 to 6 feet, that are strongly compacted (indurated). Such pans cause difficulty in excavation. The hardness of pans is similar to that of bedrock. A rippable pan can be excavated, but a hard pan generally requires blasting.

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

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering test data

Table 19 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 morphology." The soil samples were tested by 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), D2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM); Shrinkage.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(7).* 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 20, 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 Aridisol.

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 Orthid (*Orth*, meaning true, plus *id*, from Aridisol).

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 Calciorthids (*Calci*, meaning calcic horizonation, plus *orthid*, the suborder of the Aridisols that have a calcic horizon).

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 Calciorthids.

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, thermic Typic Calciorthids.

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

Soil series and morphology

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

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual *(4).* Many of the technical terms used in the descriptions are defined in Soil Taxonomy *(7).* 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 "Soil maps for detailed planning."

Arno series

The Arno series consists of deep, moderately well drained clayey soils formed in calcareous, saline clayey alluvium on bottom land. Slopes are less than 1 percent.

Typical pedon of Arno clay in an area of Pecos-Patrole-Arno association; from Imperial, 15.1 miles east on Farm Road 11, 0.35 mile northeast on oil company road, 0.85 mile east on private road, and 10 feet north in pasture:

A1—0 to 6 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; massive; extremely hard, extremely firm; few fine and medium roots; few threads of gypsum salts; surface crust about 1 inch thick; vertical cracks 1.5 to 2.5 cm wide extend to lower boundary; moderately saline; calcareous; moderately alkaline; clear smooth boundary.

C1—6 to 44 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; massive; extremely hard, extremely firm; few fine roots; common threads of gypsum salts, fewer gypsum salt deposits below 26 inches; vertical cracks 1 to 2 cm wide below 20 inches; bedding planes are evident; few small slickensides; strongly saline; calcareous; moderately alkaline; gradual smooth boundary.

C2—44 to 60 inches; reddish brown (5YR 5/4) clay, dark reddish brown (5YR 3/4) moist; massive; extremely hard, extremely firm; common threads and soft masses of gypsum salts; extremely saline; calcareous; moderately alkaline.

Thickness of the soil is more than 60 inches. Salinity ranges from moderate to extreme. The soil when dry has cracks 1.0 to 2.5 cm wide at a depth of 20 inches. The average clay content in the 10- to 40-inch control section ranges from 40 to 60 percent.

The A horizon is 6 to 14 inches thick. It is light reddish brown, reddish brown, light brown, or brown. The texture is clay, silty clay, or silty clay loam.

The C horizon is reddish brown, light brown, brown, grayish brown, or olive brown. Some pedons have gray or brown mottles in the lower part of the subsoil. The texture is clay or silty clay. Some pedons have discontinuous strata of loam, silt loam, or silty clay loam up to about 1 inch thick. Secondary calcium sulfate and calcium carbonate in threads and soft powdery masses range from a few to about 10 percent of the soil mass.

Balmorhea series

The Balmorhea series consists of deep, somewhat poorly drained loamy soils on flood plains. These soils formed in calcareous loamy materials that were formerly spring fed marshes. Slopes are 0 to 2 percent.

Typical pedon of Balmorhea silt loam in an area of Balmorhea association; from intersection of U.S. Highway 290 and Texas Highway 1053 in Fort Stockton, 0.7 mile east on U. S. Highway 290, 0.7 mile north on Boundary Street, 1.2 miles northeast on county road along railroad tracks, 0.4 mile north on county road to entrance of city incineration site, 0.5 mile east on private road, and 50 feet north in pasture:

A11—0 to 6 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak fine subangular blocky structure; slightly hard, very friable; common fine roots; many worm casts; few fine concretions of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

A12—6 to 24 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak medium subangular blocky structure; slightly hard, very friable; common fine roots; many worm casts; few fine concretions of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

Ab—24 to 38 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak fine and medium subangular blocky structure; hard, friable; few fine roots; few worm casts; few fine concretions of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

C—38 to 60 inches; light gray (10YR 6/1) silty clay loam, gray (10YR 5/1) moist; massive; hard, firm; many fine concretions of calcium carbonate; calcareous; moderately alkaline.

Thickness of the solum ranges from 24 to 48 inches. Thickness of the mollic epipedon ranges from 21 to 48 inches. Salinity ranges from nonsaline to extremely saline. Some pedons have fragments of tufa up to 2 feet across in the solum.

The A horizon is very dark gray, dark gray, gray, or grayish brown. The texture is loam, silt loam, silty clay loam, clay loam, or silty clay.

The C horizon is gray, light gray, light brownish gray, very dark grayish brown, or pale brown. It is silty clay loam, clay loam, or silty clay that contains accumulations of calcium carbonate.

Bigetty series

The Bigetty series consists of deep, well drained loamy soils on bottom land. These soils formed in mixed alluvium derived from limestone and igneous rocks. Slopes are 0 to 1 percent.

Typical pedon of Bigetty loam in an area of Bigetty-Rockhouse association; from intersection of Interstate Highway 10 and Texas Highway 18 in Fort Stockton, 29.5 miles west on Interstate 10 to Hovey Road, 4.4 miles south on Hovey Road, 3.0 miles west on private road, and 50 feet north in range:

A11—0 to 20 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, very friable; common fine roots; few worm casts; common fine pores; calcareous; moderately alkaline; gradual smooth boundary.

A12—20 to 36 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; hard, friable; common fine roots; few worm casts; common fine pores; calcareous; moderately alkaline; clear smooth boundary.

B2—36 to 48 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; hard, friable; few fine roots; few worm casts; few fine pores; few igneous pebbles; calcareous; moderately alkaline.

Thickness of the solum ranges from 25 to 50 inches. The mollic epipedon is more than 20 inches thick. Clay content of the 10- to 40-inch control section ranges from 27 to 35 percent. Some pedons have cobbly, gravelly, or sandy loam strata below 40 inches. Limestone and igneous coarse fragments are less than 15 percent within depths of 40 inches.

The A horizon is very dark gray, dark brown, or dark grayish brown. It is loam or silty clay loam.

The B2 horizon is brown, dark brown, dark grayish brown, or grayish brown. It is heavy loam, silty clay loam, or clay loam.

Brewster series

The Brewster series consists of very shallow to shallow, well drained loamy soils on uplands. These soils formed in loamy and cobbly materials of igneous hills and mountains. Slopes range from 5 to 40 percent.

Typical pedon of Brewster very cobbly loam in an area of Brewster-Rock outcrop association, hilly; from intersection of Interstate 10 and Texas Highway 18 in Fort Stockton, 29.2 miles west on Interstate 10, 4.4 miles south on Hovey Road, 3.7 miles west on county road to a cattleguard, 5.6 miles south on private road along fence to pasture corner, 0.5 mile north on private road along fence, and 100 feet west in range:

A1—0 to 8 inches; brown (7.5YR 5/2) very cobbly loam, dark brown (7.5YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable; many fine roots; 90 percent of surface covered by gravel and cobble size igneous fragments; about 40 percent igneous cobbles 3 to 10 inches across, 25 percent igneous gravel less than 3 inches across, and 5 percent igneous stones more than 10 inches across; neutral; abrupt boundary.

R—8 to 30 inches; coarsely fractured rhyolitic bedrock.

Thickness of the solum or depth to hard igneous bedrock ranges from 4 to 20 inches. Coarse fragments in the solum range from 35 to 80 percent. They are mostly between 3 and 10 inches across.

The A horizon is reddish brown, brown, dark grayish brown, or grayish brown. The texture is loam or clay loam and the very gravelly or very cobbly analogs.

The R horizon is rhyolitic bedrock that has a few coatings of calcium carbonate on the faces of the fracture planes. It has a hardness of more than 3, Mohs' scale.

Coyanosa series

The Coyanosa series consists of very shallow to shallow, well drained loamy soils on uplands. These soils formed in materials weathered from sandstone. The slope range is 15 to 30 percent.

Typical pedon of Coyanosa very gravelly loam in an area of Coyanosa-Rock outcrop association, hilly; from the Fort Stockton city limits on U.S. Highway 385, 30.0 miles south on U.S. Highway 385, 14.45 miles east on county road, 1.45 miles west on private road, and 225 feet south in range:

A11—0 to 4 inches; dark yellowish brown (10YR 4/4) very gravelly loam, dark yellowish brown (10YR 3/4) moist; weak fine granular structure; soft, very friable, nonsticky; common fine roots; about 50 percent by volume angular sandstone fragments up to 3 inches across; neutral; clear smooth boundary.

A12—4 to 10 inches; dark yellowish brown (10YR 4/4) very gravelly loam, dark yellowish brown (10YR 3/4) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky; common fine roots; about 70 percent by volume angular sandstone fragments up to 3 inches across; moderately alkaline; abrupt wavy boundary.

R—10 to 14 inches; strongly cemented fractured sandstone bedrock.

Thickness of the solum to sandstone bedrock is 3 to 14 inches. Reaction ranges from neutral to moderately alkaline.

The A horizon is reddish brown, brown, yellowish brown, dark yellowish brown, dark grayish brown, grayish brown, or light brownish gray. It is very gravelly sandy loam or very gravelly loam that is 15 to 25 percent clay. Volume of coarse fragments ranges from 35 to 80 percent. Most coarse fragments are $^1/_8$ to 3 inches across. Less than 5 percent are between 3 to 15 inches across.

Dalby series

The Dalby series consists of deep, well drained clayey soils. These soils formed on uplands in calcareous valley fill alluvium. Slopes are 0 to 1 percent.

Typical pedon of Dalby clay, 0 to 1 percent slopes; from Coyanosa, 6.0 miles south on Farm Road 1776, 1.9 miles west on paved county road, and 300 feet south in idle cropland:

A1—0 to 18 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; weak very fine and fine blocky and subangular blocky structure; upper 2 inches is a mass of discrete peds when dry; extremely hard, very firm, very sticky, plastic; few worm casts; calcareous; moderately alkaline; gradual wavy boundary.

AC—18 to 36 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; weak fine and medium blocky structure; massive; extremely hard, extremely firm, very sticky, plastic; small slickensides; few parallelepipeds; few cracks; calcareous; moderately alkaline; gradual wavy boundary.

Cca—36 to 60 inches; light reddish brown (5YR 6/4) clay, reddish brown (5YR 5/4) moist; massive; extremely hard, extremely firm; few soft masses of calcium carbonate; few soft masses of crystalline salts, presumably gypsum; calcareous; moderately alkaline.

Depth of the soil is more than 60 inches. When the soil is dry, cracks 1 to 2 inches wide extend to more than 30 inches. The soil is nonsaline to moderately saline in the A horizon and nonsaline to extremely saline in the lower horizons. Gilgai microrelief is in undisturbed areas. The microknolls are 3 to 10 inches higher than the microdepressions.

The A horizon ranges from 6 to 24 inches in thickness. It is brown, pinkish gray, or reddish brown.

The AC horizon ranges from 12 to 40 inches in thickness. It is reddish brown, light brown, or brown. Some pedons have films, threads, or soft masses of calcium carbonate or gypsum in the lower part.

The C horizon is light brown, light reddish brown, reddish brown, or brown. Most pedons have secondary carbonates and gypsum.

Delnorte series

The Delnorte series consists of very shallow and shallow, excessively drained very gravelly loamy soils on uplands. These soils formed in calcareous loamy and gravelly materials. The slope range is 0 to 5 percent.

Typical pedon of Delnorte very gravelly loam in an area of Delnorte association, gently undulating; from intersection of U.S. Highway 285 and Farm Road 18 in Fort Stockton, 13 miles northwest on U.S. Highway 285 and Farm Road 18 in Fort Stockton, 13 miles northwest on U.S. Highway 285 to intersection with Farm Road 1776, 0.45 mile north on Farm Road 1776, and 300 feet east in range near a caliche pit:

A1—0 to 5 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky; common fine roots; 60 percent by volume igneous fragments up to 4 inches across; calcareous; moderately alkaline; clear wavy boundary.

C1ca—5 to 9 inches; yellowish brown (10YR 5/4) very gravelly loam, dark yellowish brown (10YR 4/4) moist; massive; hard, very friable, nonsticky; common fine roots; 65 percent by volume igneous fragments up to 4 inches across and with caliche coatings; calcareous; moderately alkaline; abrupt wavy boundary.

C2cam—9 to 20 inches; white (10YR 8/2) indurated caliche mixed with many igneous fragments; upper $^{1}/_{2}$ inch is laminar and has a few fractures.

C3—20 to 40 inches; very pale brown (10YR 7/3) very gravelly loam, pale brown (10YR 6/3) moist; massive; loose; about 80 percent by volume caliche coated subrounded igneous pebbles mostly less than 3 inches across.

Thickness of the soil above the petrocalcic horizon ranges from 6 to 20 inches. Coarse fragments in the control section range from 35 to 65 percent of the soil mass. The surface cover is 25 to 75 percent igneous gravel.

The A horizon ranges from 4 to 8 inches in thickness. It is pinkish gray, light brownish gray, brown, grayish brown, or pale brown. The texture is very gravelly sandy loam or very gravelly loam.

The C1ca horizon ranges from 3 to 6 inches in thickness. It is light brown, pale brown, yellowish brown, or light yellowish brown. The texture is very gravelly sandy loam or very gravelly loam.

The C2cam horizon ranges from 7 to 26 inches in thickness. It is white, pinkish gray, or very pale brown. It is indurated or strongly cemented in the upper 3 to 7 inches and is less hard with increasing depth.

Dev series

The Dev series consists of deep, well drained gravelly and very gravelly loamy soils on flood plains along small drainageways. These soils formed in gravelly alluvium of limestone origin. Slopes are 0 to 3 percent.

Typical pedon of Dev very gravelly silty clay loam in an area of Dev-Iraan association, frequently flooded; from intersection of U.S. Highway 290 and U.S.

Highway 285 in Fort Stockton, 49 miles southeast on U.S. Highway 285, 0.6 mile east on Farm Road 2400 and 50 feet south in range:

A11—0 to 16 inches; dark grayish brown (10YR 4/2) very gravelly clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky and granular structure; slightly hard, friable, very sticky; few worm casts; common fine roots; common fine pores; about 35 percent by volume limestone fragments up to 1 inch across; calcareous; moderately alkaline; clear wavy boundary.

A12—16 to 34 inches; dark brown (10YR 4/3) very gravelly clay loam, dark brown (10YR 3/3) moist; weak fine subangular blocky and granular structure; slightly hard, friable, sticky; few fine roots; about 50 percent by volume limestone fragments $^1/_2$ to 3 inches across; calcareous; moderately alkaline; abrupt wavy boundary.

Cca—34 to 60 inches; light brownish gray (10YR 6/2) very gravelly clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, friable, sticky; few fine roots; about 70 percent by volume limestone fragments $^1/_2$ to 3 inches across; few films and threads of calcium carbonate; calcareous; moderately alkaline.

Depth of the soil is more than 60 inches. The 10- to 40-inch control section is 35 to 70 percent by volume limestone fragments less than 3 inches across.

The A horizon is dark grayish brown, dark brown, or very dark grayish brown. Texture is gravelly and very gravelly loam with fine earth fractions of clay loam or silty clay loam.

The C horizon is light brownish gray, light brown, light yellowish brown, or brown. It is gravelly and very gravelly loam with fine earth fractions of clay loam or silty clay loam.

Ector series

The Ector series consists of very shallow to shallow, well drained loamy soils on uplands. These soils are on limestone hills and mountains. The slope range is 1 to 35 percent.

Typical pedon of Ector very gravelly clay loam in an area of Ector association, hilly; from intersection of U.S. Highway 290 and U.S. Highway 285 in Fort Stockton, 49 miles southeast on U.S. Highway 285, 0.1 mile east on Farm Road 2400 and 250 feet south in range:

A1—0 to 10 inches; dark grayish brown (10YR 4/2) very gravelly clay loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; hard, friable, sticky; many fine roots; common fine pores; common worm casts; about 50 percent by volume limestone fragments up to 10 inches across; calcareous; moderately alkaline; abrupt irregular boundary.

R&Cca—10 to 17 inches; fractured limestone bedrock that has caliche coatings on the surface and sides of the fractures; clear wavy boundary.

R—17 to 25 inches; fractured limestone bedrock.

Thickness of the soil above bedrock ranges from 4 to 20 inches. Coarse fragments in the control section range from 35 to 80 percent and are up to 10 inches across. The surface cover is 60 to 95 percent limestone fragments about $^1/_{10}$ inch to 15 inches across.

The A horizon ranges from 4 to 19 inches in thickness but is generally less than 10 inches thick. It is dark brown or dark grayish brown. The texture is very gravelly, very cobbly, or very stony loam with fine earth fractions of clay loam or silty clay loam.

The R&Cca horizon has coatings of precipitated caliche on the upper surface. The cracks between rocks have caliche fillings.

Hoban series

The Hoban series consists of deep, well drained soils that formed on uplands in loamy or clayey gypsiferous sediments. Slopes are 0 to 1 percent.

Typical pedon of Hoban silty clay loam in an area of Reeves-Hoban association, nearly level; from intersection of Texas State Highway 18 and Farm Road 1450, approximately 24 miles north of Fort Stockton, 1.75 miles south on Texas Highway 18, 400 feet east on a private road, and 150 feet south in range:

Ap—0 to 9 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable; few fine and medium roots and pores; calcareous; moderately alkaline; clear smooth boundary.

A1—9 to 18 inches; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4) moist; weak fine subangular blocky structure; slightly hard, friable; few fine roots and pores; few fine threads and films of calcium carbonate; moderately alkaline; clear wavy boundary.

B2ca—18 to 45 inches; pink (7.5YR 7/4) silty clay loam, light brown (7.5YR 6/4) moist; weak fine subangular blocky structure; hard, friable; common soft masses of calcium carbonate; moderately saline; calcareous; moderately alkaline; clear wavy boundary.

C1cacs—45 to 58 inches; pink (7.5YR 7/4) silty clay loam, light brown (7.5YR 6/4) moist; massive; slightly hard, friable; many soft masses of calcium carbonate and crystalline gypsum about 25 percent by volume; calcareous; moderately alkaline.

C2csca—58 to 72 inches; pink (7.5YR 7/4) silty clay loam, brown (7.5YR 6/4) moist; massive; hard, friable; 10 percent by volume gypsum and calcium carbonate; calcareous; moderately alkaline.

Thickness of the solum above the gypsic horizon ranges from 40 to 60 inches. Depth to the calcic horizon ranges from 12 to 40 inches. The soil is nonsaline to moderately saline.

The A horizon ranges from 6 to 20 inches in thickness. It is brown, pale brown, light brown, or light brownish gray clay loam, silty clay loam, or loam.

The B horizon ranges from 16 to 35 inches in thickness. It is light brown, pale brown, brown, light brownish gray, or pink. The texture is clay loam, silty clay loam, or silty clay. Visible masses of gypsum in the lower part range from 5 to 10 percent.

The C horizon is pinkish gray, pink, light brown, or very pale brown. It is clay loam, silty clay loam, or silty clay. Visible masses of gypsum and calcium carbonate range from 5 to 50 percent by volume.

Hodgins series

The Hodgins series consists of deep, well drained loamy soils on uplands. These soils formed in calcareous loamy materials from limestone hills. Slopes are 0 to 1 percent.

Typical pedon of Hodgins silty clay loam in an area of Reagan-Hodgins association, nearly level; about 12 miles southwest of Fort Stockton to the community of Belding, 0.65 mile southwest of Belding on paved road, and 100 feet northwest in range:

A11—0 to 3 inches; light brownish gray (10YR 6/2) silty clay loam, brown (10YR 4/3) moist; weak thin platy structure in the upper 1 inch, weak fine granular structure below; slightly hard, very friable; many fine roots; calcareous; moderately alkaline; clear smooth boundary.
A12—3 to 8 inches; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; slightly hard, friable; many fine roots; calcareous; moderately alkaline; gradual smooth boundary.
B21—8 to 24 inches; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4) moist; moderate fine subangular blocky structure; hard, friable; few fine roots; few films and threads of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.
B22ca—24 to 44 inches; pink (7.5YR 7/4) silty clay loam, brown (7.5YR 5/4) moist; weak fine and medium subangular blocky structure; hard, friable; about 2 percent by volume soft bodies of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.
B23ca—44 to 66 inches; reddish yellow (5YR 6/6) silty clay loam, yellowish red (5YR 5/6) moist; weak fine and medium subangular blocky structure; hard, friable; about 3 percent visible films, threads, and soft masses of calcium carbonate; calcareous; moderately alkaline.

Depth of the soil is more than 60 inches. The 10- to 40-inch control section is 20 to 35 percent noncarbonate clay.

The A horizon ranges from 4 to 12 inches in thickness. The dry color is brown, light brown, pale brown, or light brownish gray. Texture is silty clay loam and clay loam.

The B2 horizon is light brown, pale brown, light brownish gray, or pink. It is silty clay loam, clay loam, or silty clay.

The B2ca horizon is more than 6 inches thick. The calcium carbonate equivalent is less than 15 percent. The amount of visible carbonates is less than 5 percent within 40 inches. Some pedons have a calcic horizon below 40 inches. Texture is clay loam, silty clay loam, or silty clay.

Iraan series

The Iraan series consists of deep, well drained loamy soils on bottom lands. These soils formed in calcareous loamy alluvial sediments. Slopes are 0 to 1 percent.

Typical pedon of Iraan silty clay loam, occasionally flooded; from intersection of U.S. Highway 285 and U.S. Highway 290 in Fort Stockton, 11.3 miles southeast on U.S. Highway 285, 3.1 miles on county road, 1.4 miles west on ranch road, and 100 feet north in range:

A11—0 to 7 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium granular and subangular blocky structure; hard, friable; common worm casts; many fine roots; few fine rounded limestone pebbles; calcareous; moderately alkaline; gradual smooth boundary.
A12—7 to 28 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium subangular blocky structure; hard, firm; few worm casts; common pores; few films and threads

of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B21—28 to 43 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; hard, firm; few rounded pebbles less than $^1/_8$ inch in size; few films and threads of calcium carbonate; calcareous; moderately alkaline; diffuse wavy boundary.

B22—43 to 60 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; hard, firm, plastic, and very sticky; common rounded pebbles less than $^1/_8$ inch across; few films and threads of calcium carbonate; calcareous; moderately alkaline.

The solum is more than 50 inches thick. The mollic epipedon is 20 to 40 inches thick. Total clay content of the 10- to 40-inch control section ranges from 30 to 45 percent. Content of noncarbonate clay is 27 to 35 percent. The calcium carbonate equivalent is about 5 to 30 percent. About 0 to 5 percent is in visible secondary forms. Limestone fragments $^1/_8$ to 1 inch in size range from 0 to 15 percent.

The A horizon is brown, dark brown, grayish brown, or dark grayish brown. It is silty clay loam or clay loam.

The B2 horizon is brown, light brown, light brownish gray, pale brown, light yellowish brown, dark brown, grayish brown, yellowish brown, or dark yellowish brown. It is silty clay loam, clay loam, or silty clay.

The C or Cca horizon, where present, is loam, clay loam, silty clay loam, or silty clay. Some pedons have gravelly strata below 40 inches.

Limpia series

The Limpia series consists of deep, well drained cobbly and loamy soils on uplands. These soils formed in gravelly and cobbly clayey material on alluvial fans of igneous hills and mountains. Slopes are 1 to 3 percent.

Typical pedon of Limpia very cobbly loam in an area of Limpia association, gently sloping; from intersection of Interstate Highway 10 and Texas Highway 18 in Fort Stockton, 26.5 miles west to Hovey Road, 4.4 miles south on Hovey road, 3.5 miles west on ranch road to cattleguard, 4.3 miles south on private road, and 300 feet northwest at north rim of borrow pit in range:

A1—0 to 8 inches; reddish gray (5YR 5/2) very cobbly loam, dark reddish brown (5YR 3/2) moist; weak fine granular and subangular blocky structure; slightly hard, friable; few fine roots; about 50 percent by volume gravel and cobble size igneous fragments; about 80 percent surface cover of igneous fragments; noncalcareous; neutral; clear smooth boundary.

B21t—8 to 22 inches; reddish brown (5YR 5/3) very cobbly clay, dark reddish brown (5YR 3/3) moist; moderate fine and medium blocky structure; very hard, firm, plastic; few fine roots; about 60 percent by volume gravel and cobble size igneous fragments; noncalcareous; neutral; gradual smooth boundary.

B22t—22 to 36 inches; reddish brown (5YR 5/4) very cobbly clay, reddish brown (5YR 4/4) moist; moderate fine and medium subangular blocky structure; hard, firm, plastic; about 60 percent by volume gravel and cobble size igneous fragments; calcareous; mildly alkaline; clear wavy boundary.

B23tca—36 to 60 inches; pink (5YR 7/3) very gravelly clay, light reddish brown (5YR 6/3) moist; weak coarse subangular blocky structure; hard, firm, plastic; about 50 percent by volume gravel, cobble, and stone size igneous fragments that are coated with calcium carbonate; calcareous; moderately alkaline.

The solum is more than 40 inches thick. The control section is 50 to 75 percent by volume gravel and cobble size igneous fragments. The mollic epipedon is 20 to 36 inches thick.

The A horizon ranges from 5 to 14 inches in thickness. The dry color is reddish gray, reddish brown, brown, or dark reddish gray. Texture is very gravelly or very cobbly loam with fine earth fractions of sandy clay loam or clay loam. About 35 to 70 percent by volume is gravel and cobble size igneous fragments.

The B2t horizon above the calcic horizon is reddish brown or yellowish red. The B2tca horizon is light reddish brown, reddish yellow, or pink. The texture is very gravelly clay or very cobbly clay. Volume of gravel and cobble size igneous fragments ranges from 50 to 75 percent.

The C horizon, where present, is 30 to 60 percent by volume calcium carbonate and 50 to 90 percent gravel and cobble size igneous fragments.

Lozier series

The Lozier series consists of very shallow and shallow, well drained very gravelly and stony loamy soils on uplands. These soils formed on limestone hills. Slopes range from 0 to 45 percent.

Typical pedon of Lozier very gravelly loam in an area of Lozier association, hilly; from intersection of U.S. Highway 290 and Texas Highway 18 in Fort Stockton, 9 miles north on Texas Highway 18, 0.25 mile west on oil company road, and 260 feet south in range:

A1—0 to 6 inches; light brownish gray (10YR 6/2) very gravelly loam, grayish brown (10YR 5/2) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky; common fine roots; common fine pores; about 18 percent by volume limestone and caliche fragments larger than 3 inches across and 60 percent fragments smaller than 3 inches; calcareous; moderately alkaline; abrupt irregular boundary.

R&Cca—6 to 14 inches; fractured platy limestone; caliche coatings on surface; cracks and fractures are filled and partly sealed with calcium carbonate; gradual wavy boundary.

R—14 to 30 inches; fractured limestone bedrock.

Thickness of the solum and depth to limestone bedrock range from 4 to 14 inches. The control section is 35 to 80 percent by volume limestone fragments.

The A horizon is pale brown, light gray, or light brownish gray. Texture is very gravelly or stony loam with fine earth fractions of clay loam or silty clay loam.

The R&Cca horizon is limestone bedrock that has coatings of calcium carbonate in fractures.

Monahans series

The Monahans series consists of deep, well drained loamy soils on uplands. These soils formed in calcareous and gypsiferous materials along the terraces of the Pecos River. Slopes are 0 to 1 percent.

Typical pedon of Monahans loam in an area of Monahans-Pajarito association, nearly level; from intersection of Texas Highway 1053 and Farm Road 11 in Imperial, 1.0 mile northeast on Texas Highway 1053, 1.1 miles east on ranch road, and 75 feet south in range:

A1—0 to 8 inches; light yellowish brown (10YR 6/4) loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable; few fine roots; few fine concretions of calcium carbonate; few gypsum crystals; moderately saline; calcareous; moderately alkaline; clear smooth boundary.

B2—8 to 26 inches; light brown (7.5YR 6/4) loam, brown (7.5YR 4/4) moist; weak fine subangular blocky structure; hard, friable; few fine concretions of calcium carbonate; few masses of gypsum crystals; strongly saline; calcareous; moderately alkaline; clear wavy boundary.

C1cacs—26 to 36 inches; pink (7.5YR 7/4) loam, brown (7.5YR 5/4) moist; massive; hard, friable; about 20 percent by volume gypsum crystals and masses of calcium carbonate; strongly saline; calcareous; moderately alkaline; diffuse wavy boundary.

C2cacs—36 to 60 inches; light brown (7.5YR 6/4) loam, brown (7.5YR 4/4) moist; massive; hard, friable; about 30 percent gypsum crystals and concretions of calcium carbonate; strongly saline; calcareous; moderately alkaline.

Thickness of the solum is 16 to 36 inches. The control section is less than 18 percent noncarbonate clay. The soil is nonsaline to strongly saline.

The A horizon ranges from 5 to 12 inches in thickness. It is brown, pale brown, light brown, yellowish brown, and light yellowish brown. The texture is loam or fine sandy loam.

The B horizon ranges from 14 to 21 inches in thickness. It is light brown, brown, or yellowish brown. The texture is loam, sandy loam, or sandy clay loam. In some pedons about 5 percent of the B horizon is soft masses of calcium carbonate.

The C horizon is pink or light brown. The texture is loam or sandy loam. Visible concretions of calcium carbonate and crystals of gypsum range from 15 to 35 percent.

Orla series

The Orla series consists of shallow, well drained loamy soils on uplands. These soils formed in gypsiferous loamy materials. Slopes are 0 to 2 percent.

Typical pedon of Orla loam in an area of Orla association, nearly level; from intersection of Texas Highway 18 and Farm Road 1450 approximately 24 miles north of Fort Stockton (near the Santa Rosa Plant), 1.3 miles north on Texas Highway 18, and 100 feet west in range:

A11—0 to 2 inches; pale brown (10YR 6/3) loam, brown (10YR 4/3) moist; weak medium platy structure; slightly hard, very friable; few fine roots; calcareous; moderately alkaline; abrupt smooth boundary.

A12—2 to 6 inches; very pale brown (10YR 7/3) loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; slightly hard, very friable; many fine roots; moderately saline; calcareous; moderately alkaline; clear wavy boundary.

C1cacs—6 to 18 inches; white (10YR 8/2) loam, light gray (10YR 7/2) moist; massive; hard, friable; about 80 percent by volume gypsum and calcium carbonate; extremely saline; calcareous; moderately alkaline; diffuse wavy boundary.

C2cacs—18 to 60 inches; very pale brown (10YR 8/4) loam, very pale brown (10YR 7/4) moist; massive; about 40 percent gypsum and calcium carbonate; extremely saline; calcareous; moderately alkaline.

Depth to the gypsic horizon ranges from 1 to 20 inches. Clay content of the control section ranges from 18 to 35 percent. Salinity ranges from nonsaline to extremely saline.

The A horizon is brown, very pale brown, pale brown, grayish brown, light brownish gray, or light yellowish brown. The texture is loam, silt loam, or clay loam.

The C horizon is gypsiferous material that is white, light gray, or very pale brown. The texture is fine sandy loam, loam, silt loam, clay loam, silty clay loam, or sandy clay loam.

Pajarito series

The Pajarito series consists of deep, well drained loamy soils on uplands. These soils formed on alluvial fans or old terraces of the Pecos River. Slopes are 0 to 3 percent.

Typical pedon of Pajarito fine sandy loam in an area of Monahans-Pajarito association, nearly level; from intersection of Texas Highway 1053 and Farm Road 11 at Imperial, 1.4 miles northeast on Texas Highway 1053, 1.3 miles east, 0.1 mile south, and 0.5 mile east on county road, 0.5 mile north on private road, and 75 feet west in an abandoned cultivated field:

Ap—0 to 9 inches; brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) moist; weak fine granular and subangular blocky structure; slight hard, very friable; few fine roots; calcareous; moderately alkaline; clear smooth boundary.

B2—9 to 36 inches; light brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable; few fine roots; calcareous; moderately alkaline; clear smooth boundary.

C1ca—36 to 48 inches; pink (7.5YR 7/4) fine sandy loam, light brown (7.5YR 6/4) moist; massive; few films and threads of calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary.

C2ca—48 to 62 inches; pink (7.5YR 8/4) fine sandy loam, light brown (7.5YR 6/4) moist; massive; few films, threads, and soft masses of calcium carbonate; few igneous pebbles; calcareous; moderately alkaline.

The solum ranges from 30 to 40 inches in thickness. Clay content of the control section is less than 18 percent. Limestone or igneous pebbles in the A and B2 horizons are 0 to 15 percent by volume.

The solum is light brown, brown, or light reddish brown. It is fine sandy loam or loam.

The C horizon is pink, brown, light brown, reddish yellow, or light reddish brown. The texture is sandy loam, fine sandy loam, or loam.

Patrole series

The Patrole series consists of deep, moderately well drained loamy soils on flood plains. These soils formed in recent loamy and clayey alluvium. Slopes are less than 1 percent.

Typical pedon of Patrole very fine sandy loam in an area of Pecos-Patrole-Arno association; from Imperial, 13.0 miles east on Farm Road 11, 3.3 miles north on Horsehead Crossing Road, 30 feet east at edge of Pecos River channel in range:

A11—0 to 6 inches; light reddish brown (5YR 6/3) very fine sandy loam, reddish brown (5YR 4/3) moist; weak fine subangular blocky structure; soft, very friable; few fine roots; few fine pores; many bedding planes; common threads, films, and soft masses of calcium sulfate and other salts; moderately saline; calcareous; moderately alkaline; abrupt wavy boundary.

A12—6 to 15 inches; reddish brown (5YR 5/3) very fine sandy loam, reddish brown (5YR 4/3) moist; weak fine and medium subangular blocky structure; slightly hard, friable; few fine roots; few bedding planes; many soft masses, threads, and films of gypsum and other salts; calcareous; moderately alkaline; abrupt wavy boundary.

C1—15 to 30 inches; light reddish brown (5YR 6/3) very fine sandy loam, reddish brown (5YR 4/3) moist; massive; slightly hard, very friable; many soft masses, threads, and films of gypsum; extremely saline; calcareous; moderately alkaline; clear wavy boundary.

C2—30 to 60 inches; reddish brown (5YR 5/4) clay, dark reddish brown (5YR 3/4) moist; massive; extremely hard, extremely firm, very sticky, very plastic; many soft masses of calcium sulfate and other salts; extremely saline; calcareous; moderately alkaline.

Depth to the clay layer ranges from 20 to 36 inches. Salinity ranges from slight to extreme. The control section is silt loam or very fine sandy loam. The upper part is 18 to 25 percent clay. The lower part is clay or silty clay that is 45 to 60 percent clay.

The A horizon is 9 to 16 inches thick. It is pale brown, light reddish brown, reddish brown, or light brown. The texture is silt loam, loam, or very fine sandy loam.

The C1 horizon is 12 to 20 inches thick. It is light brown, light reddish brown, reddish brown, or brown. It is silt loam, loam, or very fine sandy loam.

The C2 horizon is reddish brown, grayish brown, brown, light reddish brown, or light brown. It is clay or silty clay.

Pecos series

The Pecos series consists of deep, moderately well drained clayey soils on flood plains along the Pecos River. These soils formed in calcareous, stratified clayey alluvium. Slopes are less than 1 percent.

Typical pedon of Pecos silty clay in an area of Pecos-Patrole-Arno association; from Imperial, 13.0 miles east on Farm Road 11 to intersection with Horsehead Crossing Road, 2.4 miles north on Horsehead Crossing Road, near fence on east side of road in range:

A11—0 to 9 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; very hard, very firm; few fine roots; common threads and films of calcium salts; surface crust $^{1}/_{4}$ inch thick; few vertical cracks $^{1}/_{2}$ inch wide extending through the horizons; moderately saline; calcareous; moderately alkaline; clear smooth boundary.

A12—9 to 20 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; very hard, very firm; common threads and films and soft masses of gypsum salts; few vertical cracks $^{1}/_{2}$ inch wide extend to lower boundary; extremely saline; calcareous; moderately alkaline; abrupt smooth boundary.

C1—20 to 34 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; few fine faint reddish brown mottles; massive; extremely hard, very firm; few threads and films of gypsum salts; extremely saline; calcareous; moderately alkaline; abrupt smooth boundary.

C2—34 to 40 inches; light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; very hard, firm; many threads, films, and soft masses of gypsum salts; calcareous; moderately alkaline; clear smooth boundary.

C3—40 to 60 inches; reddish brown (5YR 5/4) silty clay, reddish brown (5YR 4/4) moist; massive; very hard, very firm; common threads and films of calcium carbonate; calcareous; moderately alkaline.

Depth of the soil is more than 60 inches. When the soil is dry, cracks are $^1/_2$ to $^3/_4$ inch wide and more than 20 inches deep. The average clay content in the control section ranges from 35 to 60 percent. Salinity ranges from moderate to extreme. The mollic epipedon is 12 to 30 inches thick.

The A horizon is dark grayish brown, grayish brown, or brown. It is clay or silty clay.

The C horizon is reddish brown, dark reddish brown, light brownish gray, grayish brown, or light reddish brown. It is clay, silty clay, or silty clay loam. Some pedons have a few fine faint mottles. Some pedons have strata of silt loam, very fine sandy loam, or fine sandy loam. Most pedons have visible gypsum and other salts ranging from 5 to 40 percent by volume.

Reagan series

The Reagan series consists of deep, well drained loamy soils on uplands. These soils formed in calcareous loamy alluvium. Slopes are 0 to 1 percent.

Typical pedon of Reagan silty clay loam in an area of Reagan-Hodgins association, nearly level; from intersection of U.S. Highway 290 and U.S. Highway 285 in Fort Stockton, 8.4 miles southeast on U.S. Highway 285, and 380 feet west on the southwest bank of borrow pit:

A1—0 to 8 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, sticky; many fine roots; many fine pores; many worm casts; calcareous; moderately alkaline; clear wavy boundary.

B21—8 to 32 inches; yellowish brown (10YR 5/4) silty clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; hard, friable, sticky; common fine roots; common fine pores; few worm casts; about 1 percent by volume soft masses of calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

B22ca—32 to 50 inches; very pale brown (10YR 7/4) silty clay loam, light yellowish brown (10YR 6/4) moist; weak medium subangular blocky structure; hard, friable, sticky; about 35 percent by volume soft powdery calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

B23ca—50 to 60 inches; very pale brown (10YR 7/4) silty clay loam, light yellowish brown (10YR 6/4) moist; weak coarse subangular blocky structure; hard, friable, sticky; about 10 percent by volume films, threads, and concretions of calcium carbonate.

Depth to the calcic horizon ranges from 20 to 40 inches. Clay content of control section ranges from 20 to 35 percent. Salinity in some areas results from irrigation with saline water.

Thickness of the A horizon ranges from 4 to 12 inches. The dry color is brown, light brown, grayish brown, or yellowish brown. Texture is loam, silt loam, or silty clay loam.

Thickness of the B2 horizon ranges from 18 to 26 inches. The dry color is brown, pale brown, light brown, or yellowish brown. Texture is loam or silty clay loam.

The Bca horizon is more than 6 inches thick. It is 15 to 60 percent by volume soft masses and concretions of calcium carbonate. It is pink, very pale brown, light brown, or light yellowish brown. The texture is loam or silty clay loam.

Reakor series

The Reakor series consists of deep, well drained loamy soils on uplands. These soils formed in calcareous loamy alluvium. Slopes are 0 to 3 percent.

Typical pedon of Reakor silty clay loam in an area of Reakor association, nearly level; from intersection of Interstate 10 and Hovey Road about 26 miles west of Fort Stockton, 1.0 mile east on Interstate 10, and 100 feet north in range:

A11—0 to 2 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; hard, friable; common fine and medium roots; calcareous; moderately alkaline; clear wavy boundary.

A12—2 to 9 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; hard, friable; common fine and medium roots; calcareous; moderately alkaline; clear wavy boundary.

B21—9 to 17 inches; very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) moist; moderate fine subangular blocky structure; hard, friable; few fine roots; calcareous; moderately alkaline; diffuse wavy boundary.

B22—17 to 34 inches; very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; hard, friable; few threads of calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

C1ca—34 to 55 inches; pink (7.5YR 8/4) silty clay loam, pink (7.5YR 7/4) moist; massive; hard, friable; about 20 percent by volume soft powdery masses of calcium carbonate; calcareous; moderately alkaline; diffuse wavy boundary.

C2ca—55 to 62 inches; pinkish white (7.5YR 8/2) silty clay loam, pink (7.5YR 7/4) moist; massive; hard, friable; about 15 percent by volume soft powdery masses and threads of calcium carbonate; calcareous; moderately alkaline.

Depth to the upper boundary of the calcic horizon ranges from 20 to 36 inches. Clay content of the control section ranges from 27 to 33 percent. The soil is moderately alkaline throughout.

The A horizon is pinkish gray, light brownish gray, brown, or pale brown. It is loam, silty clay loam, silt loam, or clay loam.

The B2 horizon is pinkish gray, pink, light brown, brown, pale brown, or very pale brown. It is loam, silty clay loam, or clay loam.

The Cca horizon is pink, pinkish white, light brown, brown, or pale brown. It is loam, silty clay loam, or clay loam. Some pedons are silty clay below 40 inches.

Reeves series

The Reeves series consists of moderately deep, well drained loamy soils on uplands. These soils formed in gypsiferous loamy alluvial materials. Slopes are 0 to 1 percent.

Typical pedon of Reeves clay loam in an area of Reeves-Hoban association, nearly level; from intersection of Texas Highway 18 and Farm Road 1450 approximately 24.0 miles north of Fort Stockton (near the Santa Rosa gas plant), 4.1 miles west on Farm Road 1450, 1.9 miles south on ranch road, and 100 feet east in range:

A1—0 to 6 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; hard, friable, sticky; few fine roots and pores; calcareous; moderately alkaline; clear wavy boundary.
B21—6 to 13 inches; pink (7.5YR 7/4) clay loam, light brown (7.5YR 6/4) moist; weak fine subangular blocky structure; hard, friable, sticky; few fine roots and pores; calcareous; moderately alkaline; clear wavy boundary.
B22—13 to 28 inches; pink (7.5YR 7/4) clay loam, light brown (7.5YR 6/4) moist; weak fine subangular blocky structure; hard, friable, sticky; few threads and films of calcium carbonate and gypsum; slightly saline; calcareous; moderately alkaline; clear wavy boundary.
C1cacs—28 to 38 inches; pink (7.5YR 8/4) loam, pink (7.5YR 7/4) moist; massive; slightly hard, very friable; about 50 percent visible crystals of calcium carbonate and gypsum; slightly saline; calcareous; moderately alkaline; gradual wavy boundary.
C2cacs—38 to 60 inches; pink (7.5YR 8/4) loam, pink (7.5YR 7/4) moist; massive; slightly hard, very friable; about 35 percent visible crystals of calcium carbonate and gypsum; moderately saline; calcareous; moderately alkaline.

Depth to the gypsic horizon ranges from 20 to 40 inches. Clay content of the control section ranges from 18 to 30 percent. The soil is slightly to moderately saline.

The A horizon is pale brown, brown, yellowish brown, light yellowish brown, or light brown. It is loam or clay loam.

The B2 horizon is pink, brown, light brown, pale brown, light yellowish brown, very pale brown, reddish brown, and light reddish brown. It is loam or clay loam.

The C horizon is pink, light brown, very pale brown, or light reddish brown. It is loam or clay loam. Visible calcium carbonate and gypsum range from 20 to 70 percent by volume.

Rockhouse series

The Rockhouse series consists of deep, well drained very cobbly and gravelly loamy soils. These soils are on flood plains along small drainageways. These soils formed in sediments from igneous and limestone hills. Slopes are 0 to 2 percent.

Typical pedon of Rockhouse very cobbly loam in an area of Bigetty-Rockhouse association; from intersection of Interstate Highway 10 and Texas Highway 18 in Fort Stockton, 26.5 miles west on Interstate Highway 10 to Hovey Road, 4.4 miles south on Hovey Road, 3.5 miles west on ranch road across a cattleguard, 2.5 miles south on private road, then 0.7 mile east near Barilla Draw:

A1—0 to 11 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; slightly hard, very friable; common fine roots; common fine pores; calcareous; moderately alkaline; abrupt wavy boundary.
C—11 to 60 inches; yellowish brown (10YR 5/4) very cobbly loamy sand, dark yellowish brown (10YR 3/4) moist; single grained; loose; about 55 percent by volume igneous fragments of gravel and cobble size; calcareous; moderately alkaline.

Depth of the soil is more than 40 inches. The control section is 40 to 80 percent igneous pebbles of mostly gravel and cobble size. The mollic epipedon is 10 to 20 inches thick.

The A horizon ranges from 10 to 18 inches in thickness. It is brown or dark grayish brown when dry. The texture is sandy loam, loam, or gravelly or cobbly sandy loam or gravelly or cobbly loam.

The C horizon is yellowish brown and dark yellowish brown. It is very cobbly loamy sand or very gravelly loamy sand.

Sanderson series

The Sanderson series consists of deep, well drained gravelly loamy soils on uplands. These soils formed in valley fill alluvium from limestone hills. The slope range is 1 to 5 percent.

Typical pedon of Sanderson gravelly clay loam in an area of Sanderson association, gently undulating; from intersection of U.S. Highway 290 and U.S. Highway 285 in Fort Stockton, 30.5 miles southeast on U.S. Highway 285, 0.8 mile east on ranch road to road bank on south side of road near draw:

A11—0 to 3 inches; grayish brown (10YR 5/2) gravelly clay loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; hard, friable, sticky; many fine roots and pores; about 25 percent by volume limestone and caliche fragments up to 1 inch across; calcareous; moderately alkaline; diffuse wavy boundary.

A12—3 to 10 inches; grayish brown (10YR 5/2) gravelly clay loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; hard, friable, sticky; common fine roots; few fine pores and insect burrows; about 30 percent by volume limestone fragments up to 1 inch across; calcareous; moderately alkaline; diffuse wavy boundary.

B2ca—10 to 30 inches; light yellowish brown (10YR 6/4) very gravelly clay loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; hard, friable, sticky; common fine roots; about 55 percent by volume limestone fragments up to 2 inches across; few films, threads, and soft masses of calcium carbonate; calcareous; moderately alkaline; diffuse wavy boundary.

C—30 to 60 inches; light yellowish brown (10YR 6/4) very gravelly clay loam, yellowish brown (10YR 5/4) moist; massive; hard, friable, sticky; few fine roots; about 60 percent by volume limestone and caliche fragments up to 3 inches across; calcareous; moderately alkaline.

The solum ranges from 24 to more than 40 inches in thickness. Limestone fragments in the control section are up to 3 inches across and range from 35 to 60 percent. Clay content is 18 to 35 percent, and calcium carbonate content is more than 40 percent.

When dry, the A horizon is grayish brown, brown, pale brown, or pinkish gray. The texture is gravelly or very gravelly loam, sandy loam, or clay loam.

The B2ca horizon has a dry color of light brown, grayish brown, brown, light yellowish brown, or pale brown. The texture of the B horizon is very gravelly loam or very gravelly clay loam.

The C horizon has a dry color that is light brownish gray, pale brown, or light yellowish brown. The texture is very gravelly sandy loam, very gravelly loam, or very gravelly clay loam.

Upton series

The Upton series consists of very shallow to shallow, well drained gravelly loamy soils on uplands. These soils formed in calcareous outwash sediments from limestone hills. Slopes are 1 to 3 percent.

Typical pedon of Upton gravelly clay loam in an area of Upton association, gently sloping; from intersection of U.S. Highway 285 and Interstate 10 in Fort Stockton, 1.0 mile southeast on U.S. Highway 285, 0.3 mile east on cemetery road, 0.3 mile north on gravel road, and 10 feet west in range:

A1—0 to 3 inches; yellowish brown (10YR 5/4) gravelly clay loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; hard, friable, sticky; common fine roots and pores; about 25 percent by volume caliche and limestone fragments; calcareous; moderately alkaline; diffuse wavy boundary.

B2ca—3 to 14 inches; light yellowish brown (10YR 6/4) gravelly clay loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; hard, friable, sticky; common fine roots and pores; about 25 percent by volume caliche and limestone fragments up to 3 inches across; calcareous; moderately alkaline; abrupt wavy boundary.

C1cam—14 to 18 inches; indurated caliche, fractured in places.

C2ca—18 to 60 inches; pink (7.5YR 7/4) caliche, weakly cemented; about 40 percent by volume limestone fragments.

Thickness of the soil above the caliche rock, the petrocalcic horizon, is 8 to 20 inches. Coarse fragments in the control section range from 15 to 35 percent by volume and are up to 3 inches across. The surface cover is 5 to 80 percent caliche and limestone fragments $^{1}/_{16}$ to 3 inches across.

The A horizon ranges from 3 to 12 inches in thickness but in most areas is less than 10 inches thick. It is grayish brown, pale brown, light grayish brown, light yellowish brown, and yellowish brown. The texture is gravelly fine sandy loam, gravelly loam, or gravelly clay loam.

The B2 horizon ranges from 5 to 16 inches in thickness. It is very pale brown, brown, pale brown, or light yellowish brown. The texture is gravelly fine sandy loam, gravelly loam, or gravelly clay loam.

The Ccam horizon has an indurated layer of caliche that is more than 1 inch thick. It is underlain by calcium carbonate rubble and marl.

Formation of the soils

In this section the factors of soil formation are discussed and related to the soils in the survey area. In addition, the processes of soil formation are described.

Factors of soil formation

The characteristics of a soil at any given point depend on (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and has existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief or lay of the land, and (5) the length of time the forces of soil development have acted on the soil material.

All five of these factors are important in the genesis of every soil; some have had more influence than others in different locations. The factors are discussed in the following paragraphs.

Parent material

Parent material is the unconsolidated mass from which a soil forms. It determines the limits of the chemical and mineralogical composition of the soils. The soils of Pecos County developed in parent material that ranges in age from Pennsylvanian to Recent.

For the most part, the surface rocks in the county are limestone beds of Cretaceous age, for example, formations of both the Comanchean and Gulfian Series. The Gulfian Series Formation occurs in a small area near the west corner of the county. Cretaceous rocks form gently sloping to steep benched hills and ridges where bedrock is near the surface. Ector and Lozier soils are characteristic soils derived from these formations.

Tertiary age material is mainly igneous rock of the Eocene Series. These areas are in the northwestern part of the county. Brewster soils formed in this material.

Quaternary age material includes soils that developed in material deposited from the Cretaceous limestone, such as Hoban, Hodgins, Reakor, and Reeves soils. These soils still receive sediment from the limestone hills and mountains. Older soils of Quaternary age developed in sediment of mixed origin and have petrocalcic horizons or moderately cemented calcic horizons. Delnorte and Upton soils are examples. Soils developed in deposits from Tertiary igneous rock are of the Bigetty, Limpia, and Rockhouse series. Orla and some of the Hoban, Monahans, and Reeves soils developed in areas of recent deposits from limestone over gypsum.

Outcrops of the Pennsylvanian and Permian Formations occur in the southern part of the county. Ector soils are dominant in this area.

The parent material of the soils on flood plains along the Pecos River consists of alluvial deposits of Recent age. Moderately alkaline and saline soils that formed in these deposits are soils of the Arno, Patrole, and Pecos series.

Climate

The semi-arid climate of Pecos County has had a definite effect on soil formation. It is fairly uniform. Summer temperatures are high. Winter temperatures are generally mild. Rainfall, evaporation, temperature, and winds are some of the influencing factors. The limited rainfall has not been great enough to leach minerals from the soils. As a result, most of the soils have a layer in which calcium carbonate has accumulated. The deep soils are seldom moist below the root zone.

Plant and animal life

Plants, micro-organisms, earthworms, insects, animals, and man contribute to the development of soils. Gains or losses of organic matter, nitrogen, and plant nutrients and changes in soil structure and porosity are among the changes caused by living organisms.

Plants are highly important in soil development in Pecos County. The fibrous root system of grasses contributes a large amount of organic matter to the soils. Roots of grasses and shrubs decay and leave pores and holes that serve as passageways for water.

Earthworms, insects, rodents, and other animals work and mix the soils to a great degree. Worms hasten the decay of organic matter. Worm casts improve soil structure to aid the movement of water and growth of plant roots. Fungi, bacteria, and other micro-organisms help to decay organic matter and improve fertility.

The activities of man also affect soil development. By fencing the range and allowing it to be overgrazed, man has changed the characteristic vegetation. Grasses are shorter, thinner, and weaker, and they return less organic matter to the soils. Irrigation with saline water and construction excavations have affected the soils in some places.

Relief

Relief or topography influences soil development through its effect on drainage and runoff. The topography of Pecos County ranges from nearly level to steep.

The degree of profile development depends on the amount and depth of penetration of moisture, if other factors are equal. Nearly level soils on flood plains, such as Arno, Patrole, and Pecos soils, have the least developed profiles but are commonly the deepest soils. Nearly level soils on uplands, such as Dalby, Hoban, Hodgins, Reagan, Reakor, and Reeves, that receive extra runoff from higher lying areas generally have weak to moderate soil development. Nearly level to rolling soils on uplands, such as Delnorte and Upton soils, that do not receive additional runoff typically have a moderately cemented calcic horizon or a petrocalcic horizon and are generally shallow. Steep soils, such as Brewster, Ector, and Lozier soils, have very little soil development and are shallow to very shallow.

Time

Many ages of time are required for the formation of soils with distinct horizons. Differences in length of time that parent material has been in place are generally reflected in the degree of development of the soil profile.

The soils in Pecos County range from young to old. The young soils have very little profile development. The older soils have well defined soil horizons. Arno, Patrole, and Pecos soils are examples of young soils lacking development.

Some of the older soils are calcareous and have an accumulation of calcium carbonate in the profile. Further aging leaches the calcium carbonates downward from the surface layer to the lower horizons as soft masses or concretions. Hoban, Reagan, and Reakor soils, for example, have calcium carbonate accumulations in the lower horizons. The calcium carbonate concentrates in the lower horizons where it becomes cemented or indurated, such as in the Delnorte and Upton soils. These indurated or petrocalcic horizons require a long time for development, possibly millions of years.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Texas Conservation Needs Committee. 1970. Conservation needs inventory. 297 pp., illus.

(4) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(5) United States Department of Agriculture. 1954. Diagnosis and improvement of saline and alkali soils. U.S. Dep. Agric. Handb. 60, 160 pp., illus.

(6) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210, 21 pp.

(7) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

Glossary

ABC soil. A soil having an A, a B, and a C horizon.

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

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.

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.

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. Mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

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.

Depth to rock. Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Electrical conductivity. The reciprocal of the electrical resistivity. The resistivity is the resistance, in ohms, of a conductor which is 1 square centimeter long and has a cross sectional area of 1 centimeter. Hence, electrical conductivity is expressed in reciprocal ohms per centimeter, or millimhos per centimeter. It is a measure of the soluble salts in soil or water.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

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.

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.

Gypsum. Hydrous calcium sulphate.

Habitat. The natural abode of a plant or animal. Refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

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 ramified 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.

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.

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.

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.

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.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous areas. Areas that have little or no natural soil and support little or no vegetation.

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.)

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

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.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, differences in slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

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 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

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.

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.

	Mhos/cm
Nonsaline	1 to 2
Slightly	2 to 4
Moderately	4 to 8
Strongly	8 to 16
Extremely	More than 16

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

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.

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.

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.

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.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the low lands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams.

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.

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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