Soil Survey of

San Juan County, New Mexico

Eastern Part

By C. Wesley Keetch, Soil Conservation Service

Fieldwork by C. Wesley Keetch, Javier E. Ruiz, Tommie L. Parham, Henry E. Bulloch, Thomas J. Anderson, Donald King, Clarence Seagraves, Jim Bayer, Alan Kosse, Michael W. Roybal, and Steward Childs, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in cooperation with United States Department of the Interior, Bureau of Indian Affairs and Bureau of Reclamation, and the New Mexico Agricultural Experiment Station

SAN JUAN COUNTY, New Mexico, Eastern Part, is in the northwestern part of New Mexico. It has a total area of 2,182,520 acres, or about 3,410 square miles.

The survey area is bordered on the north by the state of Colorado, on the east by Rio Arriba and Sandoval Counties, on the south by McKinley County, and on the west by the Navajo Indian Reservation.

Aztec, the county seat of San Juan County, is on the Animas River, in the northeastern part of the survey area. The population of the survey area is about 50,000 (*11*).

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

General nature of the survey area

This section provides general information about the survey area. It discusses climate; natural resources; physiography, relief, and drainage; land use; history and development; water for irrigation; and the Navajo Indian Irrigation Project.

Climate

By Frank E. Houghton, climatologist for New Mexico, National Weather Service, U. S. Department of Commerce.

San Juan County, New Mexico, Eastern Part, is a high plateau that is dissected in the north by the San Juan River Valley. Distant high mountains shield the plateau and valley from much precipitation and also from shallow, extremely cold airmasses in winter. The frequency and intensity of showers in summer are less in this area than in most of the northwestern half of New Mexico, even though an average of 40 thunderstorms a year do occur, occasionally accompanied by hail. Precipitation totals are slightly greater in winter than in spring and fall.

Annual precipitation ranges from an average of 7 inches in the valley at Fruitland to 12 inches along the Colorado border. Average annual precipitation generally increases as elevation increases. A wide range in amount may occur from year to year. Record low annual precipitation of 2 inches and record high annual precipitation of 24 inches have been measured. The pattern of monthly precipitation at Aztec Ruins National Monument is shown in table 1. Smaller values are likely in the valley near Farmington and Fruitland, where annual precipitation is 2 to 3 inches less.

Snowfall occurs from November through April. Total snowfall ranges from about 9 inches in the valley to more than 20 inches along the Colorado border. The higher mountains in Colorado receive more snow and

are the main source of irrigation water for the survey area.

Temperatures rarely reach 100 degrees F or higher, and only a few days a year have temperatures of zero or lower. The average daily range in temperature of 33 degrees is fairly large and is characteristic of continental areas. The extreme temperatures recorded in the area were 110 degrees at Fruitland and 35 degrees below zero at Bloomfield.

Selected probabilities of several temperature thresholds at Aztec Ruins National Monument are listed in table 2. These dates for spring are as much as 2 weeks later than those in the valley, but the dates for fall vary by only a few days throughout the area.

Evaporation for the period from May through October, as measured by a standard Class A pan, averages 49 inches at Farmington, but may be as much as 25 percent higher on the plateau, where there is much more wind. Sunshine may be expected about 70 percent of the possible hours.

Average relative humidity is about 50 percent. It ranges from about 70 percent early in the morning to about 30 percent in the afternoon. Late in spring and early in summer, the humidity averages 15 to 20 percent in the afternoon. In winter and early in spring, fog occurs in the valley. It usually occurs on only a few days and is of short duration.

Winds in the valley blow mainly from the east and the west. Spring is the windiest season, with an average windspeed of 10 miles per hour. Winds of 25 miles per hour or greater occur only 1 percent of the time, but they occasionally blow dust when the soil is dry.

Natural resources

The main natural resources in the survey area are soil, water, coal, natural gas, and oil. Cattle that graze the rangeland and crops produced on farms are marketable products from the soil. Water for irrigation, industry, municipalities, and recreation is supplied by the San Juan, Animas, and La Plata Rivers. It is stored in the Navajo Dam and in Farmington, Morgan, and Jackson Lakes. The city of Farmington diverts water from the Animas River to a city-owned electrical generating plant. Navajo Dam has been developed into a recreation center. Shallow wells supply water to some rural families. Wells, windmills, and livestock watering ponds supply water for grazing animals.

The survey area contains part of a field of strippable coal estimated at about 6 billion tons. An abundance of coal still lies beyond the strippable depths at 150 feet. Coal is mined for use by two electrical generating plants. Part of this coal is under consideration for use in the coal gasification industry.

Since 1951, the gas and oil industry has contributed greatly to the economy of the area. Ninety-eight percent of the gas produced in the area comes from Upper Cretaceous rock at a depth of 1,000 to 8,500 feet. Farmington Sandstone, the Fruitland Formation, and Pictured Cliff Sandstone are the most important geologic formations.

Physiography, relief, and drainage

The survey area is in the San Juan Basin part of the Navajo section of the Colorado Plateau physiographic province. The San Juan Basin is a structural depression containing deep Tertiary fill resting on rocks of Late Cretaceous age.

The survey area has three distinct geomorphic units (*2, 3, 5, 6*).

The first unit is in the northern and eastern parts of the survey area. It is characterized by high relief, stepped topography, upland summits, narrow valleys, and steep canyon walls. Surface deposits on uplands consist of thin veneers of eolian sediment in some areas and of gravelly alluvium in others. In many areas, bedrock crops out at the surface. Resistant sandstone beds of the early Tertiary San Jose Formation form prominent structural benches, buttes, and mesas bounded by cliffs. Elevation ranges from 6,400 to 7,200 feet.

The second unit consists of the alluvial fans and flood plains in the entrenched, narrow valleys of San Juan, Animas, and La Plata Rivers. There are several smaller ephemeral stream systems and high, level terraces and terrace gravels that form a stepped sequence of river cut benches at elevations of as much as 600 feet above the present flood plain. Elevation ranges from 4,800 to 6,000 feet. The unit crosses parts of the other two units.

The third unit is the largest of the three. It is bounded on the north and east by the first geomorphic unit and is dissected by the second geomorphic unit. The unit is characterized by moderate canyon dissection; relatively broad valleys; broad, gently sloping plateaus and mesas; locally thick deposits of alluvium; and sandy eolian sediment. Except for local areas underlain by cliff-forming Ojo Alamo and Pictured Cliff Sandstone of Late Cretaceous age, the relatively smooth and gently sloping topography of the plateaus reflects the erodibility of generally shaly bedrock such as that of the Kirtland and Nacimiento Formations of Cretaceous to early Tertiary age. Elevation ranges from 5,600 to 6,400 feet.

The survey area is drained by the San Juan River. The principal tributaries that enter the area from the north are the Animas and Navajo Rivers and Montezuma, Hallett, Butler, and Corne Creeks. Of these streams, the Animas River is the most important. The tributaries that enter from the south are intermittent streams that are subject to sudden flooding during intense rainstorms. Of these, the Chaco River is most important.

Flooding has been controlled on the San Juan River by the construction of the Navajo Dam. Flooding is still a threat to irrigation systems, farmland, and urban areas along the Animas and La Plata Rivers.

Land use

About 55,000 acres in the valleys of the San Juan, Animas, and La Plata Rivers is irrigated, and irrigation of about 110,000 acres in the Navajo Indian Irrigation Project is planned. This is about 8 percent of the total survey area. The remaining 92 percent is used for urban development, range, wildlife habitat, woodland, water areas, recreation, coal mining, and gas and oil exploration.

History and development

The area now known as San Juan County was first seen by Spanish explorers in 1541 (*4*). In the 1640's the area was extensively explored by Padre Escalante, who is credited with the naming of the San Juan, Pine, and other rivers in the San Juan Basin.

The San Juan Basin was ceded to the United States by the Treaty of Guadalupe Hidalgo, which was signed in 1848. The lower part, presently San Juan County, became a part of the territory of New Mexico in 1851. In the early stages of government, San Juan County was a part of Rio Arriba County, with its county seat at Tierra Amarilla. The present San Juan County, with its county seat at Aztec, was organized in 1887.

Early settlers in the survey area originally came from Colorado and settled in the Farmington and Cedar Hill area in 1876 and near the mouth of Largo Canyon in 1877. Later, for reasons of safety, settlements were established in the Blanco area.

Major enterprises of the early settlers were growing farm crops and raising cattle. Alfalfa and such fruit as apples, pears, and peaches were the major crops grown.

Abundant rangeland lent itself to the cattle business, which had its markets at Denver and La Junta, Colorado. Competition for rangeland between cattlemen and sheepmen led to many armed conflicts, which started in 1886 and lasted until 1905. The eventual decline of the cattle industry was caused by harsh winters, droughts, and the deterioration of the rangeland because of overstocking and poor management.

The late 1800's and early 1900's was a period during which residents of the survey area made many significant advances in education and means of communication.

In 1900 the first gas and oil wells were discovered near Farmington. This began an industry that plays a major role in the economy of the area.

The population in the survey area increased significantly in the 1950's. Farmington and Aztec in 1950 had a population of 3,637 and 885, respectively. By 1960, Farmington had a population of 23,786 and Aztec had 4,137. This increase in population can be attributed to the development of gas, oil, and coal resources. Even today, these factors are the major reasons for prosperity in the area.

Water for irrigation

Water for irrigation is diverted from the San Juan, Animas, and La Plata Rivers. In most years, the La Plata River becomes dry during the irrigation season. Water for irrigation of the Navajo Indian Irrigation Project is diverted from the Navajo Dam.

Navajo Indian Irrigation Project

The Navajo Indian Irrigation Project was authorized by an act of Congress and signed into law by President John F. Kennedy on June 13, 1962. The project area is 110,630 acres of potentially irrigable land on the elevated plateau south of the San Juan River and the city of Farmington. This land is on or adjacent to the Navajo Indian Reservation. It has been divided into eleven blocks of about 10,000 acres each, with plans to develop one block each year. The first 10,000 acres was irrigated in 1976. The method of water application for the entire project will be by different types of sprinkler irrigation systems.

The Navajo Tribal Council, by a resolution approved by the Commissioner of Indian Affairs on April 16, 1970, established the Navajo Agricultural Projects Industry as a Navajo tribal enterprise to plan for the development and use of the project land.

Navajo Lake is the storage reservoir for about 500,000 acre-feet of water allocated to irrigate the project land when totally developed. The delivery system is an extensive network of tunnels, siphons, dams, canals, and pumping plants designed and constructed by the Bureau of Reclamation for the Bureau of Indian Affairs.

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 (*8*).

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

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some

are made up of two or more kinds. The map units in this survey area are described under "General soil map for broad land use planning" and "Soil maps for detailed planning."

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

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

General soil map for broad land use planning

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

Cultivated crops are those grown extensively in the survey area. Specialty crops are the vegetables and fruits that generally require intensive management. Woodland refers to areas of native or introduced trees. Rangeland is land that supports a natural vegetative community predominantly of grasses, grasslike plants, herbs, or shrubs, and it is used by large and small grazing animals. Urban uses include residential, commercial, and industrial developments. Intensive recreation areas are campsites, picnic areas, ballfields, and other areas that are subject to heavy foot traffic. Extensive recreation areas are those used for nature study and as wilderness. Wildlife habitat is use of land to provide food, water, and protection for the wildlife in the area.

Descriptions of map units

1. Persayo-Fruitland-Sheppard

Very shallow to deep, nearly level to very steep, well drained to excessively drained soils that formed in alluvial, residual, and eolian material; on uplands and fans

This map unit consists of irregularly shaped areas in the north-central and southeastern parts of the survey area. It is on nearly level to moderately sloping fans, plateaus, and valley sides. It is also on moderately steep to very steep upland hills and breaks. Slope is 0 to 40 percent. The vegetation is dominantly grass and some pinyon and juniper. Elevation is 4,800 to 6,400 feet. The average annual precipitation is 6 to 10 inches, and the average annual air temperature is 51 to 55 degrees F.

This unit makes up about 16 percent of the survey area. It is about 25 percent Persayo and similar soils, 20 percent Fruitland soils, and 12 percent Sheppard and similar soils. Badland, Rock outcrop, and Farb soils each make up 9 percent of the unit. Gypsiorthids and similar soils make up 5 percent, and Stumble soils make up 2 percent. The remaining 9 percent is Avalon, Blackston, Blancot, and Doak soils and other soils of minor extent.

Persayo soils are on hills and breaks. These soils are shallow and well drained. They formed in residuum derived dominantly from shale. Typically, the surface layer is light brownish gray clay loam. The underlying material is light brownish gray silty clay loam. Shale is at a depth of 15 inches.

Fruitland soils are on valley sides and fans. These soils are deep and well drained. They formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown sandy loam. The underlying material is pale brown and light yellowish brown sandy loam.

Sheppard soils are on plateaus. These soils are deep and somewhat excessively drained. They formed in eolian material derived from mixed sources. Typically, the surface layer is light brown loamy fine sand. The underlying material is light brown loamy fine sand and fine sand.

Farb soils are on hills and breaks. These soils are very shallow and shallow and are excessively drained. They formed in residuum derived dominantly from sandstone. Typically, the surface layer is pale brown fine sandy loam. The underlying material is light yellowish brown sandy loam. Sandstone is at a depth of 10 inches.

Gypsiorthids are on hills. These soils are very shallow to deep and well drained to excessively drained. They formed in gypsum deposits. Typically, the surface layer is pale yellow sandy loam. The underlying material is light gray sandy loam. Gypsum is at a depth of 16 inches.

Stumble soils are on sides of valleys and fans. These soils are deep and somewhat excessively drained. They formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is yellowish brown loamy sand. The upper part of the underlying material is

pale brown and light yellowish brown sand and loamy sand. The lower part is brownish yellow gravelly sand, gravelly loamy sand, and sand.

This unit is used for livestock grazing, woodland, and wildlife habitat.

This unit is suited to woodland wildlife habitat. It provides food and cover for such wildlife as mule deer, coyote, gray fox, jackrabbit, prairie dog, kangaroo rat, and scaled quail. The main limitations for wildlife habitat are low precipitation and the small amount of understory grasses. Suitable wildlife habitat improvement practices include installation of wildlife watering facilities and proper use of forage by domestic livestock and wildlife.

2. Fruitland-Riverwash-Stumble

Deep, nearly level to moderately steep, well drained to somewhat excessively drained soils that formed in alluvium, and Riverwash; on fans and in valleys

This map unit consists of elongated areas in the northern part of the survey area. It is on fans and in valleys. Slope is 0 to 20 percent. The vegetation is dominantly grasses, sedges, and hardwood trees along drainageways. Elevation is 4,800 to 6,400 feet. The average annual precipitation is 6 to 10 inches, and the average annual air temperature is 51 to 55 degrees F.

This unit makes up about 5 percent of the survey area. It is about 21 percent Fruitland soils, 20 percent Riverwash, 12 percent Stumble soils, and 8 percent Turley soils. The remaining 39 percent is Garland, Walrees, Werlog, Green River, and Youngston soils, Fluvaquents, and other soils of minor extent.

Fruitland soils are on fans and in valleys. These soils are deep and well drained. They formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown sandy loam. The underlying material is pale brown and light yellowish brown sandy loam.

Riverwash is in streambeds and arroyos and on flood plains. It consists of unstabilized sandy, silty, clayey, and gravelly sediment that is frequently flooded and reworked by water. It supports little or no vegetation.

Stumble soils are on fans and in valleys. These soils are deep and somewhat excessively drained. They formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is yellowish brown loamy sand. The upper part of the underlying material is pale brown and light yellowish brown sand and loamy sand. The lower part is brownish yellow gravelly sand, gravelly loamy sand, and sand.

Turley soils are on fans and in valleys. These soils are deep and well drained. They formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is grayish brown clay loam. The underlying material is grayish brown, light brownish gray, and light yellowish brown clay loam.

Areas of water, such as lakes, rivers, large storage ponds, and reservoirs, are in this unit.

This unit is used for irrigated crops, urban development, recreation, and wildlife habitat.

This unit provides habitat for wetland, woodland, and openland wildlife. The major limitation is urban encroachment. The wetland wildlife habitat consists of sedges and cattails and areas of shallow water. It provides food and cover for wildlife such as ducks, geese, heron, muskrat, and beaver. Suitable wildlife habitat improvement practices include the development of wetland areas.

The woodland wildlife habitat along the drainageways consists of Fremont cottonwood, Russian-olive, New Mexico forestiera, shrubs, and grasses. It provides food and cover for wildlife such as mule deer, gray fox, porcupine, squirrels, woodpeckers, and Gambel's quail. Suitable wildlife habitat improvement practices include retaining healthy trees and clearing spots or strips of old or dense stands.

The openland wildlife habitat consists of grain and seed crops, domestic grasses and legumes, and wild herbaceous plants. It provides food and cover for such wildlife as skunk, cottontail, pheasant, Gambel's quail, meadowlark, field sparrows, and killdeer. Suitable wildlife habitat improvement practices include stripcropping, planting windbreaks, and planting small grain for winter use.

3. Shiprock-Sheppard-Doak

Deep, nearly level to moderately steep, well drained to somewhat excessively drained soils that formed in alluvial and eolian material; on uplands

This map unit consists of irregularly shaped areas throughout the survey area. It is on mesas, plateaus, and terraces. Slope is 0 to 30 percent. The vegetation is dominantly grass. Elevation is 5,500 to 6,400 feet. The average annual precipitation is 6 to 10 inches, and the average annual air temperature is 51 to 55 degrees F.

This unit makes up about 19 percent of the survey area. It is about 28 percent Shiprock soils, 23 percent Sheppard and similar soils, 23 percent Doak and similar soils, and 8 percent Mayqueen and similar soils. The remaining 18 percent is Avalon, Uffens, Beebe, Turley, Blancot, Notal soils and other soils of minor extent.

Shiprock soils are on mesas and plateaus. These soils are deep and well drained. They formed in alluvial and eolian material derived dominantly from sandstone and shale. Typically, the surface layer is pale brown fine sandy loam. The subsoil is pale brown and brown fine sandy loam. The substratum is brown and light yellowish brown fine sandy loam and sandy loam.

Sheppard soils are on mesas and plateaus. These soils are deep and somewhat excessively drained. They formed in eolian material derived from mixed sources. Typically, the surface layer is light brown loamy fine sand. The underlying material is light brown loamy fine sand and fine sand.

Doak soils are on mesas, plateaus, and terraces. These soils are deep and well drained. They formed in

alluvial and eolian material derived dominantly from sandstone and shale. Typically, the surface layer is brown loam. The subsoil is brown and light brown silty clay loam and clay loam. The substratum is light yellowish brown clay loam.

Mayqueen soils are on mesas and plateaus. These soils are deep and somewhat excessively drained. They formed in alluvial and eolian material derived dominantly from sandstone and shale. Typically, the surface layer is brown loamy fine sand. The subsoil is reddish brown fine sandy loam. The substratum is light brown and light yellowish brown loamy sand and loamy fine sand.

This unit is used for irrigated crops, livestock grazing, urban development, and wildlife habitat.

This unit provides habitat for openland and rangeland wildlife. The openland wildlife habitat provides food and cover for such wildlife as cottontail, Gambel's quail, pheasant, mourning dove, meadowlark, field sparrows, and killdeer. The rangeland wildlife habitat provides food and cover for wildlife such as antelope, coyote, red fox, jackrabbit, cottontail, prairie dog, and scaled quail. The main limitation for wildlife habitat is low precipitation. Suitable habitat improvement practices include installation of wildlife watering facilities and proper use of forage by domestic livestock and wildlife.

4. Haplargids-Blackston-Torriorthents

Very shallow to deep, nearly level to steep, well drained to excessively drained soils that formed in alluvium and residuum; on terraces, mesas, and plateaus

This map unit consists of irregularly shaped areas in the northern part of the survey area. It is on terraces, mesas, and plateaus. Slope is 0 to 50 percent. The vegetation is dominantly grasses. The average annual precipitation is 6 to 13 inches, and the average annual air temperature is 48 to 55 degrees F.

This unit makes up about 3 percent of the survey area. It is about 41 percent Haplargids, 34 percent Blackston soils, 21 percent Torriorthents and similar soils, and 1 percent Farb soils. The remaining 3 percent consists of Rock outcrop and of other soils of minor extent.

Haplargids are on terraces. These soils are shallow to deep and well drained to excessively drained. They formed in alluvium derived from mixed sources. Typically, the surface layer is dark brown cobbly sandy loam. The subsoil is brown and yellowish brown cobbly sandy clay loam. The substratum is light brownish gray, light gray, and pale olive cobbly sandy clay loam and loam.

Blackston soils are on terraces, mesas, and plateaus. These soils are deep and well drained. They formed in alluvium derived from mixed sources. Typically, the surface layer is light brown loam. The subsoil is brown loam. The upper part of the substratum is pinkish white very gravelly clay loam. The lower part is multicolored very gravelly sand.

Torriorthents are on terraces. These soils are shallow and well drained. They formed in alluvium derived from mixed sources. Typically, the surface layer is light brownish gray cobbly loam. The substratum is light brownish gray clay loam. Shale is at a depth of 15 inches.

Farb soils are on uplands. These soils are very shallow and shallow and are excessively drained. They formed in residuum derived dominantly from sandstone. Typically, the surface layer is pale brown fine sandy loam. The underlying material is light yellowish brown sandy loam. Sandstone is at a depth of 10 inches.

This unit is used for livestock grazing, urban development, and wildlife habitat.

This unit is suited to rangeland wildlife habitat. It provides food and cover for such wildlife as antelope, jackrabbit, cottontail, scaled quail, and chukar. The main limitations are shallow soil depth, low precipitation, and steepness of slope. Suitable wildlife habitat improvement practices include installation of wildlife watering facilities and proper use of forage by livestock and wildlife.

5. Blancot-Notal

Deep, nearly level to gently sloping, well drained to somewhat excessively drained soils that formed in alluvium; on valley sides, valley bottoms, and fans

This map unit consists of generally elongated areas in the northern and eastern parts of the survey area. It is nearly level soils on fans and gently sloping soils in valleys. Slope is 0 to 5 percent. The vegetation is dominantly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is 6 to 10 inches, and the average annual air temperature is 51 to 55 degrees F.

This unit makes up about 10 percent of the survey area. It is about 54 percent Blancot soils, 24 percent Notal and similar soils, and 2 percent Stumble soils. The remaining 20 percent consists of Turley, Huerfano, Muff, and Uffens soils, Rock outcrop, Badland, and other soils of minor extent.

Blancot soils are on fans and in upland valleys. These soils are deep and well drained. They formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is pale brown loam. The subsoil is pale brown, brown, and light brownish gray clay loam. The substratum is light grayish brown and grayish brown sandy clay loam and clay loam.

Notal soils are on fans and valley bottoms. These soils are deep and well drained. They formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown silty clay loam. The subsoil and substratum are grayish brown clay.

Stumble soils are on fans and valley sides. These soils are deep and somewhat excessively drained. They formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is yellowish brown loamy sand. The upper part of the substratum is pale brown and light yellowish brown sand and loamy sand. The lower part is brownish yellow gravelly sand, gravelly loamy sand, and sand.

This unit is used for livestock grazing and wildlife habitat.

This unit is suited to rangeland wildlife habitat. It provides food and cover for such wildlife as antelope, mule deer, coyote, prairie dog, scaled quail, chukar, and hawks. The main limitations are low precipitation and varying degrees of salinity and alkalinity. Suitable wildlife habitat improvement practices include installation of wildlife watering facilities and proper use of forage by livestock and wildlife.

6. Sheppard-Huerfano-Notal

Shallow to deep, nearly level to steep, well drained to somewhat excessively drained soils that formed in eolian material, alluvium, and residuum; on uplands, bottom lands, and fans

This map unit consists of irregularly shaped areas in the southwestern part of the survey area. It is nearly level to gently sloping soils on valley bottoms and fans and nearly level to steep soils on mesas and plateaus. Slope is 0 to 40 percent. The vegetation is dominantly grasses. Elevation is 5,500 to 6,400 feet. The average annual precipitation is 6 to 10 inches, and the average annual air temperature is 51 to 55 degrees F.

This unit makes up about 15 percent of the survey area. It is about 25 percent Sheppard and similar soils, 23 percent Huerfano and similar soils, 13 percent Notal and similar soils, 6 percent Avalon soils, and 6 percent Doak and similar soils. The remaining 27 percent is Muff, Uffens, Blancot, Stumble, Shiprock, and Fruitland soils and other soils of minor extent.

Sheppard soils are on mesas and plateaus. These soils are deep and somewhat excessively drained. They formed in eolian material derived from mixed sources. Typically, the surface layer is light brown loamy fine sand. The substratum is light brown loamy fine sand and fine sand.

Huerfano soils are on mesas and upland valley bottoms. These soils are shallow and well drained. They formed in alluvium and residuum derived dominantly from shale and siltstone. Typically, the surface layer is light yellowish brown sandy clay loam. The subsurface layer is light gray sandy clay loam. The subsoil is brown, dark yellowish brown, and yellowish brown clay loam and sandy clay loam. Shale is at a depth of 15 inches.

Notal soils are on valley bottoms and fans. These soils are deep and well drained. They formed in alluvium derived from sandstone and shale. Typically, the surface layer is brown silty clay loam. The subsoil and substratum are grayish brown clay.

Avalon soils are on mesas and plateaus. These soils are deep and well drained. They formed in eolian and alluvial material derived dominantly from sandstone and shale. Typically, the surface layer is brown sandy loam. The subsoil is light brown fine sandy loam. The upper part of the substratum is white sandy clay loam, and the lower part is pink gravelly sandy clay loam.

Doak soils are on mesas, plateaus, and terraces. These soils are deep and well drained. They formed in eolian and alluvial material derived dominantly from sandstone and shale. Typically, the surface layer is brown loam. The subsoil is brown and light brown silty clay loam and clay loam. The substratum is light yellowish brown clay loam.

This unit is used for irrigated crops, livestock grazing, urban development, and wildlife habitat.

This unit is suited to rangeland wildlife habitat. It provides food and cover for such wildlife as coyote, jackrabbit, prairie dog, and hawks. The main limitations are low precipitation and varying degrees of salinity and alkalinity. Suitable wildlife habitat improvement practices include installation of wildlife watering facilities and proper use of forage by livestock and wildlife.

7. Travessilla-Rock outcrop-Weska

Very shallow to deep, nearly level to extremely steep, well drained soils that formed in alluvium, residuum, and eolian material, and Rock outcrop; on uplands

This map unit consists of irregularly shaped areas in the northern and eastern parts of the survey area. It is on hills, mesas, and plateaus. Slope is 0 to 100 percent. The vegetation is dominantly grasses and scattered pinyon and juniper. Elevation is 4,800 to 7,200 feet. The average annual precipitation is 6 to 13 inches, and the average annual air temperature is 48 to 55 degrees F.

This unit makes up about 16 percent of the survey area. It is about 27 percent Travessilla and similar soils, 27 percent Rock outcrop, 17 percent Weska and similar soils, and 11 percent Penistaja and similar soils. The remaining 18 percent is Buckle, Twick, Silver, Notal, Blancot, and Blackston soils, Torriorthents, Haplargids, and other soils of minor extent.

Travessilla soils are on hills and mesas. These soils are very shallow and shallow and are well drained. They formed in residuum derived dominantly from sandstone. Typically, the surface layer is brown sandy loam. The underlying material is brown sandy loam. Sandstone is at a depth of 12 inches.

Rock outcrop is on cliffs, ridges, breaks, and ledges. It is nearly level to extremely steep exposures of barren sandstone.

Weska soils are on hills and mesas. These soils are very shallow and shallow and well drained. They formed in residuum derived dominantly from shale. Typically, the surface layer is grayish brown silty clay loam. The underlying material is grayish brown clay loam. Shale is at a depth of 7 inches.

Penistaja soils are on mesas and plateaus. These soils are deep and well drained. They formed in alluvial and eolian material derived from sandstone and shale. Typically, the surface layer is brown loam. The subsoil is brown clay loam. The substratum is light brown clay loam.

This unit is used for livestock grazing, woodland, recreation, and wildlife habitat.

This unit is suited to rangeland wildlife habitat. It provides food and cover for mule deer, coyote, porcupine,

jackrabbit, cottontail, squirrel, turkey, and sage grouse. The main limitations are low precipitation in some areas and extremely steep slopes. Suitable wildlife habitat improvement practices include installation of wildlife watering facilities and proper use of forage by livestock and wildlife.

8. Badland-Rock outcrop-Monierco

Badland and Rock outcrop, and shallow, nearly level to gently sloping, well drained soils that formed in alluvial and eolian material; on uplands

This map unit consists of irregularly shaped areas in the western part of the survey area. It is nearly level to gently sloping soils on uplands and moderately sloping to extremely steep areas of Badland on upland hills, ridges, and in canyons. Slope is 0 to 100 percent. The vegetation is dominantly grasses. Elevation is 4,800 to 7,200 feet. The average annual precipitation is 6 to 10 inches, and the average annual air temperature is 51 to 55 degrees F.

This unit makes up about 16 percent of the survey area. It is about 74 percent Badland, 15 percent Rock outcrop, and 8 percent Monierco soils. The remaining 3 percent consists of Riverwash and of Notal, Turley, Blancot, Uffens, and Sheppard soils and other soils of minor extent.

Badland is on uplands that are dissected by deep, intermittent drainageways and gullies. It is moderately sloping to extremely sloping, nonstony, barren shale.

Rock outcrop is on cliffs, ridges, breaks, and ledges. It is moderately sloping to extremely steep exposures of barren sandstone.

Monierco soils are on mesas, knolls, and plateaus. These soils are shallow and well drained. They formed in alluvial and eolian material derived dominantly from sandstone and shale. Typically, the surface layer is light yellowish brown fine sandy loam. The subsoil is brown, yellowish brown, and pale brown fine sandy loam and clay loam. Shale is at a depth of 13 inches.

This unit is used for livestock grazing and wildlife habitat.

This unit is suited to rangeland wildlife habitat. It provides some food and cover for such wildlife as coyote, jackrabbit, prairie dog, and hawks. The main limitations are shallow soil depth, low precipitation, and low productivity of plants. Suitable wildlife habitat improvement practices include installation of wildlife watering facilities and proper use of forage by livestock and wildlife.

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, Werlog loam is one of several phases in the Werlog series.

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

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Fruitland-Slickspots complex, 0 to 3 percent slopes, is an example.

A *soil association* is made up of two or more geographically associated soils that are shown as one unit on the maps. Because of present or anticipated soil uses in the survey area, it was not considered practical or necessary to map the soils separately. The pattern and relative proportion of the soils are somewhat similar. Doak-Avalon association, gently sloping, 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. Badland 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 3 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.

Ap—Apishapa clay loam. This deep, somewhat poorly drained soil is on flood plains and low river terraces. It formed in alluvium derived from mixed sources. Slope is 0 to 1 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is light brownish gray clay loam about 5 inches thick. The underlying material to a depth of 81 inches or more is grayish brown and brown clay.

Included in this unit are small areas of Werlog soils, mainly along the edges of mapped areas, and Walrees soils throughout the unit. Included areas make up about 10 percent of the total acreage.

Permeability of this Apishapa soil is slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. A seasonal high water table is at a depth of 24 to 30 inches during the irrigation season. This soil is subject to frequent, brief periods of flooding in May and June. Where the soil has a cover of native vegetation, the average annual wetting depth is about 6 inches. This soil is strongly saline.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops is grain sorghum. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slow permeability, the hazard of flooding, the severe hazard of soil blowing, the seasonal high water table, and strong salinity. The selection of crops that can be grown is limited by the seasonal high water table and by the salinity and alkalinity of the soil. The water table can be lowered by installing an adequate drainage system. The risk of flooding can be reduced by the use of levees, dikes, and diversions.

Surface irrigation systems are suited to this unit. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

This unit is poorly suited to urban development. The main limitations are wetness, the hazard of flooding, slow permeability, and high shrink-swell potential. Flooding can be controlled only by use of major flood control structures.

If this unit is irrigated, it is suited to windbreaks. The main limitations are wetness, the hazard of flooding, slow permeability, and strong salinity. The selection of trees and shrubs is limited to varieties that can tolerate the seasonal water table.

As—Apishapa clay. This deep, somewhat poorly drained soil is on flood plains and low river terraces. It formed in alluvium derived from mixed sources. Slope is 0 to 1 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is light brownish gray clay about 6 inches thick. The underlying material to a depth of 81 inches or more is grayish brown and brown clay.

Included in this unit are small areas of Werlog soils, mainly along the edges of mapped areas, and Walrees soils throughout the unit. Included areas make up about 10 percent of the total acreage.

Permeability of this Apishapa soil is slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. A seasonal high water table is at a depth of 24 to 30 inches during the irrigation season. This soil is subject to frequent, brief periods of flooding in May and June. Where the soil has a cover of native vegetation, the average annual wetting depth is about 5 inches. This soil is strongly saline.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops is grain sorghum. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slow permeability, the hazard of flooding, the severe hazard of soil blowing, the seasonal high water table, and strong salinity. The selection of crops that can be grown is limited by the seasonal high water table and by the salinity and alkalinity of the soil. The water table can be lowered by installing an adequate drainage system. The risk of flooding can be reduced by the use of levees, dikes, and diversions.

Surface irrigation systems are suited to this unit. Water should be applied at a slow rate over a long period to insure that the root zone is properly wetted.

Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting, and increases the water intake rate. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

This unit is poorly suited to urban development. The main limitations are wetness, the hazard of flooding,

slow permeability, and high shrink-swell potential. Flooding can be controlled only by use of major flood control structures.

If this unit is irrigated, it is suited to windbreaks. The main limitations are wetness, the hazard of flooding, slow permeability, and strong salinity. The selection of trees and shrubs is limited to varieties that can tolerate the seasonal high water table.

AT—Atrac-Florita-Travessilla association, hilly. This map unit is on hills, fans, mesas, and breaks. Slope is 3 to 30 percent. The native vegetation is mainly pinyon, juniper, brush, and grass. Elevation is 6,400 to 7,200 feet. The average annual precipitation is about 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 135 days.

This unit is 35 percent Atrac loam, 3 to 15 percent slopes; 30 percent Florita sandy loam, 3 to 15 percent slopes; and 20 percent Travessilla sandy loam, 5 to 30 percent slopes. Atrac loam is on hills and fans, Florita sandy loam is on hills, and Travessilla sandy loam is on hills, mesas, and breaks.

Included in this unit are small areas of Buckle soils on fans and in upland valleys; Penistaja soils on mesas and plateaus; Weska soils on hills, mesas, and breaks; and rock outcrop on ridges. Included areas make up about 15 percent of the total acreage.

The Atrac soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown loam about 3 inches thick. The subsoil is light brown and yellowish brown sandy clay loam about 21 inches thick. The substratum to a depth of 60 inches or more is pale brown and very pale brown sandy clay loam and sandy loam.

Permeability of the Atrac soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 21 inches.

The Florita soil is deep and well drained. It formed in alluvium and residuum derived dominantly from sandstone and shale. Typically, the surface layer is very dark grayish brown sandy loam over brown loamy coarse sand about 12 inches thick. The upper 31 inches of the underlying material is brown and pale brown sandy loam. The lower part to a depth of 60 inches or more is light yellowish brown loamy coarse sand.

Permeability of the Florita soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 30 inches.

The Travessilla soil is very shallow to shallow and well drained. It formed in residuum derived dominantly from sandstone. Typically, the surface layer is pale brown sandy loam about 2 inches thick. The underlying material to a depth of 12 inches is brown very fine sandy loam. Sandstone is at a depth of 12 inches.

Permeability of the Travessilla soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is 6 to 12 inches.

This unit is used for livestock grazing, woodland, and wildlife habitat.

The potential plant community on this unit is mainly pinyon, oneseed juniper, Indian ricegrass, and needleandthread. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are annual forbs, perennial forbs, woody shrubs, and pinyon.

Suitable grazing management systems are those that increase the production of sideoats grama, Indian ricegrass, needleandthread, and mountainmahogany and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of salting facilities, water development, fences, and trails.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. The Travessilla soil is not suited to ponds or pipelines because of the shallow depth of the soil.

This unit produces stands of oneseed juniper and pinyon. The Florita soil is well suited to the production of these species. It can produce about 16 cords of wood per acre in a stand of trees that averages 5 inches in diameter measured at a height of 1 foot. The Atrac and Travessilla soils are moderately well suited to the production of these species. They can produce about 11 cords of wood per acre in a stand of trees that averages 5 inches in diameter measured at a height of 1 foot. Deterioration of the stands of pinyon and oneseed juniper on the soils in this unit can be prevented by managing them for a combination of uses, including wood production.

Av—Avalon sandy loam, 2 to 5 percent slopes. This deep, well drained soil is on mesas and plateaus. It formed in alluvial and eolian material derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown sandy loam about 4 inches thick. The subsoil is light brown fine sandy loam

about 10 inches thick. The upper 39 inches of the substratum is white sandy clay loam. The lower part to a depth of 72 inches or more is pink gravelly sandy clay loam.

Included in this unit are small areas of Shiprock and Shiprock Variant soils on mesas and plateaus and Doak soils on mesas, plateaus, and terraces. Included areas make up about 5 percent of the total acreage.

Permeability of this Avalon soil is moderate to a depth of 53 inches and moderately rapid below this depth. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 14 inches. This soil is slightly saline.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops is small grain. Some areas are used for livestock grazing, urban development, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slope and excess salt.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this soil. Sprinkler irrigation is the most suitable method of applying water. The method used generally is governed by the crop. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate. Excess lime can cause chlorosis in some plants.

The potential plant community is mainly Indian ricegrass, winterfat, Mormon-tea, and galleta.

Suitable grazing management systems are those that increase the production of Indian ricegrass, galleta, winterfat, and blue grama and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of water developments, fences, trails, and salting facilities.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of low precipitation and the hazard of soil blowing.

This unit is suited to urban development. The main limitations for buildings and roads are potential frost action and low soil strength. Slope and seepage are limitations for sewage lagoon areas

Ax—Avalon sandy loam, 5 to 8 percent slopes. This deep, well drained soil is on mesas and plateaus. It formed in alluvial and eolian material derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown sandy loam about 2 inches thick. The subsoil is brown loam about 14 inches thick. The upper 30 inches of the substratum is white loam. The lower part to a depth of 80 inches or more is light yellowish brown sandy clay loam.

Included in this unit are small areas of Shiprock and Shiprock Variant soils on mesas and plateaus. Included areas make up about 5 percent of the total acreage.

Permeability of this Avalon soil is moderate. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 16 inches. This soil is slightly saline.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops is small grain. Some areas are used for livestock grazing, urban development, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slope and excess salt.

In summer, irrigation is required for maximum production of most crops. Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Crop residue left on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate. Excess lime can cause chlorosis in some plants.

The potential plant community is mainly Indian ricegrass, winterfat, Mormon-tea, and galleta. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, threeawn, annual forbs, and perennial forbs.

Suitable grazing management systems are those that increase the production of Indian ricegrass, needleandthread, galleta, and winterfat, and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of salting facilities, fences, water developments, and trails.

This unit is suited to such range management practices as planned grazing systems, deferred grazing, and proper grazing use. It is not suited to range seeding because of low precipitation and the hazard of soil blowing.

This unit is suited to urban development. The main limitations for buildings and roads are potential frost action, low soil strength, and slope. Slope and seepage are limitations for sewage lagoons.

Ay—Avalon loam, 0 to 3 percent slopes. This deep, well drained soil is on mesas and plateaus. It formed in alluvial and eolian material derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown loam about 8 inches thick. The subsoil is strong brown loam about 10 inches thick. The upper 22 inches of the substratum is pinkish white clay loam. The lower part to a depth of 60 inches or more is light yellowish brown loam.

Included in this unit are small areas of Shiprock and Shiprock Variant soils on mesas and plateaus and Doak soils on mesas, plateaus, and terraces. Included areas make up about 10 percent of the total acreage.

Permeability of this Avalon soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 18 inches. This soil is slightly saline.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are small grain and corn. Some areas are used for livestock grazing, urban development, and wildlife habitat.

If this unit is used for irrigated crops, the main limitation is excess salt.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. Sprinkler irrigation is the most suitable method of applying water. The method used generally is governed by the crop. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to nitrogen. Legumes respond to phosphate. Excess lime can cause chlorosis in some plants.

The potential plant community is mainly Indian ricegrass, winterfat, Mormon-tea, and galleta. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, threeawn, annual forbs, and perennial forbs.

Suitable grazing management systems are those that increase the production of Indian ricegrass, needleandthread, galleta, and winterfat and that vary the period of use from year to year. Proper distribution of livestock grazing generally can be accomplished by the placement of salting facilities, fences, water developments, and trails.

This unit is suited to such range management practices as planned grazing systems, deferred grazing, and proper grazing use. It is not suited to range seeding because of low precipitation and the hazard of soil blowing.

This unit is suited to urban development. The main limitations for buildings and roads are potential frost action and low soil strength. Seepage is a limitation for sewage lagoons.

AZ—Avalon-Sheppard-Shiprock association, gently sloping. This map unit is on mesas and plateaus. Slope is 0 to 8 percent. The native vegetation is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 35 percent Avalon sandy loam, 0 to 5 percent slopes, 25 percent Sheppard loamy fine sand, 3 to 8 percent slopes, and 25 percent Shiprock sandy loam, 0 to 5 percent slopes.

Included in this unit are small areas of Doak soils on mesas, plateaus, and terraces and Shiprock Variant soils on mesas and plateaus. Included areas make up about 15 percent of the total acreage.

The Avalon soil is deep and well drained. It formed in alluvial and eolian material derived dominantly from sandstone and shale. Typically, the surface layer is pale brown sandy loam about 3 inches thick. The subsoil is light brown loam about 6 inches thick. The upper 36 inches of the substratum is pinkish white loam. The lower part to a depth of 60 inches or more is very pale brown loam.

Permeability of the Avalon soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 9 inches. This soil is slightly saline.

The Sheppard soil is deep and somewhat excessively drained. It formed in eolian material derived dominantly from sandstone and shale. Typically, the surface layer is light yellowish brown loamy fine sand about 3 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown loamy fine sand and fine sand.

Permeability of the Sheppard soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very

severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

The Shiprock soil is deep and well drained. It formed in alluvial and eolian material derived dominantly from sandstone and shale. Typically, the surface layer is brown sandy loam about 3 inches thick. The subsoil is brown fine sandy loam about 8 inches thick. The substratum to a depth of 60 inches or more is pale brown and very pale brown sandy loam and fine sandy loam.

Permeability of the Shiprock soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is high. Where this soil has a cover of native vegetation, the average annual wetting depth is about 20 inches.

This unit is used for livestock grazing and for wildlife habitat.

The potential plant community on the Avalon soil is mainly Indian ricegrass, winterfat, galleta, and Mormon-tea. The potential plant community on the Sheppard soil is mainly Indian ricegrass, giant dropseed, alkali sacaton, and needleandthread. The potential plant community on the Shiprock soil is mainly Indian ricegrass, blue grama, and fourwing saltbush.

As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, Mormon-tea, and annual forbs.

Suitable grazing management systems are those that increase the production of Indian ricegrass, alkali sacaton, fourwing saltbush, and needleandthread and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year.

Proper distribution of livestock grazing generally can be accomplished by the placement of fences, water developments, and salting facilities. Soil blowing can be controlled and damage to seedlings reduced by maintaining residue on the surface of the soil.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of low precipitation and the hazard of soil blowing.

BA—Badland. This map unit consists of nonstony, barren shale uplands that are dissected by deep intermittent drainageways and gullies (fig. 1). Slope is 5 to 80 percent. Elevation is 4,800 to 7,200 feet. The average annual precipitation is about 8 inches, the average

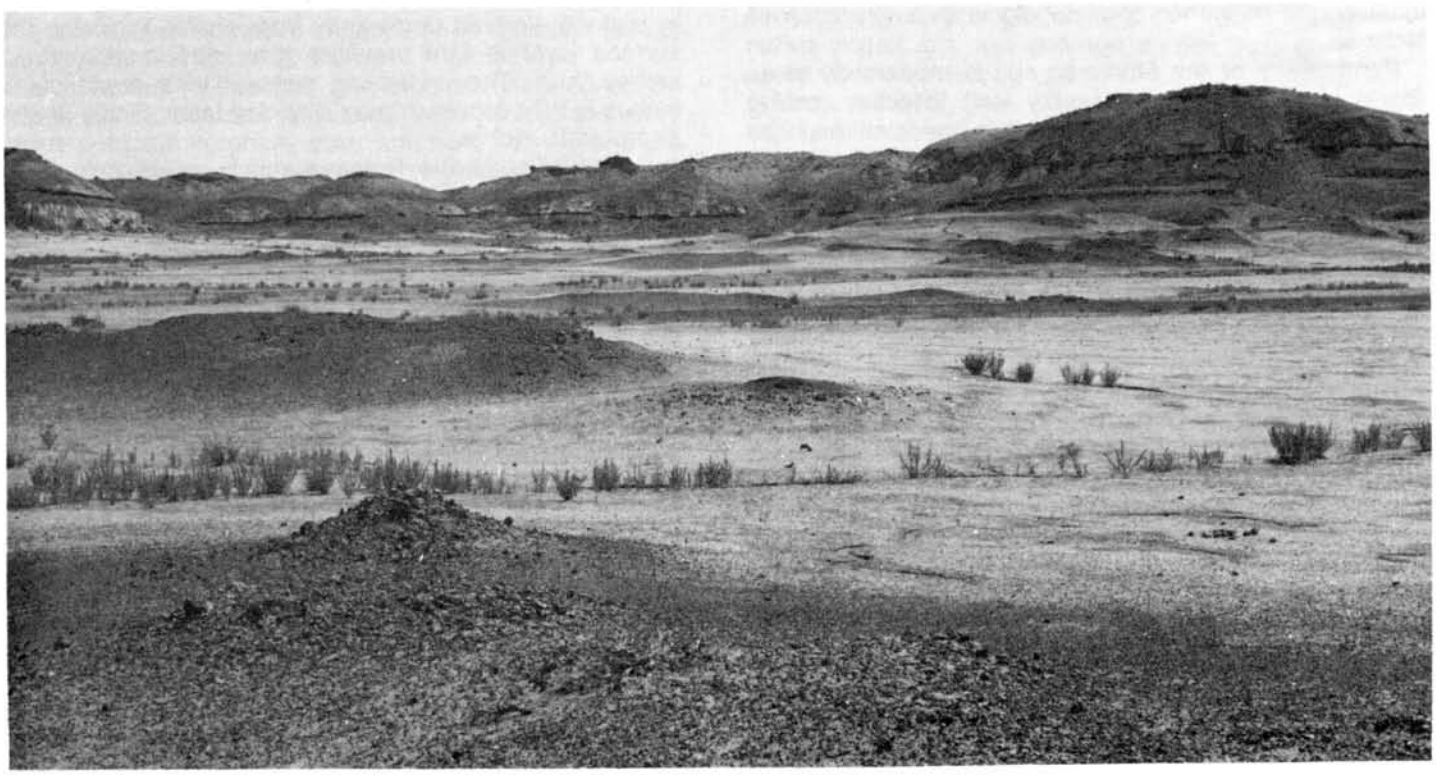

Figure 1.—Area of Badland.

annual air temperature is about 53 degrees F, and the average frost-free season is about 150 days.

This unit is used for wildlife habitat.

BB—Badland-Monierco-Rock outcrop complex, moderately steep. This map unit is on hills, ridges, and mesas. Slope is 0 to 30 percent. The native vegetation is mainly grass. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 40 percent Badland, 5 to 30 percent slopes; 30 percent Monierco fine sandy loam, 0 to 8 percent slopes; and 20 percent Rock outcrop, 5 to 30 percent slope. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Avalon, Sheppard, and Shiprock soils on mesas and plateaus and Doak soils on mesas, plateaus, and terraces. Included areas make up about 10 percent of the total acreage.

Badland consists of nonstony, barren shale uplands that are dissected by deep, intermittent drainageways and gullies.

The Monierco soil is shallow and well drained. It formed in alluvial and eolian material derived dominantly from shale. Typically, the surface layer is light yellowish brown fine sandy loam about 2 inches thick. The subsoil is brown and yellowish brown clay loam and sandy clay loam about 12 inches thick. Shale is at a depth of 14 inches.

Permeability of the Monierco soil is moderately slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 11 inches.

Rock outcrop consists of barren sandstone on ridges, benches, and escarpments.

This unit is used for livestock grazing and for wildlife habitat.

The potential plant community on the Monierco soil is mainly Indian ricegrass, galleta, winterfat, and big sagebrush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are Indian ricegrass, galleta, Mormon-tea, and blue grama.

Suitable grazing management systems are those that increase the production of Indian ricegrass, galleta, winterfat, and blue grama and that vary the period of use from year to year. Use of such systems helps produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of trails, fences, and salting facilities.

This soil is suited to such range management practices as planned grazing systems, proper grazing use, and deferred grazing. It is not suited to pipelines, ponds, range seeding, or range renovation because of low precipitation and shallow soil depth.

BC—Badland-Rock outcrop-Persayo complex, extremely steep. This map unit is on hills, ridges, and breaks. Slope is 30 to 70 percent. The native vegetation is mainly pinyon, juniper, and grass. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 35 percent Badland, 30 to 50 percent slopes; 30 percent Rock outcrop, 40 to 70 percent slopes; and 20 percent Persayo clay loam, 30 to 40 percent slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Farb soils on hills and breaks and rubble land on the lower part of slopes. Included areas make up about 15 percent of the total acreage.

Badland consists of nonstony, barren shale uplands that are dissected by deep, intermittent drainageways and gullies.

Rock outcrop consists of barren sandstone on ridges, benches, and escarpments.

The Persayo soil is shallow and well drained. It formed in material derived dominantly from shale. Typically, the surface layer is light brownish gray clay loam about 2 inches thick. The underlying material to a depth of 12 inches is light brownish gray silty clay loam. Shale is at a depth of 12 inches.

Permeability of the Persayo soil is moderately slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 5 inches. This soil is slightly saline.

This unit is used for livestock grazing and for wildlife habitat.

The potential plant community on the Persayo soil is mainly oneseed juniper, antelope bitterbrush, pinyon, and galleta. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, threeawn, big sagebrush, and annual forbs.

Suitable grazing management systems are those that increase the production of galleta, Indian ricegrass, antelope bitterbrush, and blue grama, and vary the period of use from year to year. Use of such systems helps produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accom-

plished by the placement of trails, access roads, salting facilities, and fences.

This soil is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to ponds, pipelines, or range seeding because of the very steep slopes, shallow soil depth, and low precipitation.

Be—Beebe loamy sand. This deep, well drained soil is on flood plains and low river terraces. It formed in alluvium derived from mixed sources. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is light brownish gray loamy sand about 6 inches thick. The upper 61 inches of the underlying material is pale brown sand. The lower part to a depth of 81 inches or more is multicolored very gravelly sand.

Included in this unit are small areas of Green River and Walrees soils on flood plains and low terraces throughout the unit. Included areas make up about 10 percent of the total acreage.

Permeability of this Beebe soil is very rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. This soil is subject to frequent, very brief periods of flooding from June through September. Where this soil has a cover of native vegetation, the average annual wetting depth is about 30 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa, pasture, and small grain. Among the other crops are grain sorghum, corn, and fruit. Some areas are used for windbreaks, urban development, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are the hazards of soil blowing and flooding and seepage.

Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

If this unit is irrigated, it is suited to windbreaks. The main limitations are the hazards of soil blowing and flooding. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, blue spruce, and Rocky Mountain juniper. Among the shrubs are multiflora rose, skunkbush sumac, autumn-olive, and New Mexico forestiera.

This unit is poorly suited to urban development. The main limitations are the hazard of flooding and seepage. Flooding can be controlled only by use of major flood control structures.

Bf—Beebe Variant loamy sand. This deep, moderately well drained soil is on flood plains and low river terraces and fans. It formed in alluvium derived from mixed sources. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is light brownish gray loamy sand about 8 inches thick. The upper 59 inches of the underlying material is pale brown and light gray loamy sand and sand. The lower part to a depth of 81 or more inches is multicolored very gravelly sand.

Included in this unit are small areas of Green River and Walrees soils on flood plains and low river terraces and fans throughout the unit. Included areas make up about 15 percent of the total acreage.

Permeability of this Beebe Variant soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. A seasonal high water table is at a depth of 24 to 60 inches during the irrigation season. This soil is subject to frequent, very brief periods of flooding from June through September. Where this soil has a cover of native vegetation, the average annual wetting depth is about 30 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops is corn. Some areas are used for windbreaks, urban development, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are the hazard of flooding, wetness, and droughtiness. The selection of crops that can be grown is limited by the seasonal high water table and by the salinity and alkalinity of the soil. The water table can be lowered by installing an adequate drainage system. The risk of flooding can be reduced by the use of levees, dikes, and diversions.

Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

If this unit is irrigated, it is suited to windbreaks. The main limitations are the hazard of flooding, wetness, and droughtiness. The selection of trees and shrubs is limited

to varieties that can tolerate the seasonal high water table.

This unit is poorly suited to urban development. The main limitations are the hazard of flooding, wetness, and seepage. Flooding can be controlled only by use of major flood control structures.

Bk—Blackston loam, 0 to 3 percent slopes. This deep, well drained soil is on river terraces (fig. 2). It formed in alluvium derived from mixed sources. The native vegetation is mainly grass. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is light brown loam about 2 inches thick. The subsoil is brown loam about 9 inches

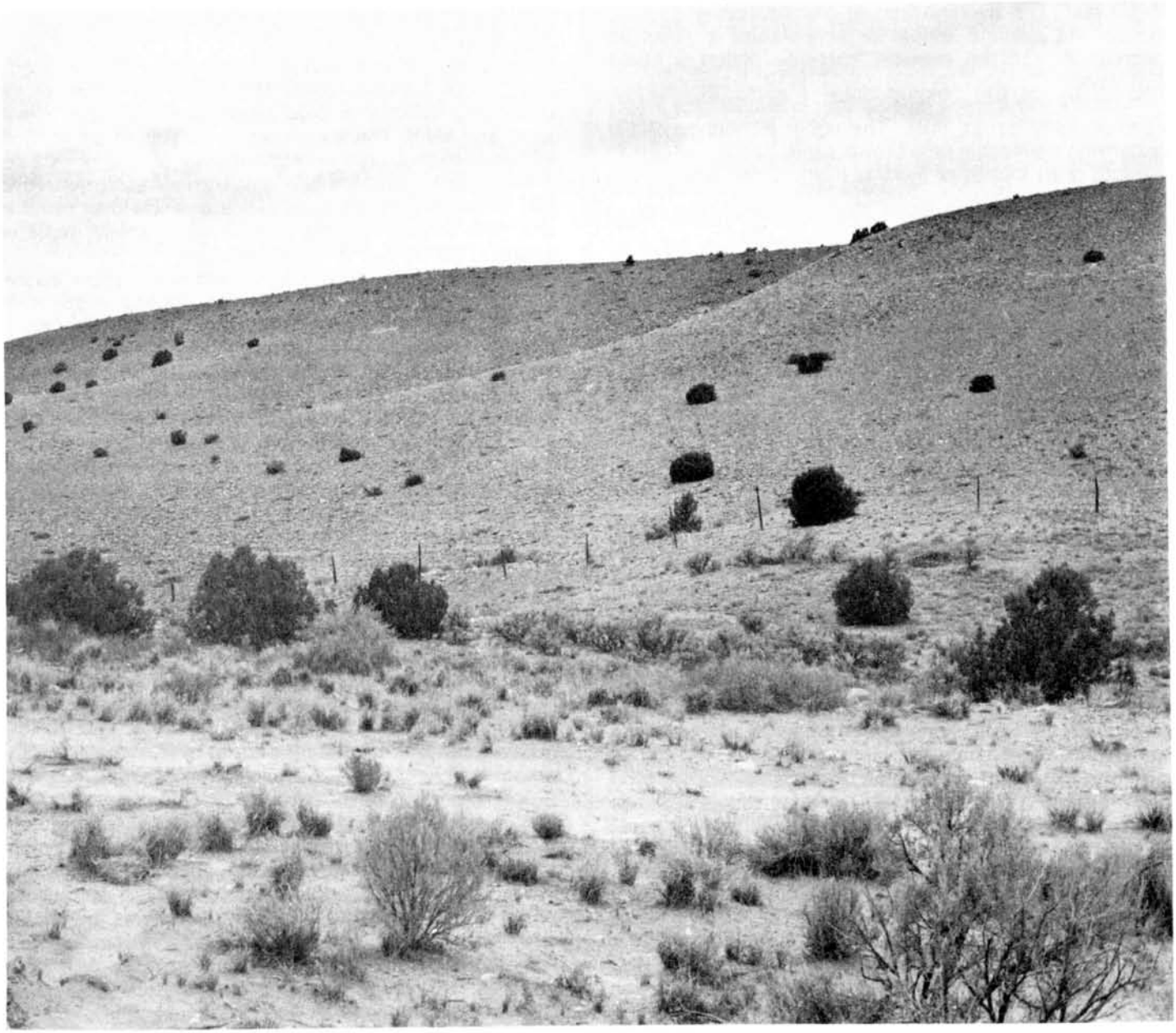

Figure 2.—Area of Blackston loam, 0 to 3 percent slopes, in foreground and Haplargids-Blackston-Torriorthents complex, very steep, in background.

thick. The upper 16 inches of the substratum is pinkish white very gravelly clay loam. The lower part to a depth of 80 inches or more is multicolored very gravelly sand.

Included in this unit are small areas of Avalon soils on mesas and plateaus throughout the unit. Included areas make up about 5 percent of the total acreage.

Permeability of this Blackston soil is moderate to a depth of 27 inches and rapid below this depth. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 11 inches. This soil is slightly saline.

This unit is used for livestock grazing, urban development, and wildlife habitat.

The potential plant community on this unit is mainly Indian ricegrass, galleta, New Mexico feathergrass, and fourwing saltbush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are big sagebrush, broom snakeweed, Douglas rabbitbrush, and annual forbs.

Suitable grazing management systems are those that increase the production of Indian ricegrass, galleta, New Mexico feathergrass, and fourwing saltbush and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of fences, trails, pipelines, and salting facilities.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding or ponds because of low precipitation and moderate depth to very gravelly sand.

This unit is suited to urban development. The high content of gravel and stones in this Blackston soil is a limitation for buildings, roads, and septic tank absorption fields. Seepage is a limitation for sewage lagoon areas.

Bm—Blackston gravelly loam, 3 to 8 percent slopes. This deep, well drained soil is on river terraces. It formed in alluvium derived from mixed sources. The native vegetation is mainly grass. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is yellowish brown gravelly loam about 2 inches thick. The subsoil is brown gravelly loam about 7 inches thick. The upper 16 inches of the substratum is pinkish white very gravelly clay loam. The lower part to a depth of 60 inches or more is multicolored very gravelly sand.

Included in this unit are small areas of Avalon soils on mesas and plateaus throughout the unit. Included areas make up about 5 percent of the total acreage.

Permeability of this Blackston soil is moderate to a depth of 25 inches and rapid below this depth. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 9 inches. This soil is slightly saline.

This unit is used for livestock grazing, urban development, and wildlife habitat.

The potential plant community is mainly Indian ricegrass, New Mexico feathergrass, galleta, and fourwing saltbush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are big sagebrush, broom snakeweed, Douglas rabbitbrush, and annual forbs.

Suitable grazing management systems are those that increase the production of Indian ricegrass, galleta, New Mexico feathergrass, and fourwing saltbush and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of fences, trails, pipelines, and salting facilities.

This unit is suited to such range management practices as proper grazing use, deferred grazing, and planned grazing systems. It is not suited to range seeding or ponds because of low precipitation and moderate depth to very gravelly sand.

This unit is suited to urban development. The high content of gravel and stones in the soil in this unit is a limitation for buildings, roads, and septic tank absorption fields. Seepage is a limitation for sewage lagoons.

BP—Blackston-Farb complex, moderately steep. This map unit is on terraces, hills, and breaks. Slope is 0 to 25 percent. The native vegetation is mainly pinyon, juniper, and grass. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 50 percent Blackston loam, 0 to 8 percent slopes, and 30 percent Farb sandy loam, 5 to 25 percent slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Avalon soils on mesas and plateaus and Persayo soils on hills and breaks. Included areas make up about 20 percent of the total acreage.

The Blackston soil is deep and well drained. It formed in alluvium derived from mixed sources. Typically, the surface layer is yellowish brown loam about 3 inches

thick. The subsoil is brown loam about 9 inches thick. The upper 18 inches of the substratum is pinkish white very gravelly loam. The lower part to a depth of 60 inches or more is multicolored very gravelly sand.

Permeability of the Blackston soil is moderate to a depth of 30 inches and rapid below this depth. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 12 inches. This soil is slightly saline.

The Farb soil is very shallow to shallow and excessively drained. It formed in residuum derived dominantly from sandstone. Typically, the surface layer is pale brown sandy loam about 7 inches thick. The underlying material to a depth of 10 inches is very pale brown loamy sand. Sandstone is at a depth of 10 inches.

Permeability of the Farb soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 5 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 8 to 10 inches.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Blackston soil is mainly Indian ricegrass, New Mexico feathergrass, fourwing saltbush, and galleta. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are big sagebrush, broom snakeweed, Douglas rabbitbrush, and annual forbs. Suitable grazing management systems are those that increase the production of Indian ricegrass, galleta, fourwing saltbush, and New Mexico feathergrass.

The potential plant community on the Farb soil is mainly oneseed juniper, pinyon, antelope bitterbrush, and Indian ricegrass. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are annual forbs, oneseed juniper, broom snakeweed, and threeawn. Suitable grazing management systems are those that increase the production of Indian ricegrass, antelope bitterbrush, galleta, and needleandthread.

Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of trails, salting facilities, access roads, and fences.

This unit is suited to such range management practices as proper grazing use, deferred grazing, and planned grazing systems. The Blackston soil is not suited to range seeding, ponds, or range renovation because of low precipitation and moderate depth to very gravelly sand. The Farb soil is not suited to pipelines, ponds, brush management, range renovation, or range seeding because of very shallow to shallow soil depth and low precipitation.

BR—Blancot-Fruitland association, gently sloping. This map unit is on fans and in valleys. Slope is 0 to 8 percent. The native vegetation is mainly grass. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 45 percent Blancot loam, 0 to 5 percent slopes, and 25 percent Fruitland sandy loam, 0 to 8 percent slopes. Blancot loam is on fans and in upland valleys, and Fruitland sandy loam is on fans and valley bottoms.

Included in this unit are small areas of Stumble and Turley soils on fans and valley sides. Included areas make up about 30 percent of the total acreage.

The Blancot soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is grayish brown loam about 6 inches thick. The subsoil is brown clay loam about 9 inches thick. The substratum to a depth of 60 inches or more is light grayish brown and grayish brown sandy clay loam and loam.

Permeability of the Blancot soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 15 inches.

The Fruitland soil is deep and well drained. It formed in alluvium derived dominantly from shale and sandstone. Typically, the surface layer is brown sandy loam about 8 inches thick. The underlying material to a depth of 60 inches or more is brown and pale brown sandy loam.

Permeability of the Fruitland soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 20 inches.

This unit is used for livestock grazing, windbreaks, and wildlife habitat.

The potential plant community on the Fruitland soil is mainly Indian ricegrass, blue grama, fourwing saltbush, and giant dropseed. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, sand dropseed, and annual forbs. Suitable grazing management systems are those

that increase the production of Indian ricegrass, alkali sacaton, giant dropseed, and blue grama.

The potential plant community on the Blancot soil is mainly western wheatgrass, galleta, fourwing saltbush, and Indian ricegrass. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are big sagebrush, broom snakeweed, Douglas rabbitbrush, and annual forbs. Suitable grazing management systems are those that increase the production of galleta, Indian ricegrass, western wheatgrass, and fourwing saltbush.

Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of trails, fences, pipelines, ponds, and salting facilities.

This unit is suited to such range management practices as proper grazing use, deferred grazing, and planned grazing systems. It is not suited to range seeding because of low precipitation.

If this unit is irrigated, it is suited to windbreaks. The main limitation is the hazard of soil blowing on the Fruitland soil. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, Rocky Mountain juniper, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

BT—Blancot-Notal association, gently sloping. This map unit is on fans and in valleys. Slope is 0 to 5 percent. The native vegetation is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 55 percent Blancot loam, 0 to 5 percent slopes, and 25 percent Notal silty clay loam, 0 to 2 percent slopes. Blancot loam is on fans and in upland valleys, and Notal silty clay loam is on fans and valley bottoms.

Included in this unit are small areas of Stumble, Turley, and Fruitland soils on fans and valley sides and Uffens soils on fans and valley bottoms. Included areas make up about 20 percent of the total acreage.

The Blancot soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is pale brown loam about 2 inches thick. The subsoil is pale brown, brown, and light brownish gray clay loam about 13 inches thick. The substratum to a depth of 60 inches or more is light grayish brown and grayish brown sandy clay loam and clay loam.

Permeability of the Blancot soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 16 inches.

The Notal soil is deep and well drained. It formed in alluvium derived dominantly from shale and sandstone. Typically, the surface layer is brown silty clay loam about 3 inches thick. The subsoil is grayish brown clay about 20 inches thick. The substratum to a depth of 60 inches or more is grayish brown clay.

Permeability of the Notal soil is very slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. The estimated content of exchangeable sodium is about 15 to 50 percent. Where this soil has a cover of native vegetation, the average annual wetting depth is about 6 inches. This soil is slightly saline.

This unit is used for livestock grazing, windbreaks, and wildlife habitat.

The potential plant community on the Blancot soil is mainly western wheatgrass, galleta, Indian ricegrass, and fourwing saltbush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are big sagebrush, Douglas rabbitbrush, broom snakeweed, and annual forbs. Suitable grazing management systems are those that increase the production of western wheatgrass, galleta, blue grama, and fourwing saltbush.

The potential plant community on the Notal soil is mainly alkali sacaton, galleta, black greasewood, and western wheatgrass. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are black greasewood, big sagebrush, Douglas rabbitbrush, and annual forbs. Suitable grazing management systems on the Notal soil are those that increase the production of alkali sacaton, western wheatgrass, galleta, and fourwing saltbush.

Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the use of trails, access roads, salting, and pipelines.

This unit is suited to such range management practices as deferred grazing, planned grazing systems, and proper grazing use. The Notal soil is not suited to ponds or other earthen structures or to range seeding because of the high content of sodium and low rainfall.

If this unit is irrigated, it is suited to windbreaks. The main limitations are the hazard of soil blowing and the very slow permeability of the Notal soil. Among the trees that are suitable for planting are Lombardy poplar, Rocky Mountain juniper, Russian-olive, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

BU—Buckle silt loam, gently sloping. This deep, well drained soil is on fans and valley bottoms. It formed in alluvium derived dominantly from sandstone and shale. Slope is 0 to 5 percent. The native vegetation is mainly grass. Elevation is 6,400 to 7,200 feet. The average annual precipitation is about 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is brown silt loam about 2 inches thick. The subsoil is brown silt loam and brown clay loam about 42 inches thick. The substratum to a depth of 66 inches or more is pale brown and light brownish gray silty clay loam.

Included in this unit are small areas of Blancot soils on fans and in upland valleys and Penistaja soils on mesas and plateaus. Included areas make up about 5 percent of the total acreage.

Permeability of this Buckle soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 15 inches.

This unit is used for livestock grazing, recreation, windbreaks, and wildlife habitat.

The potential plant community is mainly western wheatgrass, blue grama, galleta, and Indian ricegrass. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are big sagebrush, broom snakeweed, rabbitbrush, and annual forbs.

Suitable grazing management systems are those that increase the production of western wheatgrass, blue grama, and galleta and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of ponds, pipelines, fences, and salting facilities.

This unit is suited to such range management practices as deferred grazing, range seeding, brush management, and planned grazing systems.

This unit is moderately well suited to recreational development. The main limitations are slope, dustiness, and moderately slow permeability.

If this unit is irrigated, it is suited to windbreaks. The main limitations are moderately slow permeability and the hazard of soil blowing. Among the trees suitable for planting are Lombardy poplar, Rocky Mountain juniper, and Russian-olive. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

Da—Doak loam, 0 to 1 percent slopes. This deep, well drained soil is on mesas, plateaus, and terraces. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown loam about 6 inches thick. The subsoil is reddish brown and light brown silty clay loam and clay loam about 35 inches thick. The substratum to a depth of 60 inches or more is light brown clay loam.

Included in this unit are small areas of Avalon, Shiprock, and Shiprock Variant soils on mesas and plateaus throughout the unit. Included areas make up about 5 percent of the total acreage.

Permeability of this Doak soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 17 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are small grain, corn, and fruit. Some areas are used for livestock grazing, urban development, and wildlife habitat.

If this unit is used for irrigated crops, the main limitation is the hazard of soil blowing.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

The potential plant community is mainly blue grama, western wheatgrass, Indian ricegrass, and needleandthread. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, rabbitbrush, and annual forbs.

Suitable grazing management systems are those that increase the production of blue grama, western wheatgrass, needleandthread, and Indian ricegrass and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of ponds, pipelines, fences, and salting facilities.

This unit is suited to such range management practices are deferred grazing, planned grazing systems, and proper grazing use. It is not suited to range seeding because of low precipitation.

This unit is suited to urban development. The main limitations for buildings and roads are moderate shrink-swell potential and low soil strength.

Roads should be designed to offset the limited ability of the soil to support traffic. If buildings are constructed on this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage resulting from shrinking and swelling and low soil strength.

The main limitation for septic tank absorption fields is moderately slow permeability. This limitation can be overcome by increasing the size of the absorption field.

Db—Doak loam, 1 to 3 percent slopes. This deep, well drained soil is on mesas, plateaus, and terraces. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown loam about 4 inches thick. The subsoil is reddish brown and light brown clay loam about 29 inches thick. The substratum to a depth of 60 inches or more is light brown clay loam.

Included in this unit are small areas of Avalon, Shiprock, and Shiprock Variant soils on mesas and plateaus throughout the unit. Included areas make up about 10 percent of the total acreage.

Permeability of this Doak soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 12 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn, small grain, and fruit. Some areas are used for livestock grazing, urban development, recreation, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slope and the hazard of erosion.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts small enough to minimize the leaching of plant nutrients.

Crop residue left on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

The potential plant community is mainly blue grama, western wheatgrass, Indian ricegrass, and needleandthread. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, rabbitbrush, and annual forbs.

Suitable grazing management systems are those that increase the production of blue grama, western wheatgrass, needleandthread, and Indian ricegreass and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of ponds, pipelines, fences, and salting facilities.

This unit is suited to such range management practices as deferred grazing, planned grazing systems, and proper grazing use. It is not suited to range seeding because of low precipitation.

This unit is suited to urban development. The main limitations for buildings and roads are moderate shrink-swell potential and low soil strength.

Roads should be designed to offset the limited ability of the soil in this unit to support traffic. If buildings are constructed on this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage resulting from shrinking and swelling and low soil strength.

The main limitation for septic tank absorption fields is moderately slow permeability. This limitation can be overcome by increasing the size of the absorption field.

This unit is moderately well suited to recreational development. The main limitation is dustiness.

Dc—Doak loam, 3 to 5 percent slopes. This deep, well drained soil is on mesas, plateaus, and terraces. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown loam about 3 inches thick. The subsoil to a depth of 60 inches or more is reddish brown and light brown clay loam.

Included in this unit are small areas of Avalon, Shiprock, and Shiprock Variant soils on mesas and plateaus throughout the unit. Also included is a soil that is similar to this Doak soil but is moderately deep. Included areas make up about 20 percent of the total acreage.

Permeability of this Doak soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 10 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn, small grain, and fruit. Some areas are used for

livestock grazing, urban development, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slope and the hazard of erosion.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. Sprinkler irrigation is the most suitable method of applying water. The method used generally is governed by the crop. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Crop residue left on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

The potential plant community is mainly blue grama, western wheatgrass, Indian ricegrass, and needleandthread. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, rabbitbrush, and annual forbs.

Suitable grazing management systems are those that increase the production of blue grama, western wheatgrass, needleandthread, and Indian ricegrass and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of ponds, pipelines, fences, and salting facilities.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of low precipitation.

This unit is suited to urban development. The main limitations for buildings and roads are moderate shrink-swell potential and low soil strength.

Roads should be designed to offset the limited ability of the soil in this unit to support traffic. If buildings are constructed on the soil, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage resulting from shrinking and swelling and low soil strength.

The main limitation for septic tank absorption fields is moderately slow permeability. This limitation can be overcome by increasing the size of the absorption field.

Dd—Doak clay loam, 0 to 2 percent slopes. This deep, well drained soil is on mesas, plateaus, and terraces. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown clay loam about 5 inches thick. The subsoil is brown and light brown clay loam and silty clay loam about 22 inches thick. The substratum to a depth of 60 inches or more is light brown clay loam.

Included in this unit are small areas of Avalon, Shiprock, and Shiprock Variant soils on mesas and plateaus. Included areas make up about 15 percent of the total acreage.

Permeability of this Doak soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 11 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn, small grain, and fruit. Some areas are used for livestock grazing, urban development, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slope and the hazard of soil blowing.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Crop residue left on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

The potential plant community is mainly alkali sacaton, blue grama, western wheatgrass, and fourwing saltbush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, threeawn, and annual forbs.

Suitable grazing management systems are those that increase the production of alkali sacaton, western wheatgrass, fourwing saltbush, and blue grama and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of ponds, fences, pipelines, and salting facilities.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of low precipitation.

This unit is suited to urban development. The main limitations for buildings and roads are moderate shrink-swell potential and low soil strength.

Roads should be designed to offset the limited ability of the soil in this unit to support traffic. If buildings are

constructed on this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage resulting from shrinking and swelling and low soil strength.

The main limitation for septic tank absorption fields is moderately slow permeability. This limitation can be overcome by increasing the size of the absorption field.

DN—Doak-Avalon association, gently sloping. This map unit is on mesas, plateaus, and terraces. Slope is 0 to 5 percent. The native vegetation is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 50 percent Doak loam, 0 to 3 percent slopes, and 35 percent Avalon loam, 3 to 5 percent slopes.

Included in this unit are small areas of Mayqueen, Sheppard, Shiprock, and Shiprock Variant soils on mesas and plateaus throughout the unit. Included areas make up about 15 percent of the total acreage.

The Doak soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown loam about 5 inches thick. The subsoil is brown and light brown silty clay loam and clay loam about 38 inches thick. The substratum to a depth of 69 inches or more is light yellowish brown clay loam.

Permeability of the Doak soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 16 inches.

The Avalon soil is deep and well drained. It formed in alluvial and eolian material derived dominantly from sandstone and shale. Typically, the surface layer is brown loam about 4 inches thick. The subsoil is brown loam about 10 inches thick. The upper 22 inches of the substratum is pinkish white loam. The lower part to a depth of 60 inches or more is light yellowish brown loam.

Permeability of the Avalon soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is high. Where this soil has a cover of native vegetation, the average annual wetting depth is about 18 inches. This soil is slightly saline.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Doak soil is mainly blue grama, western wheatgrass, Indian ricegreass, and needleandthread. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, rabbitbrush, and annual forbs.

The potential plant community on the Avalon soil is mainly Indian ricegreass, winterfat, galleta, and blue grama. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are Mormon-tea, broom snakeweed, threeawn, and annual grasses.

Suitable grazing management systems on this unit are those that increase the production of blue grama, western wheatgrass, Indian ricegrass, and needleandthread. Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of ponds, pipelines, fences, and salting facilities.

This unit is suited to such range management practices as proper grazing use, planned grazing systems, and deferred grazing. It is not suited to range seeding because of low precipitation.

DS—Doak-Sheppard-Shiprock association, rolling. This map unit is on mesas, plateaus, and terraces. Slope is 0 to 15 percent. The native vegetation is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the frost-free period is about 150 days.

This unit is 40 percent Doak loam, 0 to 5 percent slopes; 30 percent Sheppard loamy fine sand, 0 to 15 percent slopes; and 20 percent Shiprock fine sandy loam, 0 to 5 percent slopes.

Included in this unit are small areas of Avalon and Mayqueen soils on mesas and plateaus; Monierco soils on knolls, mesas, and plateaus; and Uffens soils on fans, valley bottoms, mesas, and plateaus. Included areas make up about 10 percent of the total acreage.

The Doak soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown loam about 3 inches thick. The subsoil is reddish brown and light brown silty clay loam and clay loam about 38 inches thick. The substratum to a depth of 60 inches or more is light brown clay loam.

Permeability of the Doak soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 15 inches.

The Sheppard soil is deep and somewhat excessively drained. It formed in eolian material derived from mixed sources. Typically, the surface layer is light yellowish brown loamy fine sand about 3 inches thick. The under-

lying material to a depth of 60 inches or more is yellowish brown and light yellowish brown loamy fine sand and fine sand.

Permeability of the Sheppard soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 30 inches.

The Shiprock soil is deep and well drained. It formed in alluvial and eolian material derived dominantly from sandstone. Typically, the surface layer is brown fine sandy loam about 3 inches thick. The subsoil is brown fine sandy loam about 9 inches thick. The substratum to a depth of 60 inches or more is light brown and very pale brown fine sandy loam and sandy loam.

Permeability of the Shiprock soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 13 inches.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Doak soil is mainly blue grama, western wheatgrass, Indian ricegrass, and needleandthread. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, rabbitbrush, big sagebrush, and annual forbs. Suitable grazing management systems are those that increase the production of blue grama, western wheatgrass, Indian ricegrass, and needleandthread.

The potential plant community on the Sheppard soil is mainly Indian ricegrass, giant dropseed, alkali sacaton, and needleandthread. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are Mormon-tea, sand sagebrush, big sagebrush, and annual forbs. Suitable grazing management systems are those that increase the production of Indian ricegrass, giant dropseed, alkali sacaton, and fourwing saltbush.

The potential plant community on the Shiprock soil is mainly Indian ricegrass, blue grama, giant dropseed, and fourwing saltbush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are big sagebrush, broom snakeweed, rabbitbrush, and annual forbs. Suitable grazing management systems are those that increase the production of Indian ricegrass, giant dropseed, blue grama, and fourwing saltbush.

Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of pipelines, fences, and salting facilities.

Soil blowing can be controlled and damage to seedlings reduced by maintaining residue on the surface of the soil.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of low precipitation.

Du—Doak-Uffens complex, 0 to 3 percent slopes. This map unit is on mesas and plateaus. The native vegetation is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 40 percent Doak very fine sandy loam and 35 percent Uffens fine sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Shiprock soils on mesas and plateaus; Monierco soils on knolls, mesas, and plateaus; Muff soils on mesas, in upland valleys, on fans, and in swales; and Huerfano soils on mesas and in upland valleys. Included areas make up about 25 percent of the total acreage.

The Doak soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown very fine sandy loam about 5 inches thick. The subsoil is yellowish red sandy clay loam about 14 inches thick. The substratum to a depth of 60 inches or more is reddish brown loam.

Permeability of the Doak soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. The estimated content of exchangeable sodium is about 15 to 25 percent. Where this soil has a cover of native vegetation, the average annual wetting depth is about 19 inches.

The Uffens soil is deep and well drained. It formed in alluvium derived dominantly from shale. Typically, the surface layer is pale brown fine sandy loam about 5 inches thick. The subsurface layer is light brown very fine sandy loam about 1 inch thick. The subsoil is reddish brown clay loam about 12 inches thick. The substratum to a depth of 60 inches or more is light gray and pale yellow sandy clay loam.

Permeability of the Uffens soil is moderately slow. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. The estimated content of exchangeable sodium is about 15 to 25 percent. Where this soil has a cover of native vegetation, the average annual wetting depth is about 12 inches. This soil is strongly saline.

This unit is used for livestock grazing, windbreaks, and wildlife habitat.

The potential plant community on the Doak soil is mainly blue grama, galleta, Indian ricegrass, and needleandthread. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, rubber rabbitbrush, big sagebrush, and annual forbs. Suitable grazing management systems are those that increase the production of blue grama, needleandthread, western wheatgrass, and Indian ricegrass.

The potential plant community on the Uffens soil is mainly alkali sacaton, galleta, black greasewood, and fourwing saltbush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are black greasewood, shadscale, broom snakeweed, and annual forbs. Suitable grazing management systems are those that increase the production of fourwing saltbush, alkali sacaton, western wheatgrass, and galleta.

Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the use of fences, trails, herding, and water developments.

This unit is suited to such range management practices as planned grazing systems, proper grazing use, and deferred grazing. It is not suited to range seeding because of low precipitation. The Uffens soil has limited suitability for ponds or other earthen structures because of the high content of sodium.

If this unit is irrigated, it is suited to windbreaks. The main limitations are the hazard of soil blowing and moderately slow permeability. Among the trees that are suitable for planting are Lombardy poplar, Rocky Mountain juniper, Russian-olive, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

Dw—Doak-Uffens complex, 3 to 8 percent slopes. This map unit is on mesas and plateaus. The native vegetation is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 40 percent Doak very fine sandy loam, 3 to 5 percent slopes, and 35 percent Uffens fine sandy loam, 3 to 8 percent slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Shiprock soils on mesas and plateaus; Monierco soils on knolls, mesas, and plateaus; Muff soils on mesas, in upland valleys, on fans, and in swales; and Huerfano soils on mesas and in upland valleys. Included areas make up about 25 percent of the total acreage.

The Doak soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown very fine sandy loam about 3 inches thick. The subsoil is yellowish red clay loam about 12 inches thick. The substratum to a depth of 60 inches or more is reddish brown loam.

Permeability of the Doak soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. The estimated content of exchangeable sodium is about 15 to 25 percent. Where this soil has a cover of native vegetation, the average annual wetting depth is about 15 inches.

The Uffens soil is deep and well drained. It formed in alluvium derived dominantly from shale. Typically, the surface layer is pale brown fine sandy loam about 4 inches thick. The subsoil is reddish brown clay loam and sandy clay loam about 18 inches thick. The substratum to a depth of 60 inches or more is pale yellow sandy clay loam.

Permeability of the Uffens soil is moderately slow. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. The estimated content of exchangeable sodium is about 25 to 75 percent. Where this soil has a cover of native vegetation, the average annual wetting depth is about 14 inches. This soil is strongly saline.

This unit is used for livestock grazing, windbreaks, and wildlife habitat.

The potential plant community on the Doak soil is mainly blue grama, galleta, Indian ricegrass, and needleandthread. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, rabbitbrush, big sagebrush, and annual forbs. Suitable grazing management systems are those that increase the production of blue grama, western wheatgrass, Indian ricegrass, and needleandthread.

The potential plant community on the Uffens soil is mainly alkali sacaton, galleta, black greasewood, and fourwing saltbush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are black greasewood, shadscale, broom snakeweed, and annual forbs. Suitable grazing management systems are those that increase the production of alkali sacaton, fourwing saltbush, western wheatgrass, and galleta.

Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be

accomplished by the placement of fences, trails, and water developments and by herding.

This unit is suited to such range management practices as deferred grazing, planned grazing systems, and proper grazing use. It is not suited to range seeding because of low precipitation. The Uffens soil has limited suitability for ponds or other earthen structures because of the high content of sodium.

If this unit is irrigated, it is suited to windbreaks. The main limitations are the hazard of soil blowing and moderately slow permeability. Among the trees that are suitable for planting are Lombardy poplar, Rocky Mountain juniper, Russian-olive, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

DZ—Dune land. This map unit is on mesas and plateaus and in major drainageways. It consists of deep, excessively drained active sand dunes. Slope is 5 to 25 percent. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is used for wildlife habitat.

FA—Farb-Persayo-Rock outcrop complex, moderately steep. This map unit is on hills and breaks. Slope is 3 to 30 percent. The native vegetation is mainly pinyon, juniper, and grass. Elevation is 5,200 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 40 percent Farb fine sandy loam, 3 to 30 percent slopes; 30 percent Persayo clay loam, 3 to 30 percent slopes; and 20 percent Rock outcrop, 10 to 30 percent slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Stumble soils on valley sides and fans and Doak soils on mesas and plateaus. Included areas make up about 10 percent of the total acreage.

The Farb soil is very shallow to shallow and excessively drained. It formed in residuum derived dominantly from sandstone. Typically, the surface layer is pale brown fine sandy loam about 7 inches thick. The underlying material to a depth of 10 inches is light yellowish brown sandy clay loam. Sandstone is at a depth of 10 inches.

Permeability of the Farb soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 5 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 8 to 12 inches.

The Persayo soil is shallow and well drained. It formed in residuum derived dominantly from shale. Typically, the surface layer is light brownish gray clay loam about 2 inches thick. The substratum to a depth of 15 inches is light brownish gray silty clay loam. Shale is at a depth of 15 inches.

Permeability of the Persayo soil is moderately slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is high. The hazard of soil blowing is high. Where this soil has a cover of native vegetation, the average annual wetting depth is about 13 to 17 inches. This soil is slightly saline.

Rock outcrop is barren sandstone on benches, ridges, and breaks.

This unit is used for livestock grazing, woodland, and wildlife habitat.

The potential plant community on the Farb and Persayo soils is mainly oneseed juniper, pinyon, antelope bitterbrush, and Indian ricegrass. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are oneseed juniper, big sagebrush, broom snakeweed, and annual forbs.

Suitable grazing management systems are those that increase the production of antelope bitterbrush, Indian ricegrass, and mountainmahogany and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of access roads, trails, and fences and by herding.

This unit is suited to such range mangement practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to brush management, range seeding, or construction of pipelines because of low precipitation and very shallow and shallow soil depth.

This unit produces stands of juniper and pinyon. The Farb soil is poorly suited to the production of these species. It can produce about 5 cords of wood per acre in a stand of trees that averages 5 inches in diameter measured at a height of 1 foot. The Persayo soil also is poorly suited to the production of these species. It can produce about 9 cords of wood per acre in a stand of trees that averages 5 inches in diameter measured at a height of 1 foot.

Deterioration of the stands of pinyon and juniper on this unit can be prevented if these trees are managed for a combination of uses, including wood production.

FP—Fluvaquents, ponded. These deep, very poorly drained soils are on flood plains. They formed in alluvium derived from mixed sources. Slope is 0 to 1 percent. The native vegetation is mainly salt-tolerant grasses, cattails, and sedges. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface is covered with a mat of decomposing organic matter about 4 inches thick. The surface layer is grayish brown loam about 4 inches thick. The upper 26 inches of the underlying material is light brownish gray loam. The lower part to a depth of 60 inches is multicolored stratified sand, loamy sand, and gravel.

Permeability of Fluvaquents, ponded, is very slow to very rapid. Available water capacity is low to very high. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. The hazard of soil blowing is slight.

This unit is used for wildlife habitat.

Fr—Fruitland sandy loam, 0 to 2 percent slopes. This deep, well drained soil is on fans and in valleys. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown sandy loam about 7 inches thick. The underlying material to a depth of 60 inches or more is pale brown and light yellowish brown sandy loam.

Included in this unit are small areas of Stumble soils on the sides of valleys and Fruitland sandy clay loam throughout the unit. Included areas make up about 5 percent of the total acreage.

Permeability of this Fruitland soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 20 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn, small grain, and fruit. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitation is the hazard of soil blowing.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

This unit is well suited to urban development. It has few limitations. Seepage is a limitation for sewage lagoon areas.

If this unit is irrigated, it is suited to windbreaks. The main limitation is the hazard of soil blowing. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

Fs—Fruitland sandy loam, 2 to 5 percent slopes. This deep, well drained soil is on fans and in valleys. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown sandy loam about 6 inches thick. The underlying material to a depth of 60 inches or more is pale brown sandy loam.

Included in this unit are small areas of Stumble soils on the sides of valleys and Fruitland sandy clay loam throughout the unit. Included areas make up about 5 percent of the total acreage.

Permeability of this Fruitland soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 20 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn, small grain, and fruit. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are the hazard of soil blowing and slope.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this soil. Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

This unit is well suited to urban development. It has few limitations. Seepage is a limitation for sewage lagoon areas.

If this unit is irrigated, it is suited to windbreaks. The main limitations are the hazard of soil blowing and slope. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, Rocky Mountain juniper, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

Ft—Fruitland sandy loam, wet, 0 to 2 percent slopes. This deep, somewhat poorly drained soil is on

fans and in valleys. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown sandy loam about 6 inches thick. The underlying material to a depth of 60 inches or more is pale brown sandy loam.

Included in this unit are small areas of Beebe Variant soils on fans, flood plains, and low terraces and Fruitland sandy clay loam throughout the unit. Included areas make up about 10 percent of the total acreage.

Permeability of this Fruitland soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. A seasonal high water table is at a depth of 24 to 60 inches during the irrigation season. Where this soil has a cover of native vegetation, the average annual wetting depth is about 20 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn and small grain. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitation is wetness. The selection of crops that can be grown is limited by the seasonal high water table. The water table can be lowered by installing an adequate drainage system.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. Sprinkler irrigation is the most suitable method of applying water. The method used generally is governed by the crop. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

This unit is poorly suited to urban development. The main limitation is wetness. Wetness can be reduced by installing drain tile around footings.

If this unit is irrigated, it is suited to windbreaks. The main limitation is wetness. The selection of trees and shrubs is limited to those varieties that can tolerate the seasonal high water table.

Fu—Fruitland loam, 1 to 3 percent slopes. This deep, well drained soil is on fans and in valleys. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the frost-free period is about 150 days.

Typically, the surface layer is brown loam about 8 inches thick. The underlying material to a depth of 60 inches or more is brown and pale brown sandy loam.

Included in this unit are small areas of Turley soils on fans and in valleys throughout the unit. Included areas make up about 5 percent of the total acreage.

Permeability of this Fruitland soil is moderately rapid. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 12 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn, small grain, and fruit. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitation is the hazard of soil blowing.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. Sprinkler irrigation is the most suitable method of applying water. The method used generally is governed by the crop. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

This unit is well suited to urban development. It has few limitations. Seepage is a limitation for sewage lagoon areas.

If this unit is irrigated, it is suited to windbreaks. It has few limitations. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, Rocky Mountain juniper, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

Fw—Fruitland loam, 5 to 8 percent slopes. This deep, well drained soil is on fans and in valleys. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is light brownish gray loam about 3 inches thick. The underlying material to a depth of 60 inches or more is light olive brown, light brownish gray, and light gray sandy loam.

Included in this unit are small areas of Fruitland sandy loam, 0 to 2 percent slopes, throughout the unit. Included areas make up about 25 percent of the total acreage.

Permeability of this soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 12 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slope and the hazard of erosion.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. Sprinkler irrigation is the most suitable method of applying water. The method used generally is governed by the crop. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, helps to control erosion, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

This unit is well suited to urban development. It has few limitations. Seepage is a limitation for sewage lagoon areas.

If this unit is irrigated, it is suited to windbreaks. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, Rocky Mountain juniper, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

FX—Fruitland-Persayo-Sheppard complex, hilly. This map unit is on hills, mesas, plateaus, fans, and breaks (fig. 3). Slope is 5 to 30 percent. The native vegetation is mainly grass and some pinyon and juniper. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 40 percent Fruitland sandy loam, 30 percent Persayo clay loam, and 25 percent Sheppard loamy fine sand. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Farb soils on hills and breaks and rock outcrop on ridges and hills throughout the unit. Included areas make up about 5 percent of the total acreage.

The Fruitland soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown sandy loam about 4 inches thick. The underlying material to a depth of 60 inches or more is brown fine sandy loam.

Permeability of the Fruitland soil is moderately rapid.

Figure 3.—Area of Fruitland-Persayo-Sheppard complex, hilly, in foreground and Badland-Rock outcrop-Persayo complex, extremely steep, in background.

Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

The Persayo soil is shallow and well drained. It formed in residuum derived dominantly from shale. Typically, the surface layer is light brownish gray clay loam about 2 inches thick. The substratum, to a depth of 18 inches, is light yellowish brown clay loam. Shale is at a depth of 18 inches.

Permeability of the Persayo soil is moderately slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is high. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 12 inches. This soil is slightly saline.

The Sheppard soil is deep and somewhat excessively drained. It formed in eolian material derived from mixed sources. Typically, the surface layer is light yellowish brown loamy fine sand about 4 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown loamy fine sand and fine sand.

Permeability of the Sheppard soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

This unit is used for livestock grazing, woodland, windbreaks, and wildlife habitat.

The potential plant community on the Fruitland soil is mainly Indian ricegreas, blue grama, fourwing saltbush, and giant dropseed. The potential plant community on the Sheppard soil is mainly Indian ricegrass, giant dropseed, alkali sacaton, and sand sagebrush. As the potential plant community on these soils deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, Mormon-tea, threeawn, and annual forbs. Suitable grazing management systems on the Fruitland and Sheppard soils are those that increase the production of Indian ricegrass, giant dropseed, fourwing saltbush, and blue grama.

The potential plant community on the Persayo soil is mainly oneseed juniper, pinyon, antelope bitterbrush, and blue grama. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, oneseed juniper, and annual forbs. Suitable grazing management systems are those that increase the production of antelope bitterbrush and blue grama.

Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the use of herding, salting, fencing, and water developments.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. The Persayo soil is not suited to range seeding, brush management, or earthen structures because of low precipitation and shallow soil depth. The Sheppard soil is not suited to range seeding because of low precipitation and the hazard of soil blowing.

The Persayo soil produces stands of oneseed juniper and pinyon. This soil is suited to the production of these species. It can produce about 8 cords of wood per acre in a stand of trees that averages 5 inches in diameter measured at a height of 1 foot. Deterioration of the stands of pinyon and oneseed juniper on this soil can be prevented by managing the trees for a combination of uses, including wood production.

If this unit is irrigated, it is suited to windbreaks. The main limitation is the hazard of soil blowing. Among the trees that are suitable for planting are Lombardy poplar, Rocky Mountain juniper, Russian-olive, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

Fy—Fruitland-Slickspots complex, 0 to 3 percent slopes. This map unit is on fans and in valleys. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 75 percent Fruitland sandy loam, 0 to 3 percent slopes and 20 percent Slickspots. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Stumble soils on fans throughout the unit. Included areas make up about 5 percent of the total acreage.

The Fruitland soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown sandy loam about 9 inches thick. The underlying material to a depth of 60 inches or more is pale brown and light yellowish brown sandy loam.

Permeability of the Fruitland soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

Slickspots are strongly alkali-affected (*9*). The estimated content of exchangeable sodium is 15 to 50 percent. The surface layer is easily puddled and crusted. The underlying material is dense and is slowly permeable. Slickspots are circular areas 4 to 10 feet in diameter. They support little or no vegetation.

Most areas of this unit are used for irrigated crops, mainly alfalfa and irrigated pasture. Among the other crops are corn and small grain. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are the hazard of soil blowing and the areas of Slickspots.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain

soil tilth and organic matter content. Application of gypsum or sulfur can reduce the content of sodium and increase the permeability of Slickspots. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

The Fruitland soil is well suited to urban development. It has few limitations. Seepage is a limitation for sewage lagoon areas.

Slickspots are poorly suited to urban development. The main limitations are the high content of sodium and slow permeability.

If this unit is irrigated, it is suited to windbreaks. The main limitations are the hazard of soil blowing and the areas of Slickspots. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, Rocky Mountain juniper, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

Ga—Garland loam. This deep, well drained soil is on terraces and sides of valleys. It formed in alluvium derived from mixed sources. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown loam about 4 inches thick. The subsoil is brown clay loam about 20 inches thick. The substratum to a depth of 60 inches or more is light brownish gray very gravelly loamy sand and multicolored very gravelly sand.

Included in this unit are small areas of Doak soils on terraces. Included areas make up about 5 percent of the total acreage.

Permeability of this Garland soil is moderate to a depth of 24 inches and rapid below this depth. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 15 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn, small grain, and fruit. Some areas are used for urban development and wildlife habitat.

If this unit is used for irrigated crops, the main limitation is the hazard of soil blowing.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize leaching of plant nutrients.

Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

This unit is suited to urban development. The main limitations for buildings and roads are moderate shrink-swell potential and low soil strength.

Roads should be designed to offset the limited ability of the soil in this unit to support traffic. If buildings are constructed on this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage resulting from shrinking and swelling.

The main limitation for sewage lagoon areas and trench type sanitary landfills is seepage.

Gr—Green River fine sandy loam. This deep, somewhat poorly drained soil is on flood plains and low river terraces. It formed in alluvium derived from mixed sources. Slope is 0 to 1 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is pale brown fine sandy loam about 6 inches thick. The underlying material to a depth of 60 inches or more is brown and light yellowish brown, stratified fine sandy loam, sandy loam, and loam.

Included in this unit are small areas of Werlog soils and saline spots on flood plains and low river terraces. Included areas make up about 10 percent of the total acreage.

Permeability of this Green River soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. A seasonal high water table is at a depth of 24 to 60 inches during the irrigation season. This soil is subject to frequent, brief periods of flooding from March through September. Where this soil has a cover of native vegetation, the average annual wetting depth is about 16 inches. This soil is slightly saline.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops is small grain. Some areas are used for urban development and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are the hazard of flooding, wetness, and excess salt. The selection of crops that can be grown is limited by the seasonal high water table and by the salinity and alkalinity of the soil. The water table can be lowered by installing an adequate drainage system. The risk of flooding can be reduced by the use of levees, dikes, and diversions.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

This unit is poorly suited to urban development. The main limitations are the hazard of flooding, wetness, and seepage. Flooding can be controlled only by the use of major flood control structures.

If this unit is irrigated, it is suited to windbreaks. The main limitations are the hazard of flooding, wetness, and excess salt. The selection of trees and shrubs is limited to those varieties that can tolerate the seasonal high water table.

GY—Gypsiorthids-Badland-Stumble complex, moderately steep. This map unit is on hills, knolls, and breaks and in valleys. Slope is 5 to 30 percent. The native vegetation is mainly grass and some pinyon and juniper. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 35 percent Gypsiorthids, 5 to 30 percent slopes; 35 percent Badland, 5 to 30 percent slopes; and 15 percent Stumble loamy sand, 5 to 8 percent slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Farb and Persayo soils on hills and breaks throughout the unit. Included areas make up about 15 percent of the total acreage.

Gypsiorthids are very shallow to deep and well drained to excessively drained. They formed in material derived dominantly from gypsum. No single profile is typical of Gypsiorthids, but one commonly observed in the survey area has a surface layer of pale yellow sandy loam about 4 inches thick. The substratum to a depth of 16 inches is light gray sandy loam. Gypsum is at a depth of 16 inches.

Permeability of the Gypsiorthids is slow to rapid. Available water capacity is very low to high. Effective rooting depth is 6 to 60 inches. Runoff is slow to medium, and the hazard of water erosion is slight to moderate. The hazard of soil blowing is severe. Where these soils have a cover of native vegetation, the average annual wetting depth is 6 to 15 inches.

Badland consists of nonstony, barren shale uplands that are dissected by deep, intermittent drainageways and gullies.

The Stumble soil is deep and somewhat excessively drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is yellowish brown loamy sand about 8 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown and pale brown loamy sand and sand.

Permeability of the Stumble soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Stumble soil is mainly Indian ricegrass, giant dropseed, alkali sacaton, and bottlebrush squirreltail. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are Mormon-tea, broom snakeweed, sandhill muhly, and sand sagebrush.

Suitable grazing management systems are those that increase the production of giant dropseed, alkali sacaton, Indian ricegrass, and needleandthread and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of fences, pipelines, and wells and by herding.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding or brush management because of low precipitation and the hazard of soil blowing.

HA—Haplargids-Blackston-Torriorthents complex, very steep. This map unit is on terraces, mesas, and plateaus. Slope is 8 to 50 percent. The native vegetation is mainly grass and scattered pinyon and juniper. Elevation is 4,800 to 7,200 feet. The average annual precipitation is about 9 inches, the average annual air temperature is about 52 degrees F, and the average frost-free period is about 140 days.

This unit is 45 percent Haplargids, 8 to 50 percent slopes; 30 percent Blackston gravelly loam, 8 to 40 percent slopes; and 20 percent Torriorthents, 8 to 50 percent slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of rock outcrop on ledges, shelves, and breaks. Included areas make up about 5 percent of the total acreage.

Haplargids are shallow to deep and well drained to excessively drained. They formed in alluvium derived from mixed sources. No single profile is typical of Haplargids, but one commonly observed in the survey area has a surface layer of dark brown cobbly sandy loam about 7 inches thick. The subsoil is brown and yellowish brown cobbly sandy clay loam about 19 inches thick. The substratum to a depth of 60 inches or more is light brownish gray, light gray, and pale olive cobbly sandy clay loam and loam.

Permeability of Haplargids is moderate to moderately slow. Available water capacity is low to high. Effective

rooting depth is 14 to 60 inches. Runoff is slow to rapid, and the hazard of water erosion is slight to severe. The hazard of soil blowing is slight. Where this soil has a cover of native vegetation, the average annual wetting depth is about 14 inches.

The Blackston soil is deep and well drained. It formed in alluvium derived from mixed sources. Typically, the surface layer is yellowish brown gravelly loam about 2 inches thick. The subsoil is brown gravelly loam about 9 inches thick. The upper 17 inches of the substratum is pinkish white very gravelly clay loam. The lower part to a depth of 60 inches is multicolored very gravelly sand.

Permeability of the Blackston soil is moderately slow to a depth of 26 inches and rapid below this depth. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 11 inches.

Torriorthents are shallow to deep and well drained. They formed in alluvium derived from mixed sources. No single profile is typical of Torriorthents, but one commonly observed in the survey area has a surface layer of light brownish gray cobbly loam about 3 inches thick. The substratum to a depth of 15 inches is light brownish gray clay loam. Shale is at a depth of 15 inches.

Permeability of Torriorthents is moderately rapid to moderately slow. Available water capacity is low to high. Effective rooting depth is 10 to 60 inches. Runoff is slow to rapid, and the hazard of water erosion is slight to severe. The hazard of soil blowing is slight. Where this soil has a cover of native vegetation, the average annual wetting depth is 10 to 15 inches.

This unit is used for livestock grazing, urban development, woodland, and wildlife habitat.

The potential plant community on the Blackston soil is mainly New Mexico feathergrass, fourwing saltbush, Indian ricegrass, and galleta. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, rabbitbrush, and big sagebrush.

Suitable grazing management systems are those that increase the production of Indian ricegrass, fourwing saltbush, galleta, and needleandthread and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of fences, salting facilities, and water developments and by herding.

This unit is suited to such range management practices as deferred grazing, planned grazing systems, and proper grazing use. It is not suited to range seeding or brush management because of low precipitation and steepness of slope.

Haplargids and Torriorthents have variable properties. If these soils are used for urban development, onsite investigation is needed.

The Blackston soil is poorly suited to urban development. The main limitation is slope. Excavations can also have unstable walls.

This unit produces stands of pinyon and oneseed juniper. It is moderately well suited to the production of these species. It can produce about 11 cords of wood per acre in a stand of trees that averages 5 inches in diameter measured at a height of 1 foot. Deterioration of the stands of pinyon and juniper on this unit can be prevented by managing the trees for a combination of uses, including wood production.

HU—Huerfano-Muff-Uffens complex, gently sloping. This map unit is on mesas and in valleys (fig. 4). Slope is 0 to 8 percent. The native vegetation is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 40 percent Huerfano sandy clay loam, 0 to 3 percent slopes; 30 percent Muff very fine sandy loam, 0 to 8 percent slopes; and 20 percent Uffens fine sandy loam, 0 to 5 percent slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Avalon and Shiprock soils on mesas and plateaus; Doak soils on mesas, plateaus, and terraces; and Notal soils on fans and valley bottoms. Included areas make up about 10 percent of the total acreage.

The Huerfano soil is shallow and well drained. It formed in alluvium and residuum derived dominantly from shale and siltstone. Typically, the surface layer is light yellowish brown sandy clay loam about 1 inch thick. The subsurface layer is light gray sandy clay loam about 1 inch thick. The subsoil is dark yellowish brown, brown, and yellowish brown clay loam and sandy clay loam about 13 inches thick. Shale is at a depth of 15 inches.

Permeability of the Huerfano soil is moderately slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. The estimated content of exchangeable sodium is about 25 to 75 percent. Where this soil has a cover of native vegetation, the average annual wetting depth is about 4 inches.

The Muff soil is moderately deep and well drained. It formed in alluvium derived dominantly from shale. Typically, the surface layer is pale brown very fine sandy loam about 3 inches thick. The subsurface layer is light gray very fine sandy loam about 1 inch thick. The subsoil is brown and light brown clay loam about 20 inches thick. Shale is at a depth of 24 inches.

Permeability of the Muff soil is slow. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water ero-

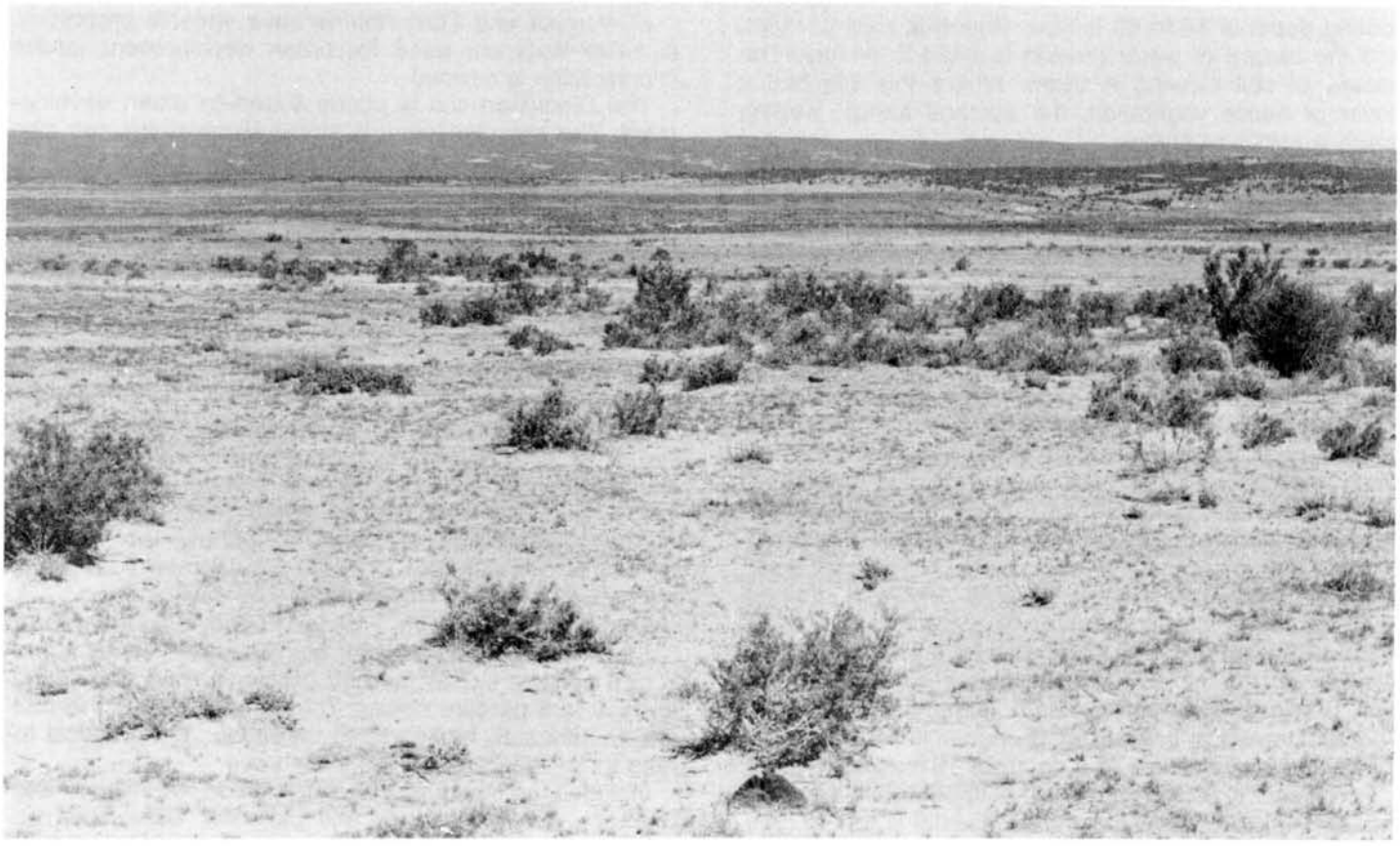

Figure 4.—Area of Huerfano-Muff-Uffens complex, gently sloping, in foreground, Doak-Avalon association in middle background, and Farb-Persayo-Rock outcrop complex, moderately steep, in far background.

sion is moderate. The hazard of soil blowing is severe. The estimated content of exchangeable sodium is about 25 to 75 percent. Where this soil has a cover of native vegetation, the average annual wetting depth is about 6 inches. This soil is slightly saline.

The Uffens soil is deep and well drained. It formed in alluvium derived dominantly from shale. Typically, the surface layer is pale brown and light yellowish brown fine sandy loam and very fine sandy loam about 8 inches thick. The subsurface layer is light gray very fine sandy loam about 11 inches thick. The substratum to a depth of 60 inches or more is pale brown sandy clay loam (fig. 5).

Permeability of the Uffens soil is moderately slow. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. The estimated content of exchangeable sodium is about 25 to 75 percent. Where this soil has a cover of native vegetation, the average annual wetting depth is about 12 inches.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Huerfano and Muff soils is mainly alkali sacaton, galleta, fourwing saltbush, and black greasewood. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are black greasewood, shadscale, broom snakeweed, and annual forbs. Suitable grazing management systems are those that increase the production of alkali sacaton, galleta, and fourwing saltbush.

The potential plant community on the Uffens soil is mainly alkali sacaton, galleta, black greasewood, and fourwing saltbush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are black greasewood, shadscale, broom snakeweed, and annual forbs. Suitable grazing management systems are those that increase the production of alkali sacaton, fourwing saltbush, and galleta.

Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a

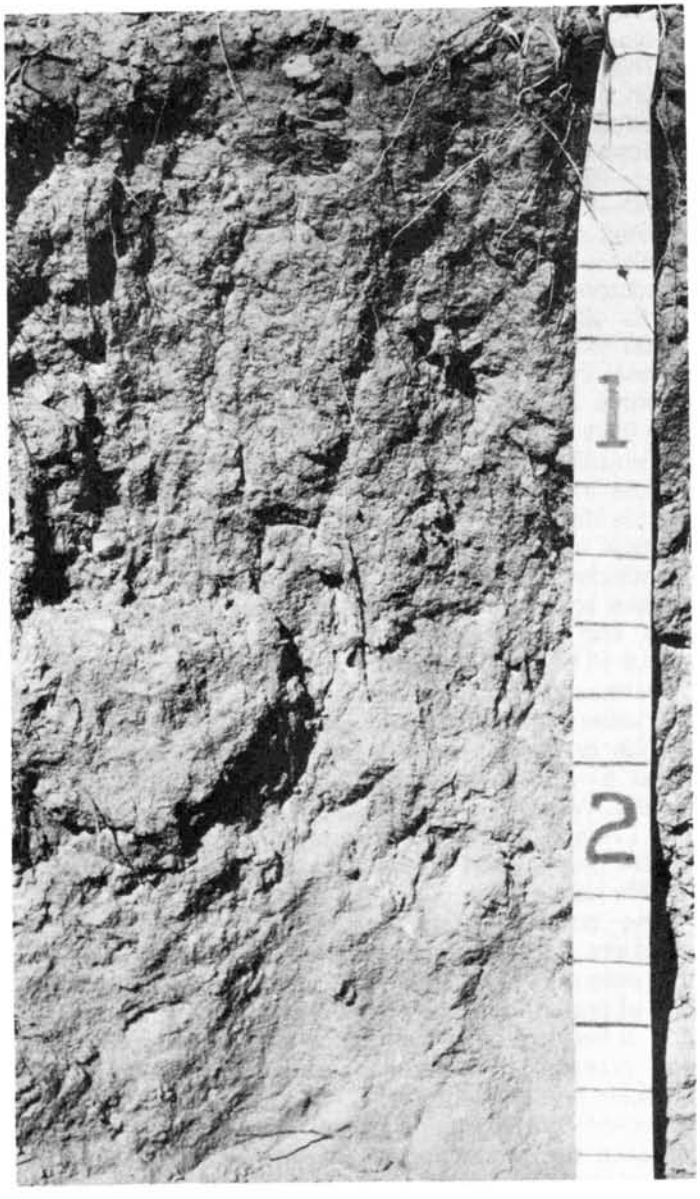

Figure 5.—Profile of Uffens sandy loam, 0 to 5 percent slopes, in an area of Huerfano-Muff-Uffens complex, gently sloping. The moderate grade of prismatic structure in the B2t horizon can be observed at a depth of 6 to 18 inches.

variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of fences, trails, and wells and by herding.

This unit is suited to such range management practices as planned grazing systems, proper grazing use, and deferred grazing. It is not suited to range seeding because of low precipitation. The Huerfano soil has limited suitability for ponds or other earthen structures because of the high content of sodium and shallow soil depth.

Ma—Mayqueen loamy fine sand. This deep, somewhat excessively drained soil is on mesas and plateaus. It formed in alluvial and eolian material derived dominantly from sandstone and shale. Slope is 0 to 8 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown loamy fine sand about 4 inches thick. The subsoil is reddish brown fine sandy loam about 12 inches thick. The substratum to a depth of 60 inches or more is light brown and light yellowish brown loamy sand and loamy fine sand.

Included in this unit are small areas of Shiprock soils on mesas and plateaus throughout the unit. Included areas make up about 5 percent of the total acreage.

Permeability of this Mayqueen soil is moderately rapid to a depth of 16 inches and rapid below this depth. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn and small grain. Some areas are used for livestock grazing, urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are the hazard of soil blowing and droughtiness.

Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface helps to reduce runoff, soil blowing, and damage to seedlings and also helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

The potential plant community is mainly Indian ricegrass, giant dropseed, alkali sacaton, and sand sagebrush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, Mormon-tea, threeawn, and annual forbs.

Suitable grazing management systems are those that increase the production of alkali sacaton, Indian ricegrass, giant dropseed, and sand dropseed. Proper distribution of livestock grazing generally can be accomplished by the placement of salting facilities, fencing, and water developments and by herding.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of low precipitation.

This unit is moderately well suited to urban development. The very severe hazard of soil blowing is a limitation. Seepage is a limitation for sewage lagoon areas.

If this unit is irrigated, it is suited to windbreaks. The main limitation is the hazard of soil blowing. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, Rocky Mountain juniper, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

MO—Monierco fine sandy loam, gently sloping. This shallow, well drained soil is on knolls, mesas, and plateaus. It formed in alluvial and eolian material derived dominantly from sandstone and shale. Slope is 0 to 8 percent. The native vegetation is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is light yellowish brown fine sandy loam about 3 inches thick. The subsoil is brown, yellowish brown, and pale brown fine sandy loam and clay loam about 13 inches thick. Shale is at a depth of 13 inches.

Included in this unit are small areas of Doak soils on mesas and plateaus throughout the unit. Included areas make up about 10 percent of the total acreage.

Permeability of this Monierco soil is moderately slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 10 inches.

This unit is used for livestock grazing, urban development, and wildlife habitat.

The potential plant community is mainly Indian ricegrass, galleta, winterfat, and blue grama. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, threeawn, big sagebrush, and annual forbs.

Suitable grazing management systems are those that increase the production of Indian ricegrass, galleta, winterfat, and blue grama and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of fencing, salting facilities, and access roads and by herding.

This unit is suited to such range management practices as deferred grazing, planned grazing systems, and proper grazing use. It is not suited to range seeding because of low precipitation and shallow soil depth.

This unit is poorly suited to urban development. The main limitation is shallow soil depth. The deep cuts needed to provide essentially level building sites can expose bedrock.

PO—Penistaja loam, gently sloping. This deep, well drained soil is on mesas and plateaus (fig. 6). It formed in alluvium and eolian material derived dominantly from sandstone and shale. The native vegetation is mainly grass. Slope is 0 to 5 percent. Elevation is 6,400 to 7,200 feet. The average annual precipitation is about 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is brown loam about 2 inches thick. The subsoil is brown clay loam about 36 inches thick. The substratum to a depth of 67 inches or more is light brown clay loam.

Included in this unit are small areas of Travessilla and Weska soils on hills, breaks, and mesas; Twick soils on hills; and Buckle soils on fans. Included areas make up about 10 percent of the total acreage.

Permeability of this Penistaja soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

This unit is used for livestock grazing, recreation, and wildlife habitat.

The potential plant community is mainly western wheatgrass, Indian ricegrass, blue grama, and galleta. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, rabbitbrush, and annual forbs.

Suitable grazing management systems are those that increase the production of western wheatgrass, Indian ricegrass, blue grama, and galleta and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of fencing, trails, and water developments and by herding.

This unit is suited to such range management practices as brush management and range seeding.

This unit is well suited to recreational development. The main limitation is slope.

PP—Penistaja-Buckle association, gently sloping. This map unit is on mesas, plateaus, and fans and in valleys. Slope is 0 to 5 percent. The native vegetation is mainly grass. Elevation is 6,400 to 7,200 feet. The average annual precipitation is about 12 inches, the average

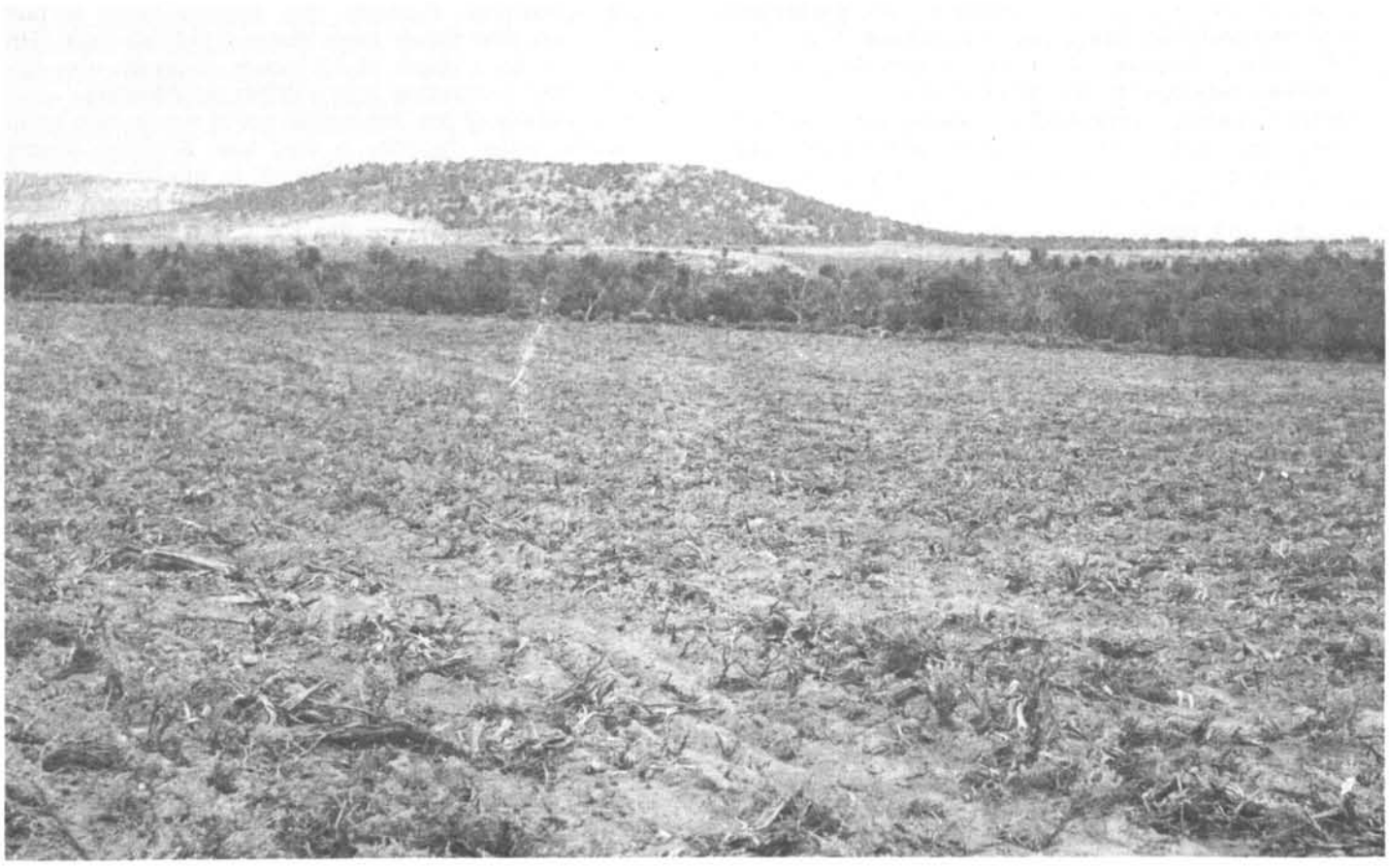

Figure 6.—Area of Penistaja loam, gently sloping, that has been prepared for seeding, in foreground. Travessilla-Weska-Rock outcrop complex, moderately steep, on the border, and Twick-Silver association, moderately steep, in background.

annual air temperature is about 50 degrees F, and the average frost-free period is about 135 days.

This unit is 50 percent Penistaja loam and 35 percent Buckle silt loam. The Penistaja soil is on mesas and plateaus, and the Buckle soil is on fans and in valleys.

Included in this unit are small areas of Travessilla and Weska soils on hills, mesas, and breaks and Twick soils on hills. Included areas make up about 15 percent of the total acreage.

The Penistaja soil is deep and well drained. It formed in alluvial and eolian material derived dominantly from sandstone and shale. Typically, the surface layer is brown loam about 3 inches thick. The subsoil is brown clay loam about 25 inches thick. The substratum to a depth of 60 inches or more is light brown and yellowish brown clay loam.

Permeability of the Penistaja soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

The Buckle soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown silt loam about 8 inches thick. The upper part of the subsoil is brown silt loam about 5 inches thick. The lower part is grayish brown and light brownish gray silty clay loam about 34 inches thick. The substratum to a depth of 66 inches or more is pale brown silt loam.

Permeability of the Buckle soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 26 inches.

This unit is used for livestock grazing, recreation, windbreaks, and wildlife habitat.

The potential plant community is mainly western wheatgrass, blue grama, galleta, and big sagebrush. As the potential plant community deteriorates, the propor-

tion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Among the plants that increase are big sagebrush, broom snakeweed, rabbitbrush, and annual forbs.

Suitable grazing management systems are those that increase the production of western wheatgrass, blue grama, and galleta and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of fencing, salting facilities, and water developments and by herding.

This unit is suited to such range management practices as range seeding, brush management, deferred grazing, and planned grazing systems.

This unit is moderately well suited to recreational development. The main limitations are slope and dustiness and the moderately slow permeability of the Buckle soil.

If this unit is irrigated, it is suited to windbreaks. The main limitations are the hazard of soil blowing on the Penistaja soil and moderately slow permeability of the Buckle soil. Among the trees that are suitable for planting are Lombardy poplar, Rocky Mountain juniper, Russian-olive, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

PT—Penistaja-Travessilla association, moderately sloping. This map unit is on mesas, plateaus, hills, and breaks. Slope is 0 to 15 percent. The native vegetation is mainly grass, pinyon, and juniper. Elevation is 6,400 to 7,200 feet. The average annual precipitation is about 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 135 days.

This unit is 65 percent Penistaja loam, 0 to 5 percent slopes, and 30 percent Travessilla very fine sandy loam, 0 to 15 percent slopes. The Penistaja soil is on mesas and plateaus. The Travessilla soil is on hills, breaks, and mesas.

Included in this unit are small areas of rock outcrop on ridges, hills, and breaks. Included areas make up about 5 percent of the total acreage.

The Penistaja soil is deep and well drained. It formed in alluvial and eolian material derived dominantly from sandstone and shale. Typically, the surface layer is brown loam about 3 inches thick. The subsoil is reddish brown clay loam about 21 inches thick. The substratum to a depth of 60 inches or more is light reddish brown and reddish yellow clay loam.

Permeability of the Penistaja soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

The Travessilla soil is very shallow and shallow and well drained. It formed in residuum derived dominantly from sandstone. Typically, the surface layer is pale brown very fine sandy loam about 2 inches thick. The substratum to a depth of 12 inches is brown very fine sandy loam. Sandstone is at a depth of 12 inches.

Permeability of the Travessilla soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 6 to 10 inches.

This unit is used for livestock grazing, woodland, recreation, and wildlife habitat.

The potential plant community on the Penistaja soil is mainly western wheatgrass, blue grama, galleta, and big sagebrush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, rabbitbrush, and annual forbs. Suitable grazing management systems are those that increase the production of western wheatgrass, blue grama, Indian ricegrass, and needleandthread.

The potential plant community on the Travessilla soil is mainly oneseed juniper, pinyon, sideoats grama, and blue grama. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are pinyon, oneseed juniper, broom snakeweed, and annual forbs. Suitable grazing management systems are those that increase the production of sideoats grama, blue grama, galleta, and needleandthread.

Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of access roads, trails, salting facilities, and fences.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. The Travessilla soil is not suited to range seeding or earthen structures because of very shallow and shallow soil depth.

This unit produces stands of oneseed juniper and pinyon; however, these stands on the Penistaja soil are invaders. This unit is well suited to the production of these species. It can produce about 11 cords of wood per acre in a stand of trees that averages 5 inches in diameter measured at a height of 1 foot. Deterioration of the stands of pinyon and juniper on this unit can be prevented by managing the trees for a combination of uses, including wood production.

The Penistaja soil is well suited to recreational development. The main limitation is slope.

The Travessilla soil is poorly suited to recreational development. The main limitations are very shallow and shallow soil depth, slope, and dustiness.

PX—Pits. Pits consists of areas from which gravel and borrow material have been removed. Areas are 5 acres or more in size. The largest pits in the survey area are near Navajo Dam.

This unit is used as a source of construction material and for wildlife habitat.

RA—Riverwash. Riverwash consists of areas of unstabliized sandy, silty, clayey, or gravelly sediment on flood plains, streambeds, and riverbeds and in arroyos. These areas support little or no vegetation because of frequent flooding and reworking by water. Slope is 0 to 3 percent. Elevation is 4,800 to 7,200 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

This unit is used as a source of construction material and for wildlife habitat.

RO—Rock outcrop. This map unit consists of exposures of barren sandstone on cliffs, breaks, bluffs, and ridges. Slope is 5 to 100 percent. Elevation is 4,800 to 7,200 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

This unit is used as a source of construction material and for wildlife habitat.

RT—Rock outcrop-Travessilla-Weska complex, extremely steep. This map unit is on hills, breaks, and mesas (fig. 7). Slope is 30 to 70 percent. The native vegetation is mainly pinyon and juniper. Elevation is 6,400 to 7,200 feet. The average annual precipitation is about 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 135 days.

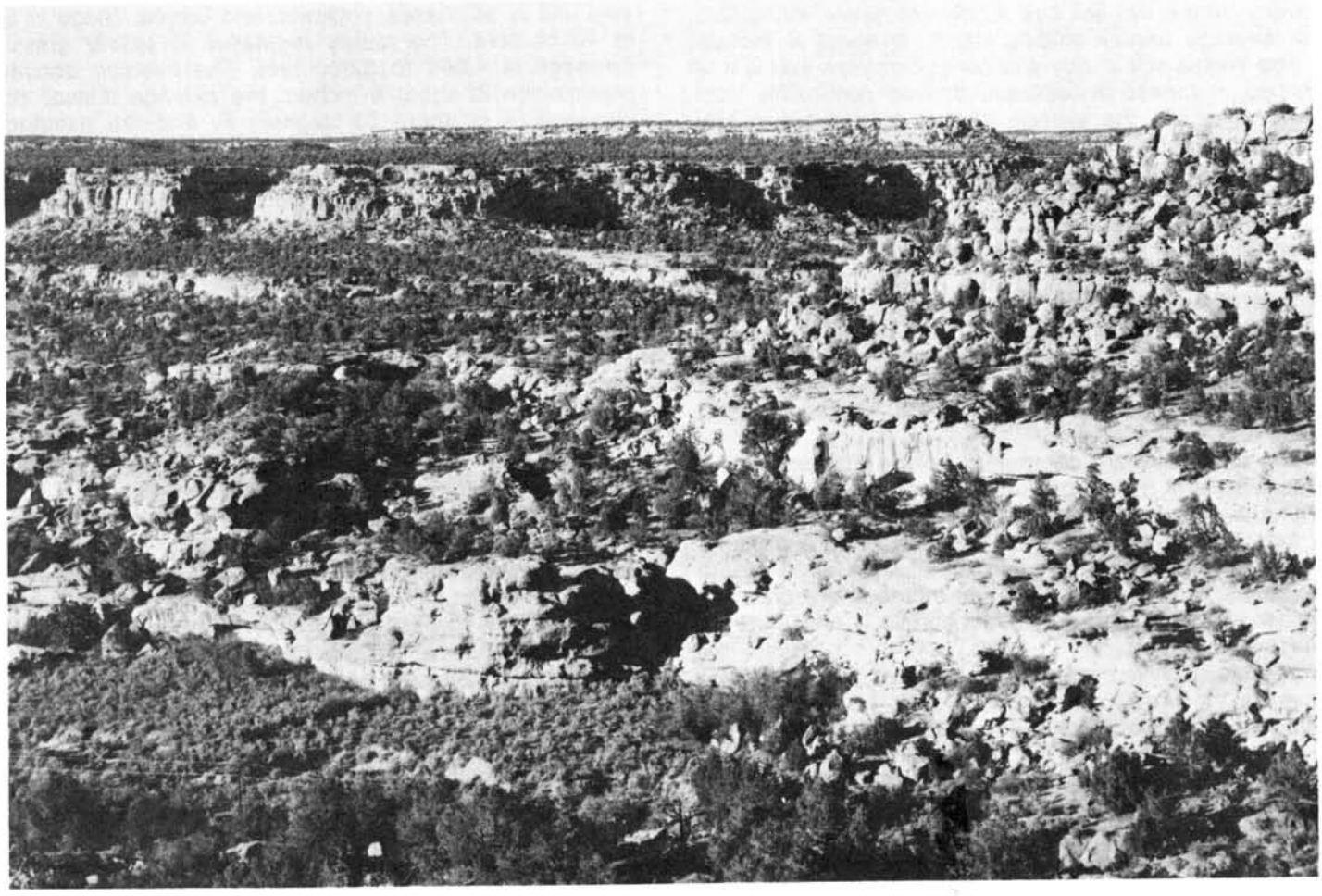

Figure 7.—Area of Rock outcrop-Travessilla-Weska complex, extremely steep.

This unit is 40 percent Rock outcrop, 40 to 70 percent slopes; 30 percent Travessilla sandy loam, 30 to 40 percent slopes; and 20 percent Weska silty clay loam, 30 to 40 percent slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Atrac and Twick soils on hills and rubble land at the bottom of steep slopes. Included areas make up about 10 percent of the total acreage.

Rock outcrop is exposed areas of barren sandstone.

The Travessilla soil is very shallow and shallow and is well drained. It formed in residuum derived dominantly from sandstone. Typically, the surface layer is pale brown sandy loam about 1 inch thick. The underlying material to a depth of 9 inches is pale brown sandy loam. Sandstone is at a depth of 9 inches.

Permeability of the Travessilla soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 8 inches.

The Weska soil is very shallow and shallow and is well drained. It formed in residuum derived dominantly from shale. Typically, the surface layer is grayish brown silty clay loam about 1 inch thick. The underlying material to a depth of 7 inches is grayish brown clay loam. Shale is at a depth of 7 inches.

Permeability of the Weska soil is moderately slow. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is very rapid, and the hazard of water erosion is very severe. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 6 to 8 inches.

This unit is used for livestock grazing, woodland, recreation, and wildlife habitat.

The potential plant community on the Travessilla and Weska soils is mainly oneseed juniper, pinyon, sideoats grama, and blue grama. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are oneseed juniper, big sagebrush, rabbitbrush, and broom snakeweed.

Suitable grazing management systems are those that increase the production of blue grama, sideoats grama, bluegrass, and bottlebrush squirreltail and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of access roads, trails, and fences and by herding.

This unit is suited to such range management practices as proper grazing use, planned grazing systems, and deferred grazing. It is not suited to range seeding, brush management, or earthen structures because of very shallow and shallow soil depth and slope.

The Travessilla and Weska soils produce stands of oneseed juniper and pinyon. The Weska soil is well suited to the production of these species. It can produce about 13 cords of wood per acre in a stand of trees that averages 5 inches in diameter measured at a height of 1 foot. The Travessilla soil is also well suited to the production of oneseed juniper and pinyon. It can produce about 11 cords of wood per acre in a stand of trees that averages 5 inches in diameter measured at a height of 1 foot.

Deterioration of the stands of pinyon and oneseed juniper on the soils in this unit can be prevented by managing the trees for a combination of uses, including wood production.

This unit is poorly suited to recreational development. The main limitations are very shallow and shallow soil depth and slope.

SB—Sheppard-Badland complex, very steep. This map unit is on mesas, plateaus, and breaks. Slope is 5 to 40 percent. The native vegetation is mainly grass. Elevation is 4,800 to 5,600 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 70 percent Sheppard loamy fine sand and 25 percent Badland. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Turley soils on fans and valley sides and rock outcrop. Included areas make up about 5 percent of the total acreage.

The Sheppard soil is deep and somewhat excessively drained. It formed in eolian material derived from mixed sources. Typically, the surface layer is light yellowish brown loamy fine sand about 2 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown loamy fine sand and fine sand.

Permeability of the Sheppard soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

Badland is nonstony, barren shale that is dissected by drainageways and gullies.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Sheppard soil is mainly Indian ricegrass, giant dropseed, alkali sacaton, and needleandthread. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are Mormon-tea, sandhill muhly, sand sagebrush, and broom snakeweed.

Suitable grazing management systems are those that increase the production of Indian ricegrass, alkali sacaton, giant dropseed, and fourwing saltbush and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of fences, water developments, and salting facilities and by herding.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of low precipitation.

SC—Sheppard-Huerfano-Notal complex, gently sloping. This map unit is on valley bottoms, fans, mesas, and plateaus (fig. 8). Slope is 0 to 8 percent. The native vegetation is mainly grass. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 40 percent Sheppard loamy fine sand, 2 to 8 percent slopes; 30 percent Huerfano sandy clay loam, 0 to 3 percent slopes; and 20 percent Notal clay loam, 0 to 2 percent slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Muff soils on fans and in swales and Turley and Uffens soils on fans and in valleys. Included areas make up about 10 percent of the total acreage.

The Sheppard soil is deep and somewhat excessively drained. It formed in eolian material derived from mixed sources. Typically, the surface layer is light brown loamy fine sand about 5 inches thick. The underlying material to a depth of 60 inches or more is light brown loamy fine sand and fine sand.

Permeability of the Sheppard soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

The Huerfano soil is shallow and well drained. It formed in alluvium and residuum derived dominantly from shale and siltstone. Typically, the surface layer is light yellowish brown sandy clay loam about 1 inch thick. The subsurface layer is light gray sandy clay loam about 1 inch thick. The subsoil is brown, dark yellowish brown, and yellowish brown clay loam and sandy clay loam about 13 inches thick. Shale is at a depth of 15 inches.

Permeability of the Huerfano soil is moderately slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is high. The estimated content of exchangeable sodium is about 25 to 75 percent. Where this soil has a cover of native vegetation, the average annual wetting depth is about 8 inches. This soil is strongly saline.

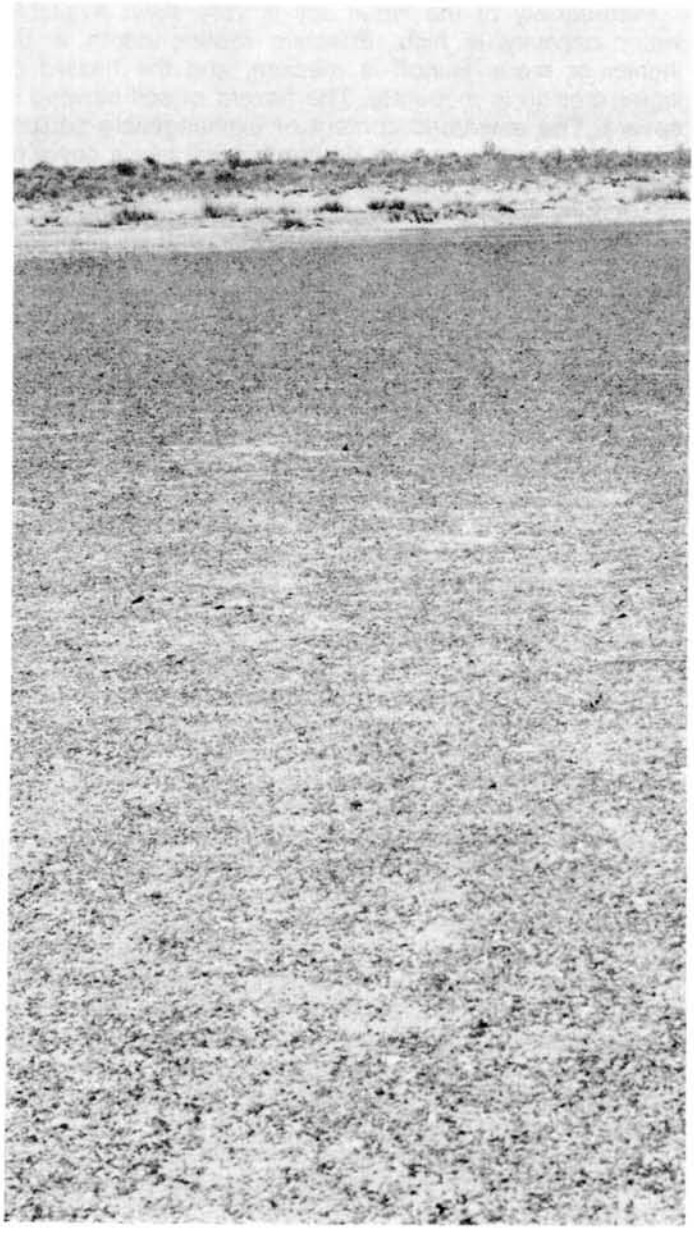

Figure 8.—Area of Sheppard-Huerfano-Notal complex, gently sloping. Huerfano soil in foreground and Sheppard soils in background.

The Notal soil is deep and well drained. It formed in alluvium derived dominantly from shale. Typically, the surface layer is grayish brown clay loam about 3 inches thick. The subsoil is grayish brown clay about 20 inches thick. The substratum to a depth of 60 inches or more is grayish brown clay.

Permeability of the Notal soil is very slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. The estimated content of exchangeable sodium is about 15 to 60 percent. Where this soil has a cover of native vegetation, the average annual wetting depth is about 6 inches. This soil is slightly saline.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Sheppard soil is mainly alkali sacaton, giant dropseed, needleandthread, and Indian ricegrass. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are sandhill muhly, Mormon-tea, broom snakeweed, and annual forbs. Suitable grazing management systems are those that increase the production of Indian ricegrass, alkali sacaton, giant dropseed, and needleandthread.

The potential plant community on the Huerfano soil is mainly alkali sacaton, fourwing saltbush, galleta, and black greasewood. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are black greasewood, big sagebrush, threeawn, and broom snakeweed. Suitable grazing management systems are those that increase the production of alkali sacaton, fourwing saltbush, and galleta.

The potential plant community on the Notal soil is mainly alkali sacaton, galleta, shadscale, and western wheatgrass. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are black greasewood, big sagebrush, broom snakeweed, and annual forbs. Suitable grazing management systems are those that increase the production of alkali sacaton, western wheatgrass, and galleta.

Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Soil blowing can be controlled and damage to seedlings reduced by maintaining residue on the surface of the soil. Proper distribution of livestock grazing generally can be accomplished by the placement of salting facilities, fencing, and wells and by herding.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of low precipitation. The Notal soil has limited suitability for earthen structures because of the high content of sodium.

Sd—Sheppard-Mayqueen-Shiprock complex, 0 to 8 percent slopes. This map unit is on mesas and plateaus. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 45 percent Sheppard loamy fine sand, 5 to 8 percent slopes; 30 percent Mayqueen loamy fine sand, 2 to 8 percent slopes; and 20 percent Shiprock fine sandy loam, 0 to 5 percent slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Avalon and Shiprock Variant soils on mesas and plateaus throughout the unit. Included areas make up about 5 percent of the total acreage.

The Sheppard soil is deep and somewhat excessively drained. It formed in eolian material derived from mixed sources. Typically, the surface layer is light brown loamy fine sand about 1 inch thick. The underlying material to a depth of 62 inches or more is light brown loamy fine sand and fine sand.

Permeability of the Sheppard soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

The Mayqueen soil is deep and somewhat excessively drained. It formed in alluvial and eolian material derived from mixed sources. Typically, the surface layer is brown loamy fine sand about 3 inches thick. The subsoil is reddish brown fine sandy loam about 9 inches thick. The substratum to a depth of 60 inches or more is light brown and light yellowish brown loamy fine sand and loamy sand.

Permeability of the Mayqueen soil is rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 20 inches.

The Shiprock soil is deep and well drained. It formed in alluvial and eolian material derived dominantly from sandstone and shale. Typically, the surface layer is brown fine sandy loam about 1 inch thick. The subsoil is brown fine sandy loam about 9 inches thick. The substratum to a depth of 60 inches or more is light brown, very pale brown, and pale brown fine sandy loam and sandy loam.

Permeability of the Shiprock soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 20 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are

small grain and corn. Some areas are used for livestock grazing, urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slope, the hazard of soil blowing, and droughtiness.

Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff and soil blowing and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

The potential plant community on the Sheppard and Mayqueen soils is mainly giant dropseed, alkali sacaton, Indian ricegrass, and needleandthread. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred forage plants increases. Among the plants that increase are sandhill muhly, Mormon-tea, broom snakeweed, and annual forbs. Suitable grazing management systems are those that increase the production of Indian ricegrass, alkali sacaton, giant dropseed, and needleandthread.

The potential plant community on the Shiprock soil is mainly Indian ricegrass, blue grama, fourwing saltbush, and big sagebrush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are big sagebrush, broom snakeweed, galleta, and annual forbs. Suitable grazing management systems are those that increase the production of Indian ricegrass, blue grama, and fourwing saltbush.

Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Soil blowing can be controlled and damage to seedlings reduced by maintaining residue on the surface of the soil. Proper distribution of livestock grazing generally can be accomplished by the placement of ponds, pipelines, and fences and by herding.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of low precipitation.

This unit is moderately well suited to urban development. The very severe hazard of soil blowing is a limitation. Slope is a limitation for small commercial buildings. Seepage is a limitation for sewage lagoon areas.

If this unit is irrigated, it is suited to windbreaks. The main limitation is the hazard of soil blowing. Among the trees that are suitable for planting are Lombardy poplar, Rocky Mountain juniper, Russian-olive, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

Sh—Shiprock loamy fine sand, 0 to 2 percent slopes. This deep, well drained soil is on mesas and plateaus. It formed in alluvial and eolian material derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown very loamy fine sand about 10 inches thick. The subsoil is brown fine sandy loam about 10 inches thick. The substratum to a depth of 60 inches or more is brown and very pale brown sandy loam and fine sandy loam.

Included in this unit are small areas of Sheppard and Mayqueen soils on mesas and plateaus throughout the unit. Included areas make up about 15 percent of the total acreage.

Permeability of this Shiprock soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is 20 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are small grain, corn, and fruit. Some areas are used for livestock grazing, urban development, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are the hazard of soil blowing and droughtiness.

Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

The potential plant community is mainly Indian ricegrass, giant dropseed, sand bluestem, and little bluestem. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, Mormon-tea, sandhill muhly, and annual forbs.

Suitable grazing management systems are those that increase the production of sand bluestem, little bluestem, Indian ricegrass, and giant dropseed and that vary the period of use from year to year. Use of such systems

helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of water developments, fencing, and salting facilities and by herding.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of the hazard of soil blowing and low precipitation.

This unit is well suited to urban development. The main limitation is the very severe hazard of soil blowing. Seepage is a limitation for sewage lagoon areas.

Sk—Shiprock loamy fine sand, 2 to 5 percent slopes. This deep, well drained soil is on mesas and plateaus. It formed in alluvial and eolian material derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown loamy fine sand about 9 inches thick. The subsoil is brown fine sandy loam about 10 inches thick. The substratum to a depth of 60 inches or more is brown fine sandy loam and sandy loam.

Included in this unit are small areas of Sheppard and Mayqueen soils on mesas and plateaus throughout the unit. Included areas make up about 15 percent of the total acreage.

Permeability of this Shiprock soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 19 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn, small grain, and fruit. Some areas are used for livestock grazing, urban development, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slope, the hazard of soil blowing, and droughtiness.

Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

The potential plant community is mainly Indian ricegrass, giant dropseed, sand bluestem, and little bluestem. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, Mormon-tea, sandhill muhly, and annual forbs.

Suitable grazing management systems are those that increase the production of sand bluestem, little bluestem, giant dropseed, and Indian ricegrass and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of water developments, fencing, and salting facilities and by herding.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of the hazard of soil blowing and low precipitation.

This unit is well suited to urban development. The main limitation is the very severe hazard of soil blowing. Seepage is a limitation for sewage lagoon areas.

Sm—Shiprock fine sandy loam, 0 to 2 percent slopes. This deep, well drained soil is on mesas and plateaus. It formed in alluvial and eolian material derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is pale brown fine sandy loam about 2 inches thick. The subsoil is pale brown and brown fine sandy loam about 12 inches thick. The substratum to a depth of 60 inches or more is brown and light yellowish brown fine sandy loam and sandy loam.

Included in this unit are small areas of Mayqueen and Avalon soils on mesas and plateaus and Doak soils on mesas, plateaus, and terraces. Included areas make up about 10 percent of the total acreage.

Permeability of this Shiprock soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. Where this soil has a cover of native plant vegetation, the average annual wetting depth is about 15 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn, small grain, and fruit. Some areas are used for livestock grazing, urban development, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are droughtiness and the hazard of soil blowing.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. Sprinkler irrigation is the

most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

The potential plant community is mainly Indian ricegrass, blue grama, fourwing saltbush, and big sagebrush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, threeawn, and annual forbs.

Suitable grazing management systems are those that increase the production of Indian ricegrass, blue grama, fourwing saltbush, and giant dropseed and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of water developments, fencing, and salting facilities and by herding.

This soil is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of low precipitation and the hazard of soil blowing.

This unit is well suited to urban development. The main limitation is the severe hazard of soil blowing. Seepage is a limitation for sewage lagoon areas.

So—Shiprock fine sandy loam, 2 to 5 percent slopes. This deep, well drained soil is on mesas and plateaus. It formed in alluvial and eolian material derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown fine sandy loam about 4 inches thick. The subsoil is brown fine sandy loam about 11 inches thick. The substratum to a depth of 60 inches or more is pale brown and very pale brown sandy loam and fine sandy loam.

Included in this unit are small areas of Avalon, Sheppard, and Shiprock Variant soils on mesas and plateaus throughout the unit. Included areas make up about 10 percent of the total acreage.

Permeability of this Shiprock soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 15 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn, small grain, and fruit. Some areas are used for livestock grazing, urban development, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slope, the hazard of soil blowing, and droughtiness.

Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

The potential plant community is mainly Indian ricegrass, blue grama, fourwing saltbush, and big sagebrush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, threeawn, and annual forbs.

Suitable grazing management systems are those that increase the production of Indian ricegrass, blue grama, giant dropseed, and fourwing saltbush and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of water developments, fencing, and salting facilities and by herding.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of low precipitation and the hazard of soil blowing.

This unit is well suited to urban development. The main limitation is the severe hazard of soil blowing. Seepage is a limitation for sewage lagoon areas.

Sp—Shiprock fine sandy loam, 5 to 8 percent slopes. This deep, well drained soil is on mesas and plateaus. It formed in alluvial and eolian material derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is pale brown fine sandy loam about 3 inches thick. The subsoil is brown fine

sandy loam about 9 inches thick. The substratum to a depth of 60 inches or more is light brown, pale brown, and very pale brown fine sandy loam and sandy loam.

Included in this unit are small areas of Mayqueen and Sheppard soils on mesas and plateaus and Avalon soils on ridges. Included areas make up about 15 percent of the total acreage.

Permeability of this Shiprock soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 15 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn and small grain. Some areas are used for livestock grazing, urban development, recreation, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slope, droughtiness, and the hazard of soil blowing.

Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

The potential plant community is mainly Indian ricegrass, blue grama, fourwing saltbush, and big sagebrush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, threeawn, and annual forbs.

Suitable grazing management systems are those that increase the production of Indian ricegrass, blue grama, fourwing saltbush, and giant dropseed and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of water developments, fencing, and salting facilities and by herding.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding because of low precipitation and the hazard of soil blowing.

This unit is well suited to urban development. The severe hazard of soil blowing is a limitation. Slope is a limitation for small commercial buildings. Seepage is a limitation for sewage lagoon areas.

This unit is moderately well suited to recreational development. The main limitation is slope.

Sr—Shiprock Variant fine sandy loam. This deep, well drained soil is on mesas and plateaus. It formed in alluvium derived dominantly from shale and sandstone. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 5,600 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is yellowish brown fine sandy loam about 3 inches thick. The upper part of the subsoil is brown fine sandy loam about 5 inches thick. The lower part is light brown sandy clay loam about 16 inches thick. The substratum to a depth of 68 inches is very pale brown and light yellowish brown sandy clay loam and sandy loam.

Included in this unit are small areas of Shiprock soils throughout the unit and Avalon soils on ridges. Included areas make up about 5 percent of the total acreage.

Permeability of this Shiprock Variant soil is moderate to a depth of 48 inches and moderately rapid below this depth. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 20 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and corn. Among the other crops are pasture, small grain, and fruit. Some areas are used for livestock grazing, urban development, recreation, and wildlife habitat.

If this unit is used for irrigated crops, the main limitation is the hazard of soil blowing.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate. Excess lime causes chlorosis in some plants.

The potential plant community is mainly Indian ricegrass, blue grama, needleandthread, and giant dropseed. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, big sagebrush, threeawn, and rabbitbrush.

Suitable grazing management systems are those that increase the production of Indian ricegrass, blue grama,

needleandthread, and giant dropseed and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of fencing, salting facilities, and water developments and by herding.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding or brush management, because of low precipitation and the hazard of soil blowing.

This unit is well suited to urban development. The main limitation for roads and streets is low soil strength. Moderate permeability is a limitation for septic tank absorption fields. Seepage is a limitation for sewage lagoon areas.

This unit is well suited to recreational development. It has few limitations.

St—Stumble loamy sand, 0 to 3 percent slopes. This deep, somewhat excessively drained soil is on fans and valley sides. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is yellowish brown loamy sand about 5 inches thick. The upper 24 inches of the underlying material is pale brown and light yellowish brown sand and loamy sand. The lower part to a depth of 81 inches is brownish yellow gravelly sand, gravelly loamy sand, and sand.

Included in this unit are small areas of Fruitland soils throughout the unit. Included areas make up about 10 percent of the total acreage.

Permeability of this Stumble soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn and small grain. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are droughtiness, seepage, slope, and the hazard of soil blowing.

Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

This unit is well suited to urban development. The main limitation is the low stability of the soil in trenches. Seepage is a limitation for sewage lagoon areas.

If this unit is irrigated, it is suited to windbreaks. The main limitations are low available water capacity and the hazard of soil blowing. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, Rocky Mountain juniper, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

Su—Stumble loamy sand, 3 to 8 percent slopes. This deep, somewhat excessively drained soil is on fans and valley sides. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is yellowish brown very loamy sand about 5 inches thick. The upper 44 inches of the underlying material is light yellowish brown and pale brown loamy sand and sand. The lower part to a depth of 81 inches is brownish yellow gravelly sand and sand.

Included in this unit are small areas of Fruitland soils throughout the unit and Blackston and Avalon soils on valley sides. Included areas make up about 10 percent of the total acreage.

Permeability of this Stumble soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn and small grain. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are droughtiness, seepage, slope, and the hazard of soil blowing.

Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

This unit is well suited to urban development. The main limitation is the low stability of the soil in cuts. Seepage is a limitation for sewage lagoon areas.

If this unit is irrigated, it is suited to windbreaks. The main limitations are low available water capacity and the hazard of soil blowing. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, blue spruce, and Austrian pine. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

SV—Stumble sandy clay loam, gently sloping. This deep, somewhat excessively drained soil is on fans and valley sides. It formed in alluvium derived dominantly from sandstone and shale. Slope is 0 to 5 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,400 feet. The average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is brown sandy clay loam about 7 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown sand.

Included in this unit are small areas of Fruitland soils throughout the unit. Included areas make up about 10 percent of the total acreage.

Permeability of this Stumble soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn and small grain. Some areas are used for urban development, windbreaks, recreation, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are droughtiness, seepage, and slope.

Sprinkler irrigation is the most suitable method of applying water. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

This unit is well suited to urban development. The main limitation is the low stability of the soil in cuts. Seepage is a limitation for sewage lagoon areas.

If this unit is irrigated, it is suited to windbreaks. The main limitation is low available water capacity. Among the trees that are suitable for planting are Lombardy poplar, Rocky Mountain juniper, blue spruce, and Austrian pine. Among the shrubs are multiflora rose, New Mexico forestiera, and autumn-olive.

This unit is suited to recreational development. The main limitation is the sandy clay loam surface layer.

SW—Stumble-Fruitland association, gently sloping. This map unit is on fans and valley sides. Slope is 0 to 8 percent. The native vegetation is mainly grass. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 40 percent Stumble loamy sand and 30 percent Fruitland sandy loam.

Included in this unit are small areas of Turley soils on fans and valley sides and Blancot soils on fans and in upland valleys. Included areas make up about 30 percent of the total acreage.

The Stumble soil is deep and somewhat excessively drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown loamy sand about 6 inches thick. The upper 23 inches of the underlying material is light yellowish brown and pale brown loamy sand and sand. The lower part to a depth of 60 inches is brownish yellow gravelly sand.

Permeability of the Stumble soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight to none. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 30 inches.

The Fruitland soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown sandy loam about 7 inches thick. The underlying material to a depth of 60 inches or more is pale brown and light yellowish brown sandy loam.

Permeability of the Fruitland soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 24 inches.

This unit is used for livestock grazing, windbreaks, and wildlife habitat.

The potential plant community on the Stumble soil is mainly Indian ricegrass, giant dropseed, sand dropseed, and alkali sacaton. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, sand sagebrush, sandhill muhly, and Mormon-tea. Suitable grazing management systems are those that increase the production of giant dropseed, Indian ricegrass, alkali sacaton, and bottlebrush squirreltail.

The potential plant community on the Fruitland soil is mainly Indian ricegrass, blue grama, fourwing saltbush, and big sagebrush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, rabbitbrush, threeawn, and annual forbs.

Suitable grazing management systems are those that increase the production of Indian ricegrass, blue grama, fourwing saltbush, and galleta.

Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of fencing, salting facilities, and water developments and by herding.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding or brush management because of low precipitation and the hazard of soil blowing.

If this unit is irrigated, it is suited to windbreaks. The main limitations are the hazard of soil blowing and droughtiness on the Stumble soil. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, blue spruce, and Austrian pine. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

SX—Stumble-Notal complex, gently sloping. This map unit is on valley sides, valley bottoms, and fans. Slope is 0 to 8 percent. The native vegetation is mainly grass. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 55 percent Stumble loamy sand, 0 to 8 percent slopes and 30 percent Notal clay loam, 0 to 2 percent slopes. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Fruitland, Turley, and Uffens soils that occur throughout the unit. Included areas make up about 15 percent of the total acreage.

The Stumble soil is deep and somewhat excessively drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is yellowish brown loamy sand about 3 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown and pale brown loamy sand and sand.

Permeability of the Stumble soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight to none. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 30 inches.

The Notal soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is grayish brown clay loam about 4 inches thick. The subsoil is grayish brown clay loam about 20 inches thick. The substratum to a depth of 60 inches or more is grayish brown clay.

Permeability of the Notal soil is very slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. The estimated content of exchangeable sodium is about 15 to 60 percent. Where this soil has a cover of native vegetation, the average annual wetting depth is about 12 inches.

This unit is used for livestock grazing and wildlife habitat.

The potential plant community on the Stumble soil is mainly Indian ricegrass, giant dropseed, alkali sacaton, and sand sagebrush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are broom snakeweed, sand sagebrush, Mormon-tea, and sandhill muhly. Suitable grazing management systems are those that increase the production of giant dropseed, Indian ricegrass, alkali sacaton, and bottlebrush squirreltail.

The potential plant community on the Notal soil is mainly alkali sacaton, galleta, fourwing saltbush, and western wheatgrass. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are big sagebrush, rabbitbrush, shadscale, and black greasewood. Suitable grazing management systems are those that increase the production of alkali sacaton, fourwing saltbush, galleta, and western wheatgrass.

Grazing management systems should vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the placement of fencing, pipelines, and wells and by herding.

Soil blowing can be controlled and damage to seedlings reduced by maintaining residue on the surface of the soil.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to range seeding or brush management because of low precipitation and the hazard of soil blowing. The Notal soil has limited suitability for earthen structures because of the high content of sodium.

SZ—Stumble-Slickspots complex, gently sloping. This map unit is on valley sides and fans. Slope is 0 to 5 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,400 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 70 percent Stumble loamy sand, 0 to 5 percent slopes, and 20 percent Slickspots. The components of this unit are so intricately intermingled that it

was not practical to map them separately at the scale used.

Included in this unit are small areas of Fruitland soils throughout the unit. Included areas make up about 10 percent of the total acreage.

The Stumble soil is deep and somewhat excessively drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is yellowish brown loamy sand about 4 inches thick. The underlying material to a depth of 60 inches or more is pale brown and light yellowish brown sand and loamy sand.

Permeability of the Stumble soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 30 inches.

Slickspots are strongly affected by alkali. The estimated content of exchangeable sodium is 25 to 75 percent. The surface layer is easily puddled and crusted. Slickspots are circular areas 4 to 10 feet in diameter. They support little if any vegetation.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops are corn and small grain. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are droughtiness, seepage, slope, and the hazard of soil blowing.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Applications of gypsum or sulfur can reduce the content of sodium and increase the permeability of Slickspots. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to application of nitrogen. Legumes respond to phosphate.

The Stumble soil is well suited to urban development. The main limitation is the low stability of the soil in cuts. Seepage is a limitation for sewage lagoon areas.

Slickspots are poorly suited to urban development. The main limitations are the high content of sodium and slow permeability. Applications of gypsum and sulfur can reduce the content of sodium and increase the permeability of Slickspots.

If this unit is irrigated, it is suited to windbreaks. If the Stumble soil is used for windbreaks, the main limitations are low available water capacity and the hazard of soil blowing. If Slickspots are used for windbreaks, the main limitations are the high content of sodium, slow permeability, and low available water capacity. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, Rocky Mountain juniper, and blue spruce. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

TA—Travessilla-Weska-Rock outcrop complex, moderately steep. This map unit is on upland hills, breaks, and mesas. Slope is 0 to 30 percent. The native vegetation is mainly pinyon, juniper, and grass. Elevation is 6,400 to 7,200 feet. The average annual precipitation is about 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 135 days.

This unit is 40 percent Travessilla sandy loam, 30 percent Weska clay loam, and 25 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Buckle soils in upland valleys and on fans, Penistaja soils on mesas and plateaus, Twick soil on hills, and alluvial deposits of gravel and cobbles in drainageways. Included areas make up about 5 percent of the total acreage.

The Travessilla soil is very shallow and shallow and is well drained. It formed in residuum derived dominantly from sandstone. Typically, the surface layer is brown sandy loam about 2 inches thick. The underlying material to a depth of 12 inches is brown sandy loam. Sandstone is at a depth of 12 inches.

Permeability of the Travessilla soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is 6 to 12 inches.

The Weska soil is very shallow and shallow and is well drained. It formed in residuum derived dominantly from shale. Typically, the surface layer is grayish brown clay loam about 1 inch thick. The underlying material to a depth of 9 inches is light olive brown clay loam. Shale is at a depth of 9 inches.

Permeability of the Weska soil is moderately slow. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is rapid, and the hazard of water erosion is high. The hazard of soil blowing is moderate. Where this soil has a cover of native vegetation, the average annual wetting depth is 6 to 9 inches.

Rock outcrop is exposures of barren sandstone on benches, ridges, and breaks.

This unit is used for livestock grazing, woodland, recreation, and wildlife habitat.

The potential plant community on the Travessilla and Weska soils is mainly oneseed juniper, pinyon, sideoats grama, and antelope bitterbrush. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase

are broom snakeweed, big sagebrush, oneseed juniper, and pinyon.

Suitable grazing management systems are those that increase the production of antelope bitterbrush, sideoats grama, needleandthread, and muttongrass and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the use of access roads, herding, salting, and fencing.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. It is not suited to water developments or range seeding because of very shallow and shallow soil depth and moderately steep slopes.

This unit produces stands of pinyon and oneseed juniper. The Travessilla soil is suited to the production of these species. It can produce about 11 cords of wood per acre in a stand of trees that averages 5 inches in diameter measured at a height of 1 foot. The Weska soil is well suited to the production of timber. It can produce about 13 cords of wood per acre in a stand of trees that averages 5 inches in diameter measured at a height of 1 foot.

Deterioration of the stands of pinyon and juniper on the soils in this unit can be prevented by managing them for a combination of uses, including wood production.

This unit is poorly suited to recreational development. The main limitations are very shallow and shallow soil depth and moderately steep slopes.

Tp—Turley clay loam, 0 to 1 percent slopes. This deep, well drained soil is on valley sides and fans. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is grayish brown clay loam about 3 inches thick. The underlying material to a depth of 80 inches is grayish brown, light brownish gray, and light yellowish brown clay loam.

Included in this unit are small areas of Fruitland soils throughout the unit. Included areas make up about 5 percent of the total acreage.

Permeability of this Turley soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average wetting depth is about 15 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops grown are corn, small grain, and fruit. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitation is the hazard of soil blowing.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to nitrogen. Legumes respond to phosphate.

This unit is suited to urban development. The main limitations for buildings and roads are low soil strength and moderate shrink-swell potential.

Roads should be designed to offset the limited ability of the soil to support traffic. If buildings are constructed on this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage as a result of shrinking and swelling and low soil strength.

The main limitation for septic tank absorption fields is moderately slow permeability. This limitation can be overcome by increasing the size of the absorption field.

If this unit is irrigated, it is suited to windbreaks. The main limitations are moderately slow permeability and the hazard of soil blowing. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, blue spruce, and Austrian pine. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

Tr—Turley clay loam, 1 to 3 percent slopes. This deep, well drained soil is on valley sides and fans. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is grayish brown clay loam about 9 inches thick. The underlying material to a depth of 60 inches or more is light brownish gray clay loam.

Included in this unit are small areas of Fruitland soils throughout the unit. Included areas make up about 5 percent of the total acreage.

Permeability of this Turley soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 15 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops grown are corn and small grain. Some areas are used for urban development, recreation, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slope and the hazard of soil blowing.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to nitrogen. Legumes respond to phosphate.

This unit is suited to urban development. The main limitations for buildings and roads are low soil strength and moderate shrink-swell potential.

Roads should be designed to offset the limited ability of the soil to support traffic. If buildings are constructed on this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage as a result of shrinking and swelling and low soil strength.

The main limitation for septic tank absorption fields is moderately slow permeability. This limitation can be overcome by increasing the size of the absorption field.

This unit is well suited to recreational development. The main limitation is the clay loam surface layer.

If this unit is irrigated, it is suited to windbreaks. The main limitations are moderately slow permeability and the hazard of soil blowing. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, blue spruce, and Austrian pine. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

Ts—Turley clay loam, 3 to 5 percent slopes. This deep, well drained soil is on valley sides and fans. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is grayish brown clay loam about 4 inches thick. The underlying material to a depth of 60 inches or more is pale yellow clay loam.

Included in this unit are small areas of Fruitland soils along the edges of mapped areas. Included areas make up about 5 percent of the total acreage.

Permeability of this Turley soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 12 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops grown are corn and small grain. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are slope and the hazard of soil blowing.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to nitrogen. Legumes respond to phosphate.

This unit is suited to urban development. The main limitations for buildings and roads are low soil strength and moderate shrink-swell potential.

Roads should be designed to offset the limited ability of the soil to support traffic. If buildings are constructed on this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage as a result of shrinking and swelling and low soil strength.

The main limitation for septic tank absorption fields is moderately slow permeability. This limitation can be overcome by increasing the size of the absorption field.

If this unit is irrigated, it is suited to windbreaks. The main limitations are moderately slow permeability and the hazard of soil blowing. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, blue spruce, and Austrian pine. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

Tt—Turley clay loam, wet, 0 to 2 percent slopes. This deep, somewhat poorly drained soil is on fans. It formed in alluvium derived dominantly from sandstone and shale. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is grayish brown clay loam about 9 inches thick. The underlying material to a depth of 60 inches or more is light olive brown and light yellowish brown clay loam.

Included in this unit are small areas of Fruitland soils, wet, that occur throughout the unit. Included areas make up about 5 percent of the total acreage.

Permeability of this Turley soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. A seasonal high water table is at a depth of 24 to 60 inches during the irrigation season.

Where this soil has a cover of native vegetation, the average annual wetting depth is about 12 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops grown are corn and small grain. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are wetness and the hazard of soil blowing. The selection of crops that can be grown is limited by the seasonal high water table. The water table can be lowered by installing an adequate drainage system. Most climatically adapted crops can be grown if artifical drainage is provided.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to nitrogen. Legumes respond to phosphate.

This unit is poorly suited to urban development. The main limitations for buildings and roads are low soil strength, moderate shrink-swell potential, and the seasonal high water table.

Roads should be designed to offset the limited ability of the soil to support traffic. If buildings are constructed on this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage as a result of shrinking and swelling and low soil strength. Deep drainage reduces wetness.

The main limitations for septic tank absorption fields are moderately slow permeability and the seasonal high water table. These limitations are difficult to overcome.

If this unit is irrigated, it is suited to windbreaks. The main limitations are moderately slow permeability, the hazard of soil blowing, and wetness. The selection of trees and shrubs is limited to those that tolerate the seasonal high water table.

Tv—Turley-Slickspots complex, 0 to 3 percent slopes. This map unit is on fans. Slope is 0 to 3 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

This unit is 70 percent Turley clay loam, 0 to 3 percent slopes, and 20 percent Slickspots. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Fruitland soils that occur throughout the unit. Included areas make up about 10 percent of the total acreage.

The Turley soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is grayish brown clay loam about 8 inches thick. The underlying material to a depth of 60 inches or more is light yellowish brown clay loam.

Permeability of the Turley soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. Where this soil has a cover of native vegetation, the average annual wetting depth is about 10 inches.

Slickspots are strongly affected by alkali. The estimated content of exchangable sodium is 25 to 75 percent. The surface layer is slowly permeable and is easily puddled. Slickspots are circular areas 4 to 10 feet in diameter. They support little if any vegetation.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops grown are corn and small grain. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are the high content of sodium and slow permeability of Slickspots and the hazard of soil blowing on the Turley soil.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. If furrow or corrugation irrigation systems are used, runs should be on the contour or across the slope. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Gypsum or sulfur can be used to reduce the content of sodium and thus increase the permeability of Slickspots. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to nitrogen. Legumes respond to phosphate.

The Turley soil is suited to urban development. The main limitations for buildings and roads are low soil strength and moderate shrink-swell potential. Roads should be designed to offset the limited ability of the soil to support traffic. If buildings are constructed on this soil, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage as a result of shrinking and swelling and low soil strength.

The main limitation for septic tank absorption fields is moderately slow permeability. This limitation can be overcome by increasing the size of the absorption field.

Slickspots are poorly suited to urban development. The main limitations, in addition to those for the Turley soil, are the high content of sodium and slow permeability. Gypsum or sulfur can be used to reduce the content of sodium and thus increase the permeability of Slickspots.

If this unit is irrigated, it is suited to windbreaks. The main limitations of the Turley soil are moderately slow

permeability and the hazard of soil blowing. The main limitations of Slickspots are the high content of sodium and slow permeability. Among the trees that are suitable for planting are Lombardy poplar, Russian-olive, blue spruce, and Austrian pine. Among the shrubs are multiflora rose, autumn-olive, and New Mexico forestiera.

TW—Twick-Silver association, moderately sloping. This map unit is on hills (fig. 9). Slope is 0 to 25 percent. The native vegetation is mainly pinyon, juniper, and grass. Elevation is 6,400 to 7,200 feet. The average annual precipitation is about 12 inches, the average annual air temperature is about 50 degrees F, and the average frost-free period is about 135 days.

This unit is 55 percent Twick cobbly silty clay loam, 0 to 25 percent slopes, and 35 percent Silver cobbly silty clay loam, 0 to 10 percent slopes.

Included in this unit are small areas of Buckle soils on fans and in upland valleys, Penistaja soils on mesas and plateaus, and Rock outcrop on ledges and breaks. Included areas make up about 10 percent of the total acreage.

Figure 9.—Area of Twick-Silver association, moderately sloping. Cobbles are on the surface.

The Twick soil is shallow and well drained. It formed in alluvium and residuum derived dominantly from shale. Typically, the surface layer is brown cobbly silty clay loam about 1 inch thick. The upper part of the subsoil is brown cobbly clay loam about 3 inches thick. The lower part is brown clay about 13 inches thick. Shale is at a depth of 17 inches.

Permeability of the Twick soil is slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight. Where this soil has a cover of native vegetation, the average annual wetting depth is about 17 inches.

The Silver soil is deep and well drained. It formed in alluvium and residuum derived dominantly from shale. Typically, the surface layer is reddish gray cobbly silty clay loam about 2 inches thick. The upper 2 inches of the subsoil is reddish gray cobbly silty clay loam. The lower 24 inches is reddish brown clay. The substratum to a depth of 60 inches or more is reddish gray clay.

Permeability of the Silver soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight. Where this soil has a cover of native vegetation, the average annual wetting depth is about 13 inches.

This unit is used for livestock grazing, woodland, recreation, and wildlife habitat.

The potential plant community is mainly oneseed juniper, pinyon, antelope bitterbrush, and sideoats grama. As the potential plant community deteriorates, the proportion of preferred forage plants decreases and the proportion of less preferred plants increases. Among the plants that increase are big sagebrush, broom snakeweed, pinyon, and oneseed juniper.

Suitable grazing management systems are those that increase the production of sideoats grama, muttongrass, antelope bitterbrush, and blue grama and that vary the period of use from year to year. Use of such systems helps to produce a balanced plant community that provides a variety of desirable forage plants throughout the year. Proper distribution of livestock grazing generally can be accomplished by the use of fencing, herding, salting, and access roads.

This unit is suited to such range management practices as deferred grazing, proper grazing use, and planned grazing systems. The Twick soil is not suited to range seeding or range renovation because of shallow soil depth and the cobbly surface layer.

This unit produces stands of pinyon and oneseed juniper. It is suited to the production of these species. It can produce about 12 cords of wood per acre in a stand of trees that averages 5 inches in diameter measured at a height of 1 foot. Deterioration of the stands of pinyon and oneseed juniper on this unit can be prevented by managing them for a combination of uses, including wood production.

This unit is poorly suited to recreational development. The main limitations of the Twick soil are the moderately steep slopes, shallow depth to bedrock, and large stones. The main limitation of the Silver soil is the large stones in the surface layer.

Wa—Walrees loam. This moderately deep, somewhat poorly drained soil is on flood plains and terraces. It formed in alluvium derived from mixed sources. Slope is 0 to 2 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is grayish brown loam about 6 inches thick. The upper 24 inches of the substratum is light brownish gray loam. The lower part to a depth of 81 inches is multicolored, stratified sand, gravel, and cobbles.

Included in this unit are small areas of Green River and Werlog soils and a wet soil that is shallow to gravel. Included areas make up about 30 percent of the total acreage, and they are throughout the unit.

Permeability of this Walrees soil is moderately slow to a depth of 30 inches and very rapid below this depth. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. A seasonal high water table is at a depth of 24 to 60 inches during the irrigation season. This soil is subject to frequent, brief periods of flooding from June through September. Where the soil has a cover of native vegetation, the average annual wetting depth is about 15 inches. This soil is slightly saline.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops grown are corn, vegetables, and fruit. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are the hazard of flooding and wetness. The selection of crops that can be grown is limited by the seasonal high water table and by the salinity and alkalinity of the soil. The water table can be lowered by installing an adequate drainage system. The risk of flooding can be reduced by the use of levees, dikes, and diversions.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to nitrogen. Legumes respond to phosphate.

This unit is poorly suited to urban development. The main limitations are wetness and the hazard of flooding. Flooding can be controlled only by use of major flood control structures.

If this unit is irrigated, it is suited to windbreaks. The main limitations are wetness and the hazard of flooding. The selection of trees and shrubs is limited to those that tolerate the seasonal high water table.

Wr—Werlog loam. This deep, somewhat poorly drained soil is on flood plains and terraces. It formed in alluvium derived dominantly from sandstone and shale. Slope is 0 to 1 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the frost-free period is about 150 days.

Typically, the surface layer is grayish brown loam about 6 inches thick. The upper 54 inches of the substratum is light brownish gray and brown clay loam and loam. The lower part to a depth of 81 inches is stratified sand, gravel, and cobbles.

Included in this unit are small areas of Apishapa, Green River, and Walrees soils and Werlog clay loam that occur throughout the unit. Included areas make up about 30 percent of the total acreage.

Permeability of this Werlog soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is slight. A seasonal high water table is at a depth of 24 to 60 inches during the irrigation season. Where this soil has a cover of native vegetation, the average annual wetting depth is about 12 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops grown are small grain and vegetables. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitation is wetness. The selection of crops that can be grown is limited by the seasonal high water table. The water table can be lowered by installing an adequate drainage system.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to nitrogen. Legumes respond to phosphate.

This unit is poorly suited to urban development. The main limitations for buildings and roads are wetness and moderate shrink-swell potential.

Roads should be designed to offset the limited ability of the soil to support traffic. If buildings are constructed

on this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage as a result of shrinking and swelling. Wetness can be reduced by installing drain tile around footings.

The main limitations for septic tank absorption fields are the seasonal high water table and moderately slow permeability. These limitations are difficult to overcome.

If this unit is irrigated, it is suited to windbreaks. The main limitations are wetness and moderately slow permeability. The selection of trees and shrubs is limited to those that tolerate the seasonal high water table.

Ws—Werlog loam, saline. This deep, somewhat poorly drained soil is on flood plains and terraces. It formed in alluvium derived dominantly from sandstone and shale. Slope is 0 to 1 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is light yellowish brown loam about 5 inches thick. The upper 22 inches of the underlying material is brown and light brownish gray loam. The lower part to a depth of 60 inches is grayish brown silty clay loam.

Included in this unit are small areas of Apishapa, Green River, and Walrees soils that occur throughout the unit. Included areas make up about 15 percent of the total acreage.

Permeability of this Werlog soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. A seasonal high water table is at a depth of 24 to 60 inches during the irrigation season. Where this soil has a cover of native vegetation, the average annual wetting depth is about 15 inches. The soil is slightly saline.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops grown are corn and small grain. Some areas are used for urban development, windbreaks, and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are wetness and salinity. The selection of crops that can be grown is limited by the seasonal high water table and by the salinity of the soil. The water table can be lowered by installing an adequate drainage system.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to nitrogen. Legumes respond to phosphate.

This unit is poorly suited to urban development. The main limitations are wetness and moderate shrink-swell potential.

Roads should be designed to offset the limited ability of the soil to support traffic. If buildings are constructed, on this unit, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage as a result of shrinking and swelling. Wetness can be reduced by installing drain tile around footings.

The main limitations for septic tank absorption fields are the seasonal high water table and moderately slow permeability. These limitations are difficult to overcome.

If this unit is irrigated, it is suited to windbreaks. The main limitations are moderately slow permeability, wetness, and slight salinity. The selection of trees and shrubs is limited to those that tolerate the seasonal high water table.

Yo—Youngston clay loam. This deep, well drained soil is on flood plains and terraces. It formed in alluvium derived from mixed sources. Slope is 0 to 1 percent. The vegetation in areas not cultivated is mainly grass. Elevation is 4,800 to 6,000 feet. The average annual precipitation is about 8 inches, the average annual air temperature is about 53 degrees F, and the average frost-free period is about 150 days.

Typically, the surface layer is grayish brown clay loam about 10 inches thick. The underlying material to a depth of 66 inches or more is brown and pale brown loam and silt loam.

Included in this unit are small areas of Stumble soils and Slickspots that occur throughout the unit. Included areas make up about 25 percent of the total acreage.

Permeability of this Youngston soil is moderately slow. Available water capacity is very high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. This soil is subject to frequent, very brief periods of flooding from June through September. Where this soil has a cover of native vegetation, the average annual wetting depth is about 10 inches.

Most areas of this unit are used for irrigated crops, mainly alfalfa and pasture. Among the other crops grown are corn and small grain. Some areas are used for urban development and wildlife habitat.

If this unit is used for irrigated crops, the main limitations are the hazards of flooding and soil blowing. The risk of flooding can be reduced by the use of levees, dikes, and diversions.

Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used is generally governed by the crop. Water should be applied in amounts sufficient to wet the root zone but in amounts small enough to minimize the leaching of plant nutrients.

Tillage should be kept to a minimum. Maintaining crop residue on or near the surface reduces runoff, reduces soil blowing, and helps to maintain soil tilth and organic matter content. Production of crops can be maintained or increased by the use of fertilizer. Most crops, except legumes, respond to nitrogen. Legumes respond to phosphate.

This unit is poorly suited to urban development. The main limitations are the hazard of flooding and low soil strength. Flooding can be controlled only by use of major flood control structures. Roads should be designed to offset the limited ability of the soil to support traffic.

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

By Paul Boden, conservation agronomist, Soil Conservation Service.

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 and the estimated yields of the main crops and hay and pasture plants are listed for some soils.

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

About 65,000 acres in the survey area is used for irrigated crops. About 55,000 acres of this is along the San Juan, Animas, and La Plata rivers. The areas along these rivers have been irrigated for many years. Water is delivered by canal from diversions and dams along these streams.

The area included in the Navajo Indian Irrigation Project is being converted from native grazing land to irrigated farmland at a rate of about 10,000 acres per year. One 10,000-acre tract was irrigated for the first time in 1976. According to plans, a total of 110,000 acres will eventually be irrigated on this project. Water comes from Navajo Dam and is delivered to fields by a system of tunnels, canals, and siphons.

Irrigation water is adequate for good crop yields in all areas except those along the La Plata River. This stream frequently has little flow during July and August.

The main crops grown in the survey area are alfalfa for hay, improved grasses for pasture, small grain, and corn for silage. Among the other crops are vegetables, orchard crops, and sorghum. The potential is high for good yields of vegetable crops such as carrots, onions, and potatoes. Potatoes are particularly well suited to sandy, well drained soils such as those of the Fruitland, Shiprock, and Azfield series. There is also good potential for growing sugar beets if a processing plant is established nearby.

The major objectives in cropland management are proper irrigation, maintaining good soil tilth and fertility, and controlling water erosion and soil blowing. In addition, reducing excess salinity or alkalinity and providing adequate drainage are needed on some soils.

Timely application of adequate amounts of irrigation water without overirrigating is essential for high yields and efficient use of water. A properly designed irrigation system based on the soil characteristics and crops to be grown improves chances of reaching this goal. Sprinkler systems are best suited to all soils except those that have slow or very slow permeability. Overirrigation leaches plant nutrients out of the root zone, contributes to excess wetness on the lower lying soils, and reduces yields by reducing aeration of the root zone.

Use of a cropping system that helps to keep soils in good tilth is desirable. Some soils can be used for a single crop for many years with little adverse effect on yields. Other soils deteriorate rapidly unless large amounts of organic matter are returned to the soil annually. Use of a conservation cropping system tailored to

the individual soil helps to maintain good tilth, structure, soil aeration, and fertility. Rotation of crops also reduces insect, disease, and weed infestations.

Water erosion is not a serious problem on most irrigated soils in the area. However, poorly designed irrigation systems may contribute to excessive erosion on the sloping soils. Land smoothing or leveling is desirable on some of the soils to reduce the slope and runoff. Placing irrigation furrows on the contour or across the slope also reduces the hazard of erosion. Proper management of crop residue helps to control water erosion on sloping soils.

Soil blowing is a serious problem on the sandy soils in the area. It can best be controlled by leaving an adequate amount of residue from previous crops on the surface until the crop being grown provides ground cover. Cropping in strips perpendicular to the prevailing wind or planting trees and other plants for windbreaks are also effective and desirable practices.

Overirrigation and seepage from irrigation canals have contributed to the high water table and poor drainage of some of the soils on flood plains and valley sides. Alkalinity or salinity, or both, normally increase on poorly drained soils to a level that is detrimental to plant growth. Surface or subsurface drains can be installed to improve drainage and thus decrease salinity and alkalinity. However, proper irrigation of higher lying areas and lining of irrigation canals are desirable in many years to effectively lower the water table.

Yield of annual crops, hay crops, and pasture plants can be increased by other good management practices. These include proper irrigation, use of improved crop varieties, timely planting and harvesting, and a good fertilizer program that is based on the needs of the soil and crops. Other practices that contribute to increased yields are weed, insect, and disease control.

Tame pasture is a practical, economically feasible land use for most irrigated soils in the survey area. The main objective of pasture management is to maintain vigorous stands of palatable, well adapted plants for livestock feed, to improve the soil, and to control water erosion and soil blowing. Proper grazing practices, adequate fertilization, clipping, and weed control help to meet these objectives.

Proper grazing practices include delaying grazing until plants have made a good start in spring, avoiding grazing too closely, rotation grazing, grazing at the optimal time, and periodic rest from grazing. A good fertility management program involves adding fertilizer when needed and maintaining an adequate supply of all plant nutrients. Clipping some grasses helps to distribute grazing and stimulates growth. Where stands are thin, control of weeds by mowing or spraying results in more available moisture and plant nutrients for desirable species.

Grasses planted on irrigated land require as much irrigation water as alfalfa. Those practices that improve irrigation efficiency on cropland are suitable for use on irrigated pastureland.

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 4. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

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

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

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 4 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.

Rangeland

By Hank Wall, range conservationist, Soil Conservation Service.

About 85 percent of the survey area is range or grazable woodland. More than 80 percent of the farm income is derived from the production of cattle and sheep. Cow-calf-yearling operations are most common. A relatively large number of sheep operations are used for the production of mutton, wool, and lambs. Ranches of 25,000 acres or larger are common. Some small ranches are 4,000 acres or less. About 80 percent of the land is Indian trust land, which is administered by the Bureau of Indian Affairs, and federal land, which is administered by the Bureau of Land Management.

On many ranches the forage produced on rangeland is supplemented by hay and improved irrigated pasture. In winter the native forage is often supplemented with protein concentrates.

The native plant community in many parts of the survey area has been changed by continued excessive

use. Much of the area is now dominated by big sagebrush, pinyon, and oneseed juniper. The amount of forage being produced may be less than half of that originally produced. Forage production on the range can be increased by using mechanical and other management practices that are effective on specific kinds of soil and range sites.

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 5 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 5 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 moisture when air-dried.

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.

The main concern on most of the rangeland is using the native forage plants within their capability and, where needed, using mechanical manipulation or reducing the excessive amounts of brush species to that of the native plant community. Range seeding is feasible in areas that receive annual precipitation of 10 inches or more. Good range management results in a balanced native plant community that stabilizes the soil resource.

Wildlife habitat

By William S. Wallis, soil conservationist, Soil Conservation Service.

Wildlife are in many places throughout the survey area. Wherever food, cover, and water are available, there is some kind of wildlife. Wildlife habitat is most useful when all the elements needed by a certain kind of wildlife are located within the traveling distance, or home range, of that species. Elements of rangeland, woodland, openland, and wetland wildlife habitat, described elsewhere in this section, are located throughout the county in varying amounts. Elements of rangeland, woodland, openland, and wetland wildlife habitat are also described in the section "General soil map for broad land use planning."

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

In table 6, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

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

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

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

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

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are Fremont cottonwood, oak, poplar, cherry, forestiera, baccharis, hawthorn, willow, big sagebrush, and rabbitbrush. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, crabapple, and American plum.

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

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 mountainmahogany, 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, Gambel's quail, pheasant, meadowlark, field sparrow, cottontail, red fox, skunk, killdeer, and mourning dove.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants, or both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, thrushes, woodpeckers, squirrels, gray fox, raccoon, mule deer, bear, cottontail, kangaroo rat, coyote, hawks, sage grouse, and porcupine.

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. Wildlife attracted to rangeland include antelope, desert mule deer, sage grouse, meadowlark, lark bunting, jackrabbit, cottontail, prairie dog, coyote, red fox, scaled quail, chukar, hawks, gophers, and porcupine.

Windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

Recreation

The soils of the survey area are rated in table 8 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 8, 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 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

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

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

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

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

Engineering

By James E. Harris, area engineer, Soil Conservation Service.

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

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

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

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were

not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

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

Building site development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

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

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

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

Sanitary facilities

Table 10 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be

expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to 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 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

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

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

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

Construction materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

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

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

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

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

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

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

Water management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

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

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

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against

overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

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

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

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

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 extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

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

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

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 13.

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

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

Engineering index properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and 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 (*7*) 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.

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

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

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

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

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

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

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the

soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

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

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

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

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

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.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 14, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and water features

Table 15 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

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

The four hydrologic soil groups are:

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

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

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

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist

chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

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

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

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

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

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

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 15 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 15.

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

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

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

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

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.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*10*). Beginning with the broadest, these categories are the order,

suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 16, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

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

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

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

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

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

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

Soil series and 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 (*8*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*10*). 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."

Apishapa series

The soils in the Apishapa series are classified as Vertic Fluvaquents, fine, montmorillonitic (calcareous), mesic. These deep, somewhat poorly drained, saline-alkali soils are on low river terraces and flood plains. The soils formed in fine-textured alluvium of mixed origin. Slope is 0 to 1 percent. Elevation is 4,800 to 6,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Apishapa clay in an irrigated field, about 2,050 feet north and 280 feet east of the southwest corner of sec. 16, T. 29 S., R. 13 W.

Ap—0 to 6 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; few fine distinct yellowish brown (10YR 5/4) mottles; weak fine granular structure; slightly hard, friable, sticky and plastic; few fine roots; few very fine discontinuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C1—6 to 27 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; common medium distinct yellowish brown (10YR 5/6) mottles; weak coarse and medium subangular blocky structure; very hard, firm, very sticky and very plastic; few fine roots; few very fine discontinuous pores; common medium salt crystals; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C2—27 to 55 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; common medium distinct yellowish brown (10YR 5/6) mottles; massive; very hard, firm, very sticky and very plastic; few fine roots; few very fine discontinuous pores; common medium salt crystals; disseminated

calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C3—55 to 81 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; common medium distinct yellowish brown (10YR 5/6) mottles; massive; very hard, firm, sticky and plastic; few very fine roots; common medium salt crystals; disseminated calcium carbonate; slightly effervescent; moderately alkaline.

In some pedons, lenses of gravel, cobbles, sand, fine sandy loam, or loam are at a depth of 40 to 60 inches. A seasonal high water table is at a depth of 2 to 2.5 feet. The A horizon is clay loam or clay. It has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 3 to 5 when moist, and chroma of 1 to 3 when dry or moist. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 1 to 3 when dry or moist.

Atrac series

The soils in the Atrac series are classified as Ustollic Camborthids, fine-loamy, mixed, mesic. These deep, well drained soils are on hilly uplands and alluvial fans. The soils formed in loamy alluvial material derived from sandstone and shale. Slope is 3 to 15 percent. Elevation is 6,400 to 7,200 feet. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 120 to 150 days.

Typical pedon of an Atrac loam in an area of Atrac-Florita-Travessilla association, hilly, about 1,900 feet north and 1,700 feet east of the southwest corner of sec. 29, T. 32 N., R. 11 W.

A1—0 to 3 inches; brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak fine granular structure; soft, very friable; slightly sticky and slightly plastic; few fine roots; few fine continuous pores; noneffervescent; mildly alkaline; abrupt smooth boundary.

B1—3 to 9 inches; yellowish brown (10YR 5/4) sandy clay loam, dark brown (10YR 4/3) moist; weak subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common medium and fine roots; few fine continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

B2—9 to 24 inches; light brown (7.5YR 6/4) sandy clay loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard, very friable, sticky and plastic; few fine and medium roots; few fine continuous pores; noneffervescent; moderately alkaline; clear smooth boundary.

C1—24 to 44 inches; pale brown (10YR 6/3) sandy clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and medium roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; strongly alkaline; clear smooth boundary.

C2—44 to 56 inches; pale brown (10YR 6/3) sandy loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; strongly alkaline; abrupt smooth boundary.

C3—56 to 60 inches; very pale brown (10YR 7/3) sandy clay loam, yellowish brown (10YR 5/4) moist; massive; hard, friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; strongly alkaline.

The solum is 14 to 35 inches thick. The A horizon has hue of 10YR or 7.5YR, value of 4 to 6 when dry and 2 to 4 when moist, and chroma of 2 to 4 when dry or moist. The B horizon is sandy clay loam, loam, or clay loam. It has hue of 7.5YR to 2.5Y, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 3 to 6 when dry or moist. The part of the C horizon above a depth of 40 inches is sandy clay loam, loam, or clay loam. Below a depth of 40 inches it is sandy loam, loam, or sandy clay loam. It has hue of 7.5YR to 2.5Y, value of 5 to 7 when dry and 4 to 5 when moist, and chroma of 2 to 6 when dry or moist.

Avalon series

The soils in the Avalon series are classified as Typic Calciorthids, fine-loamy, mixed, mesic. These deep, well drained soils are on mesas and plateaus. The soils formed in calcareous eolian and alluvial material derived from sandstone and shale. Slope is 0 to 8 percent. Elevation is 5,600 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Avalon sandy loam, 2 to 5 percent slopes, about 1,600 feet north and 264 feet west of the southeast corner of sec. 33, T. 29 N., R. 14 W.

A1—0 to 4 inches; brown (7.5YR 5/4) sandy loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, slightly sticky and nonplastic; common fine roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; moderately alkaline; clear smooth boundary.

B2ca—4 to 14 inches; light brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 5/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few fine roots; few fine continuous pores; visible disseminated calcium carbonate; violently effervescent; moderately alkaline; clear smooth boundary.

C1ca—14 to 53 inches; white (10YR 8/2) sandy clay loam; light gray (10YR 7/2) moist; massive; slightly hard, firm, slightly sticky and slightly plastic; few fine roots; few fine discontinuous pores; visible dissemi-

nated calcium carbonate; violently effervescent; moderately alkaline; clear smooth boundary.
C2ca—53 to 72 inches; pink (7.5YR 7/4) gravelly sandy clay loam; light brown (7.5YR 6/4) moist; massive; soft, very friable, slightly sticky and slightly plastic; disseminated calcium carbonate; strongly effervescent; moderately alkaline.

The solum is 10 to 20 inches thick.

The A horizon is sandy loam or loam. It has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 3 to 5 when moist, and chroma of 3 to 6 when dry or moist. The A horizon is 0 to 10 percent fine gravel.

The B horizon is fine sandy loam, loam, or sandy clay loam. It has hue of 5YR to 10YR, value of 5 to 7 when dry and 4 to 6 when moist, and chroma of 3 to 6 when dry or moist.

The upper part of the C horizon is gravelly sandy loam, gravelly loam, loam, gravelly sandy clay loam, or clay loam. It has hue of 5YR to 10YR, value of 7 or 8 when dry and 5 to 7 when moist, and chroma of 1 to 4 when dry or moist. The lower part of the C horizon is gravelly sandy clay loam, sandy clay loam, or clay loam. It has hue of 5YR to 10YR, value of 5 to 7 when dry and 4 to 7 when moist, and chroma of 2 to 4 when dry or moist.

Beebe series

The soils in the Beebe series are classified as Typic Torrifluvents, sandy, mixed, mesic. These deep well drained soils are on flood plains and low river terraces. The soils formed in sandy alluvium of mixed origin. Slope is 0 to 1 percent. Elevation is 4,800 to 6,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Beebe loamy sand, about 2,050 feet south and 3,340 feet west of the northeast corner of sec. 17, T. 29 N., R 13 W.

A1—0 to 6 inches; light brownish gray (10YR 6/2) loamy sand, dark grayish brown (10YR 4/2) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; few fine discontinuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.
C1—6 to 30 inches; pale brown (10YR 6/3) loamy sand, dark brown (10YR 4/3) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; few fine discontinuous pores; noneffervescent; moderately alkaline; clear smooth boundary.
C2—30 to 67 inches; pale brown (10YR 6/3) sand, brown (10YR 5/3) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; few fine discontinuous pores; noneffervescent; moderately alkaline; clear wavy boundary.
C3—67 to 81 inches; multicolored very gravelly sand; single grained; loose dry and moist, nonsticky and nonplastic; few fine discontinuous pores; about 40 percent gravel; noneffervescent; moderately alkaline.

The A horizon has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 2 or 3 when dry or moist.

The C horizon is sand or loamy sand. It has value of 6 or 7 when dry and 4 to 6 when moist, and it has chroma of 2 or 3 when dry or moist. Gravelly layers or lenses are below a depth of 60 inches.

Beebe Variant

The Beebe Variant soils are classified as Aquic Ustifluvents, sandy, mixed, mesic. These deep, moderately well drained soils are on flood plains, low river terraces, alluvial fans, and side slopes. The soils formed in coarse textured alluvium of mixed origin. Slope is 0 to 2 percent. Elevation is 4,800 to 6,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Beebe Variant loamy sand, about 1,650 feet east and 1,650 feet south of the northwest corner of sec. 17, T. 29 N., R. 13 W.

A1—0 to 8 inches; light brownish gray (10YR 6/2) loamy sand, dark grayish brown (10YR 4/2) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; few fine discontinuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.
C1—8 to 28 inches; pale brown (10YR 6/3) loamy sand, dark brown (10YR 4/3) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; few fine discontinuous pores; noneffervescent; moderately alkaline; clear smooth boundary.
C2—28 to 67 inches; light gray (10YR 6/1) sand, grayish brown (10YR 5/2) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; few fine discontinuous pores; noneffervescent; moderately alkaline; clear wavy boundary.
C3—67 to 81 inches; multicolored very gravelly sand; single grained; loose dry and moist, nonsticky and nonplastic; few fine discontinuous pores; about 41 percent gravel; noneffervescent; moderately alkaline.

A seasonal high water table is at a depth of 2 to 5 feet.

The A horizon has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 2 or 3 when dry or moist.

The C horizon is sand, loamy sand, or coarse sand. It has value of 6 or 7 when dry and 4 to 6 when moist, and it has chroma of 2 or 3 when dry or moist. Gravelly layers or lenses are below a depth of 60 inches.

These soils constitute a variant to the Beebe series because the water table is at a depth of 2 to 5 feet.

Blackston series

The soils in the Blackston series are classified as Typic Calciorthids, loamy-skeletal, mixed, mesic. These deep, well drained soils are on river terraces, mesas, and plateaus. The soils formed in calcareous, gravelly alluvium of mixed origin. Slope is 0 to 40 percent. Elevation is 4,800 to 7,200 feet. The average annual precipitation is 6 to 13 inches, the average annual air temperature is 48 to 55 degrees F, and the average frost-free season is 120 to 160 days.

Typical pedon of Blackston loam, 0 to 3 percent slopes, about 1,150 feet east and 1,100 feet south of the northwest corner of sec. 3, T. 29 N., R. 13 W.

A1—0 to 2 inches; light brown (7.5YR 6/4) loam, brown (7.5YR 5/4) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; few fine continuous pores; disseminated calcium carbonates; strongly effervescent; moderately alkaline; clear smooth boundary.

B2ca—2 to 11 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; moderately alkaline; clear wavy boundary.

C1ca—11 to 27 inches; pinkish white (7.5YR 8/2) very gravelly clay loam, pinkish gray (7.5YR 7/2) moist; massive; very hard, firm, sticky and plastic; few fine roots; few fine discontinuous pores; disseminated lime; coarse fragments are moderately cemented with calcium carbonate; violently effervescent; strongly alkaline; gradual wavy boundary.

C2—27 to 80 inches; multicolored very gravelly sand; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; many interstitial pores; disseminated calcium carbonates; slightly effervescent; moderately alkaline.

The solum depth ranges from 8 to 20 inches.

The A horizon is loam or gravelly loam. It has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 3 or 4 when dry and 2 to 4 when moist.

The B horizon is loam or gravelly loam. It has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 4 to 6 when dry and 3 to 6 when moist.

The upper part of the C horizon is very gravelly loam, very gravelly clay loam, or very gravelly sandy loam. It has hue of 7.5YR or 10YR, value of 7 or 8 when dry and moist, and chroma of 1 to 3 when dry or moist. It is 20 to 35 percent calcium carbonate. The lower part of the C horizon is loose, multicolored very gravelly sandy loam or very gravelly sand.

Blancot series

The soils in the Blancot series are classified as Typic Haplargids, fine-loamy, mixed, mesic. These deep, well drained soils are in upland valleys and on alluvial fans. The soils formed in alluvium derived from sandstone and shale. Slope is 0 to 5 percent. Elevation is 5,600 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of a Blancot loam in an area of Blancot-Notal association, gently sloping, about 2,000 feet east and 2,200 feet north of the southwest corner of sec. 2, T. 31 N., R 11 W.

A1—0 to 2 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; few fine continuous pores; noneffervescent; moderately alkaline; clear smooth boundary.

B1—2 to 5 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; weak medium platy structure parting to weak fine subangular blocky; soft, very friable, slightly sticky and slightly plastic; few fine and medium roots; few fine continuous pores; noneffervescent; moderately alkaline; clear smooth boundary.

B2t—5 to 10 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; weak medium and coarse subangular blocky structure; hard, friable, slightly sticky and plastic; few fine and medium roots; few fine and medium continuous pores; thin clay films; noneffervescent; moderately alkaline; clear smooth boundary.

B3t—10 to 15 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak coarse and medium subangular blocky structure; hard, firm, slightly sticky and plastic; few fine and medium roots; few fine and medium continuous pores; few thin clay films; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C1—15 to 23 inches; light yellowish brown (2.5Y 6/4) sandy clay loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine and medium roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C2ca—23 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine and medium roots; few fine continu-

ous pores; disseminated calcium carbonate; strongly effervescent; strongly alkaline; abrupt smooth boundary.

The solum is 11 to 22 inches thick.

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 3 to 5 when moist, and chroma of 2 or 3 when dry or moist.

The B horizon is sandy clay loam, loam, or clay loam. It has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 3 to 5 when moist, and chroma of 2 or 3 when dry or moist.

The C horizon is loam, clay loam, or sandy clay loam. Thin layers of loamy sand or sand are at a depth of 40 to 60 inches in some pedons. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 3 to 5 when moist, and chroma of 2 to 4 when dry or moist.

Buckle series

The soils in the Buckle series are classified as Ustollic Haplargids, fine-loamy, mixed, mesic. These deep, well drained soils are in upland valleys and on alluvial fans. The soils formed in moderately fine textured alluvium derived from shale and sandstone. Slope is 0 to 5 percent. Elevation is 6,400 to 7,200 feet. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 120 to 150 days.

Typical pedon of Buckle silt loam, gently sloping, about 860 feet east and 2,400 feet north of the southwest corner of sec. 29, T. 32 N., R. 11 W.

A1—0 to 2 inches; brown (10YR 5/3) silt loam, brown (10YR 4/3) moist; weak thin platy structure; soft, friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; noneffervescent; mildly alkaline; abrupt smooth boundary.

B1—2 to 5 inches; brown (10YR 4/3) silt loam, dark brown (10YR 3/3) moist; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and medium roots; few fine continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

B21t—5 to 13 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak medium and coarse prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; few fine roots; few fine continuous pores; many moderately thick clay films; noneffervescent; moderately alkaline; clear smooth boundary.

B22t—13 to 29 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak medium prismatic structure parting to weak medium and fine subangular blocky; very hard, firm, sticky and plastic; common moderately thick clay films; few very fine roots; few very fine continuous pores; noneffervescent; moderately alkaline; clear smooth boundary.

B3tca—29 to 44 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; weak fine and medium subangular blocky structure; very hard, firm, sticky and plastic; few thin clay films; few very fine roots; few very fine continuous pores; disseminated calcium carbonate; strongly effervescent; moderately alkaline; abrupt smooth boundary.

C1ca—44 to 50 inches; pale brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) moist; massive; very hard, friable; slightly sticky and slightly plastic; disseminated calcium carbonate; strongly effervescent; strongly alkaline; clear smooth boundary.

C2ca—50 to 66 inches; light brownish gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) moist; massive; very hard, firm, slightly sticky and slightly plastic; disseminated calcium carbonate; strongly effervescent; strongly alkaline.

The solum is 40 to 60 inches thick.

The A horizon has value of 4 to 6 when dry and 3 or 4 when moist, and it has chroma of 2 to 4 when dry or moist.

The Bt horizon is silt loam, silty clay loam, or clay loam. It has value of 4 to 6 when dry and 3 to 5 when moist, and it has chroma of 1 to 3 when dry or moist. The B1 horizon, where present, is loam or silt loam.

The C horizon is clay loam, silt loam, or silty clay loam. It has value of 4 to 6 when dry or moist, and it has chroma of 2 or 3 when dry or moist.

Doak series

The soils in the Doak series are classified as Typic Haplargids, fine-loamy, mixed, mesic. These deep, well drained soils are on mesas, plateaus, and intermediate terraces. The soils formed in alluvial and eolian deposits derived from sandstone and shale. Slope is 0 to 5 percent. Elevation is 5,600 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of a Doak loam in an area of Doak-Avalon association, gently sloping, about 2,000 feet west and 1,240 feet south of the northeast corner of sec. 36, T. 32 N., R. 13 W.

A1—0 to 5 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, sticky and plastic; few fine and medium roots; few fine continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

B21t—5 to 17 inches; brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 4/4) moist and rubbed; weak, coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and very plastic; few fine roots; common medium continuous pores; thin continuous clay films on faces of peds; noneffervescent; mildly alkaline; clear smooth boundary.

B22tca—17 to 43 inches; light brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist and rubbed; moderate coarse and medium subangular blocky structure; very hard, firm, sticky and very plastic; few fine roots; few fine and medium continuous pores; thin patchy clay films on faces of peds; seams, filaments, and soft masses of calcium carbonate; strongly effervescent; moderately alkaline; gradual wavy boundary.

C1—43 to 69 inches; light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, sticky and plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; moderately alkaline.

The solum is 17 to 55 inches thick.

The A horizon is very fine sandy loam, loam, or clay loam. It has hue of 7.5YR or 10YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 2 to 4 when dry or moist.

The B horizon is loam, sandy clay loam, clay loam, or silty clay loam. It has hue of 5YR to 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 6 when dry or moist.

The C horizon is loam, sandy clay loam, clay loam, or silty clay loam. It has hue of 7.5YR to 10YR, value of 5 to 8 when dry and 4 to 7 when moist, and chroma of 2 to 4 when dry or moist.

Farb series

The soils in the Farb series are classified as Lithic Torriorthents, loamy, mixed (calcareous), mesic. These shallow and very shallow, excessively drained soils are on upland hills and breaks. The soils formed in residuum derived from sandstone. Local relief is 10 to 100 feet. Slope is 3 to 30 percent. Elevation is 5,200 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is about 53 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of a Farb fine sandy loam in an area of Farb-Persayo-Rock outcrop complex, moderately steep, about 2,350 feet south and 1,100 feet west of the northeast corner of sec. 34, T. 30 N., R 13 W.

A1—0 to 7 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common fine roots; few fine interstitial pores; disseminated calcium carbonate; strongly effervescent; moderately alkaline; clear smooth boundary.

C1—7 to 10 inches; light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) moist; massive, soft, very friable, nonsticky and nonplastic; common very fine and fine roots; few fine interstitial pores; disseminated calcium carbonate; strongly effervescent; moderately alkaline; abrupt smooth boundary.

R—10 inches; pale brown (10YR 6/3) hard sandstone with thin lime accumulations on bedrock.

Depth to bedrock is 5 to 20 inches.

The A horizon is sandy loam or fine sandy loam. It has hue of 10YR or 2.5Y, value of 5 to 7 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

The C horizon is loamy sand, sandy loam, or fine sandy loam. It has hue of 10YR or 2.5Y, value of 5 to 8 when dry and 4 to 7 when moist, and chroma of 2 to 6 when dry or moist.

Florita series

The soils in the Florita series are classified as Ustic Torriorthents, coarse-loamy, mixed (nonacid), mesic. These deep, well drained soils are on uplands. The soils formed in sandy alluvium and residuum derived from sandstone and shale. Slope is 3 to 15 percent. Elevation is 6,400 to 7,200 feet. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 120 to 150 days.

Typical pedon of a Florita sandy loam in an area of Atrac-Florita-Travessilla association, hilly, about 3,674 feet west and 1,169 feet north of the southeast corner of sec. 24, T. 32 N., R. 12 W.

A11—0 to 4 inches; very dark grayish brown (10YR 3/2) sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few fine roots; few fine continuous pores; noneffervescent; mildly alkaline; abrupt smooth boundary.

A12—4 to 12 inches; brown (10YR 5/3) loamy coarse sand, dark brown (10YR 3/3) moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; few fine continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

C1—12 to 21 inches; brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, nonsticky and slightly plastic; few fine and medium roots; few fine continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

C2—21 to 43 inches; pale brown (10YR 6/3) coarse sandy loam, brown (10YR 4/3) moist; massive; slightly hard, very friable, nonsticky and slightly plastic; few fine and medium roots; few fine continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

C3—43 to 60 inches; light yellowish brown (10YR 6/4) coarse sand, yellowish brown (10YR 5/4) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine and medium roots; few fine interstitial pores; noneffervescent; mildly alkaline.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 6 when dry and 2 to 5 when moist, and chroma of 2 to 4 when dry or moist.

The C horizon is sandy loam or coarse sandy loam. In some pedons lenses of coarse sand are below a depth of 40 inches. The C horizon has hue of 10YR or 7.5YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 2 to 4 when moist or dry.

Fluvaquents

Fluvaquents are deep, very poorly drained soils on flood plains. The soils formed in alluvial material. Slope is 0 to 1 percent. Elevation is 4,800 to 6,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Reference pedon abstracted in an area of Fluvaquents, ponded.

O1 and O2—4 to 0 inches; decomposed and decomposing organic material.

A1—0 to 4 inches; grayish brown (10YR 5/2) loam, dark brown (10YR 3/3) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium roots; many fine pores; slightly effervescent; moderately alkaline; clear smooth boundary.

C1—4 to 30 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; few fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; many fine and medium roots; few fine and medium pores; slightly effervescent; moderately alkaline; abrupt smooth boundary.

IIC2—30 to 60 inches; multicolored stratified sand, loamy sand, and gravel.

Fluvaquents are variable in color and texture. Stratification is common.

Fruitland series

The soils in the Fruitland series are classified as Typic Torriorthents, coarse-loamy, mixed (calcareous), mesic. These deep, well drained soils are on sides of valleys and alluvial fans. The soils formed in moderately coarse textured alluvium derived from shale and sandstone. Slope is 0 to 30 percent. Elevation is 4,800 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Fruitland sandy loam, 0 to 2 percent slopes, about 1,500 feet east and 550 feet south of the northwest corner of sec. 11, T. 29 N., R. 13 W.

A1—0 to 7 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common fine roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C1—7 to 18 inches; pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) moist; weak medium and fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C2—18 to 42 inches; light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine roots; many fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear gradual boundary.

C3—42 to 60 inches; light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline.

The A horizon is sandy loam or loam. It has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

The C horizon is sandy loam or fine sandy loam. It has hue of 7.5YR to 2.5Y, value of 5 to 7 when dry and 4 to 6 when moist, and chroma of 2 to 4 when moist or dry.

Garland series

The soils in the Garland series are classified as Typic Haplargids, fine-loamy over sandy or sandy-skeletal, mixed, mesic. These deep, well drained soils are on intermediate terraces and side slopes. The soils formed in mixed alluvium. Slope is 0 to 3 percent. Elevation is 4,800 to 6,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Garland loam, about 240 feet north and 140 feet west of the southeast corner of sec. 15, T. 29 N., R. 13 W.

Ap—0 to 4 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and medium roots; few fine continuous pores; noneffervescent; moderately alkaline; clear smooth boundary.

B21t—4 to 11 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; weak medium and fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine and medium roots; few fine and medium continuous pores; slightly effervescent; moderately alkaline; clear smooth boundary.

B22t—11 to 24 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; weak medium and

fine subangular blocky structure; hard, friable, sticky and plastic; few fine and medium roots; few fine and medium continuous pores; slightly effervescent; moderately alkaline; clear wavy boundary.

IIC1—24 to 45 inches; light brownish gray (10YR 6/2) extremely gravelly loamy sand, brown (10YR 4/3) moist; single grained; loose dry and moist; few fine roots; common medium interstitial pores; disseminated calcium carbonate; strongly effervescent; moderately alkaline; gradual wavy boundary.

IIC2—45 to 81 inches; multicolored extremely gravelly sand; single grained; loose dry and moist; few fine roots; common medium interstitial pores; disseminated calcium carbonate; strongly effervescent; moderately alkaline.

The solum is 21 to 26 inches thick.

The A horizon has value of 3 to 5 when dry and chroma of 3 or 4 when dry or moist.

The B horizon is clay loam, sandy clay loam, or loam. It has value of 4 or 5 when dry or moist and chroma of 3 or 4 when dry or moist.

The C horizon is extremely gravelly loamy sand to extremely gravelly sand.

Green River series

The soils in the Green River series are classified as Aquic Ustifluvents, coarse-loamy mixed (calcareous), mesic. These deep, somewhat poorly drained soils are on flood plains and low river terraces. The soils formed in moderately coarse textured alluvium of mixed origin. Slope is 0 to 1 percent. Elevation is 4,800 to 6,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Green River fine sandy loam, on a flood plain, about 1,254 feet west and 594 feet south of the northeast corner of sec. 28, T. 29 N., R. 11 W.

Ap—0 to 6 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; many fine and medium roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C1—6 to 10 inches; brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; few fine faint yellowish brown (10YR 5/6) mottles; massive; soft, very friable, slightly sticky and slightly plastic; common fine roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C2—10 to 15 inches; light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) moist; common fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, very friable, slightly sticky and slightly plastic; common fine roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; gradual smooth boundary.

C3—15 to 30 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; common fine distinct yellowish brown (10YR 5/6) mottles; massive; soft, very friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear wavy boundary.

C4—30 to 60 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; common medium distinct yellowish brown (10YR 5/6) mottles; massive; soft, very friable, slightly sticky and slightly plastic; few fine roots; few very fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline.

Depth to bedrock is 60 inches or more. Lenses of gravel, sand, loam, or clay are at a depth of 40 to 60 inches in some pedons. A seasonal high water table is at a depth of 2 to 5 feet.

The A horizon has value of 5 or 6 when dry and 3 to 5 when moist, and it has chroma of 2 or 3 when dry or moist.

The C horizon is loam, fine sandy loam, or sandy loam. It has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 3 or 4 when dry or moist.

Gypsiorthids

Gypsiorthids are well drained to excessively drained soils on ridges, hills, knolls, and breaks. The soils formed in gypsum deposits. They are deep to shallow to gypsum. Slope is 5 to 30 percent. Elevation is 4,800 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Reference pedon of Gypsiorthids in an area of Gypsiorthids-Badlands-Stumble complex, moderately steep, about 1,827 feet south and 406 feet west of the northeast corner of sec. 20, T. 32 N., R. 12 W.

A1—0 to 4 inches; pale yellow (2.5Y 7/4) sandy loam, light olive brown (2.5Y 5/4) moist; massive parting to coarse granular structure; soft, very friable, nonsticky and nonplastic; very few fine roots; few fine irregular pores; noneffervescent; clear smooth boundary.

C1—4 to 16 inches; light gray (2.5Y 7/2) sandy loam, grayish brown (2.5Y 5/2) moist; massive parting to coarse granular structure; soft, very friable, nonsticky and nonplastic; few fine roots; few fine and medium irregular pores; noneffervescent; gradual smooth boundary.

16 inches; gypsum.

Gypsum is at a depth of 6 to 60 inches or more. The degree of crystallization is variable.

The A horizon appears to be very sandy in texture but breaks down easily to sandy loam. It has hue of 10YR or 2.5Y, value of 6 or 7 when dry and 5 or 6 when moist, and chroma of 2 to 4 when dry or moist.

The C horizon appears to be very sandy in texture but breaks down easily to sandy loam or sandy clay loam. It has hue of 10YR or 2.5Y, value of 7 or 8 when dry and 5 to 7 when moist, and chroma of 2 to 4 when dry or moist.

Haplargids

Haplargids are well drained to excessively drained soils on ancient river terraces. The soils formed in moderately fine textured alluvium of mixed origin. They are shallow to deep to sandstone. These soils are cobbly and gravelly. Slope is 8 to 50 percent. Elevation is 4,800 to 7,200 feet. The average annual precipitation is 6 to 13 inches, the average annual air temperature is 48 to 55 degrees F, and the frost-free season is 120 to 160 days.

Reference pedon of Haplargids in an area of Haplargids-Blackston-Torriorthents complex, very steep, about 760 feet east and 320 feet south of the northwest corner of sec. 35, T. 29 N., R. 10 W.

A1—0 to 7 inches; dark brown (10YR 4/3) cobbly sandy loam, dark brown (10YR 3/3) moist; weak fine and medium granular structure; soft, friable, slightly sticky and slightly plastic; few very fine roots; few fine irregular pores; noneffervescent; moderately alkaline; clear smooth boundary.

B2t—7 to 16 inches; brown (10YR 5/3) cobbly sandy clay loam, dark grayish brown (10YR 4/2) moist; weak medium and fine subangular blocky structure; slightly hard, very firm, sticky and plastic; continuous thin clay films; few fine roots; common fine and medium irregular pores; noneffervescent; moderately alkaline; diffuse wavy boundary.

B3—16 to 26 inches; yellowish brown (10YR 5/4) cobbly sandy clay loam, brown (10YR 5/3) moist; massive; very hard, very firm, sticky and very plastic; few thin clay films; few fine roots; few fine irregular pores; disseminated calcium carbonate; slightly effervescent; strongly alkaline; diffuse smooth boundary.

C1—26 to 39 inches; light brownish gray (2.5Y 6/2) cobbly sandy clay loam, grayish brown (2.5Y 5/2) moist; hard, firm, sticky and plastic; few fine roots; few fine irregular pores; disseminated calcium carbonate; strongly effervescent; strongly alkaline; abrupt smooth boundary.

C2ca—39 to 44 inches; light gray (5Y 7/2) loam, pale olive (5Y 6/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; visible disseminated calcium carbonate; violently effervescent; strongly alkaline; abrupt smooth boundary.

C3—44 to 60 inches; pale olive (5Y 6/3) loam, olive (5Y 5/3) moist; massive; hard, friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline.

The solum is 14 to 32 inches. Sandstone is at a depth of 14 to 60 inches or more. Gravel and cobbles cover 80 to 90 percent of the surface. The subsoil and substratum are 0 to 90 percent gravel and cobbles.

The A horizon is gravelly or cobbly. It has hue of 10YR to 2.5Y, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 2 to 4 when dry or moist.

The B horizon is sandy clay loam, loam, clay loam, cobbly sandy clay loam, cobbly loam, or cobbly clay loam. It has hue of 5YR to 10YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 2 to 4 when dry or moist.

The C horizon is sandy clay loam, loam, clay loam, cobbly sandy clay loam, cobbly loam, or cobbly clay loam. It has hue of 10YR to 5Y, value of 4 to 7 when dry and moist, and chroma of 2 to 5 when dry or moist.

Huerfano series

The soils in the Huerfano series are classified as Typic Natrargids, loamy, mixed, mesic, shallow. These shallow, well drained, sodium-affected soils are on mesas and upland valley bottoms. The soils formed in alluvium and residuum derived from shale and siltstone. Slope is 0 to 3 percent. Elevation is 5,600 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of a Huerfano sandy clay loam in an area of Sheppard-Huerfano-Notal complex, gently sloping, about 1,400 feet south and 100 feet east of the northwest corner of sec. 9, T. 23 N., R. 13 W.

A1—0 to 1 inch; light yellowish brown (10YR 6/4) sandy clay loam, yellowish brown (10YR 5/4) moist; weak very fine granular structure; very hard, very firm, sticky and plastic; few fine roots; few fine pores; disseminated carbonate; strongly effervescent; moderately alkaline; clear smooth boundary.

A2—1 to 2 inches; light gray (10YR 7/2) sandy clay loam, grayish brown (10YR 5/2) moist; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; common fine and very fine discontinuous vesicular pores; disseminated calcium carbonate; violently effervescent; very strongly alkaline; abrupt smooth boundary.

B21tca—2 to 5 inches; brown (10YR 5/3) clay loam, dark yellowish brown (10YR 4/4) moist; weak fine columnar structure parting to moderate fine subangular blocky; hard, firm, slightly sticky and plastic; few very fine roots; few very fine continuous pores; disseminated calcium carbonate; violently effervescent; very strongly alkaline; clear smooth boundary.

B22tca—5 to 7 inches; dark yellowish brown (10YR 4/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky and slightly plastic; few fine roots; few very fine continuous pores; disseminated calcium carbonate; strongly effervescent; very strongly alkaline; clear wavy boundary.

B3ca—7 to 15 inches; yellowish brown (10YR 5/6) sandy clay loam, yellowish brown (10YR 5/6) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine continuous pores; disseminated calcium carbonate; violently effervescent; strongly alkaline; abrupt smooth boundary.

Cr—15 inches; shale.

Paralithic contact is at a depth of 10 to 20 inches. The profile is 25 to 75 percent exchangeable sodium. Desert pavement is present in most places, but some areas have sand accumulations.

The A horizon has hue of 10YR, value of 6 or 7 when dry and 5 or 6 when moist, and chroma of 1 to 4 when dry or moist.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5 when dry and moist, and chroma of 3 to 6 when dry or moist.

Mayqueen series

The soils in the Mayqueen series are classified as Typic Haplargids, coarse-loamy, mixed, mesic. These deep, somewhat excessively drained soils are on stabilized dunes on mesas and plateaus. The soils formed in eolian sand and alluvium. Slope is 0 to 8 percent. Elevation is 5,600 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of a Mayqueen loamy fine sand in an area of Sheppard-Mayqueen-Shiprock complex, 0 to 8 percent slopes, about 1,452 feet west and 1,782 feet south of the northeast corner of sec. 21, T. 27 N., R. 12 W.

A1—0 to 3 inches; brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; common very fine interstitial pores; noneffervescent; moderately alkaline; abrupt smooth boundary.

B2t—3 to 12 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium roots; few fine and medium continuous pores; thin continuous clay films; noneffervescent; moderately alkaline; abrupt smooth boundary.

C1—12 to 24 inches; light brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 5/4) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine and medium roots; common fine interstitial pores; noneffervescent; moderately alkaline; clear smooth boundary.

C2—24 to 38 inches; light yellowish brown (10YR 6/4) loamy fine sand, yellowish brown (10YR 5/4) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; common very fine interstitial pores; noneffervescent; moderately alkaline; clear smooth boundary.

C3—38 to 60 inches; light yellowish brown (10YR 6/4) loamy sand, yellowish brown (10YR 5/4) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; common fine interstitial pores; noneffervescent; moderately alkaline.

The solum is 10 to 20 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

The B horizon is fine sandy loam or sandy loam. It has hue of 5YR or 7.5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 3 or 4 when dry or moist.

The C horizon is loamy fine sand, fine sand, or loamy sand. It has hue of 10YR or 7.5YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 3 or 4 when dry or moist.

Monierco series

The soils in the Monierco series are classified as Typic Haplargids, loamy, mixed, mesic, shallow. These shallow, well drained soils are on knolls on mesas and plateaus. The soils formed in moderately fine textured eolian and alluvial material overlying sedimentary rock. Slope is 0 to 8 percent. Elevation is 5,600 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Monierco fine sandy loam, gently sloping, about 400 feet east and 160 feet south of the northwest corner of sec. 24, T. 27 N., R. 12 W.

A1—0 to 3 inches; light yellowish brown (10YR 6/4) fine sandy loam, brown (10YR 4/3) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few fine continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

B1—3 to 5 inches; yellowish brown (10YR 5/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine and very fine roots; few fine continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

B2t—5 to 10 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; hard, friable, sticky and plastic; common fine and very fine roots; few fine and medium continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

B3ca—10 to 16 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; strongly alkaline; clear smooth boundary.

Cr—16 inches; shale.

Thickness of the solum and depth to paralithic contact ranges from 10 to 20 inches.

The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

The B horizon is loam, fine sandy loam, sandy clay loam, or clay loam. It has hue of 5YR to 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

Muff series

The soils in the Muff series are classified as Typic Natrargids, fine-loamy, mixed, mesic. These moderately deep, well drained, sodium-affected soils are on mesas, upland valley bottoms, side slopes, and alluvial fans and in swales. The soils formed in alluvium underlain by weathered shale. Slope is 0 to 8 percent. Elevation is 5,600 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of a Muff very fine sandy loam in an area of Huerfano-Muff-Uffens complex, gently sloping, about 800 feet north and 2,000 feet east of the southwest corner of sec. 29, T. 32 N., R. 12 W.

A1—0 to 3 inches; pale brown (10YR 6/3) very fine sandy loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine interstitial pores; noneffervescent; moderately alkaline; clear smooth boundary.

A2—3 to 4 inches; light gray (10YR 7/2) very fine sandy loam, brown (10YR 5/3) moist; weak fine granular structure; loose dry and moist, very friable, nonsticky and nonplastic; few very fine roots; common fine interstitial pores; noneffervescent; moderately alkaline; abrupt smooth boundary.

B21t—4 to 6 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; weak fine and medium columnar structure parting to moderate fine and very fine subangular blocky; very hard, very firm, sticky and very plastic; few very fine roots; few fine continuous pores; thin continuous clay films; noneffervescent; moderately alkaline; abrupt smooth boundary.

B22tca—6 to 24 inches; light brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; weak fine prismatic structure parting to moderate medium and fine subangular blocky; very hard, very firm, sticky and very plastic; few fine roots; few fine and medium continuous pores; thin continuous clay films; disseminated calcium carbonate; strongly effervescent; very strongly alkaline; gradual smooth boundary.

Cr—24 inches; shale.

Paralithic contact is at a depth of 20 to 40 inches. The solum is 20 to 30 inches thick. The profile is 25 to 75 percent exchangeable sodium.

The A horizon has hue of 10YR or 7.5YR, value of 5 to 7 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

The B horizon is sandy clay loam or clay loam. It has hue of 7.5YR or 10YR, value of 4 to 6 when dry and moist, and chroma of 3 or 4 when dry or moist.

Notal series

The soils in the Notal series are classified as Typic Camborthids, fine, mixed, mesic. These deep, well drained, sodium-affected soils are on valley bottoms and alluvial fans. The soils formed in fine textured alluvium derived from sandstone and shale. Slope is 0 to 2 percent. Elevation is 5,600 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of a Notal silty clay loam in an area of Blancot-Notal association, gently sloping, about 1,000 feet south and 1,200 feet west of the northeast corner of sec. 16, T. 32 N., R. 12 W.

A1—0 to 3 inches; brown (10YR 5/3) silty clay loam, dark yellowish brown (10YR 4/4) moist; moderate thick platy structure parting to moderate fine granular; hard, friable, sticky and plastic; common fine roots; common fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; abrupt smooth boundary.

B1—3 to 6 inches; grayish brown (2.5Y 5/2) clay, olive brown (2.5Y 4/4) moist; moderate coarse prismatic structure parting to weak fine and medium subangular blocky; hard, friable, sticky and plastic; common fine roots; common very fine continuous pores; disseminated calcium carbonate; slightly effervescent; strongly alkaline; clear smooth boundary.

B2—6 to 12 inches; grayish brown (2.5Y 5/2) clay, olive brown (2.5Y 4/4) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, very sticky and very plastic;

few fine roots; few very fine continuous pores; thin clay films; disseminated calcium carbonate; slightly effervescent; strongly alkaline; gradual smooth boundary.

B3—12 to 23 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak coarse subangular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; few very fine continuous pores; disseminated calcium carbonate; slightly effervescent; strongly alkaline; gradual smooth boundary.

C1—23 to 40 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, very firm, very sticky and very plastic; few very fine roots; few very fine continuous pores; disseminated calcium carbonate; slightly effervescent; strongly alkaline; gradual smooth boundary.

C2—40 to 60 inches; grayish brown (2.5Y 5/2) clay, olive brown (2.5Y 4/4) moist; massive; extremely hard, very firm, very sticky and very plastic; few very fine roots; few very fine continuous pores; disseminated calcium carbonate; slightly effervescent; strongly alkaline.

The solum is 20 to 34 inches thick.

The A horizon is silty clay loam or clay loam. It has hue of 2.5Y or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

The B horizon is silty clay or clay. It has hue of 2.5Y or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

The C horizon is silty clay or clay. It has hue of 2.5Y or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

Penistaja series

The soils in the Penistaja series are classified as Ustollic Haplargids, fine-loamy, mixed, mesic. These deep, well drained soils are on mesas and plateaus. The soils formed in alluvial and eolian material derived from shale and sandstone. Slope is 0 to 5 percent. Elevation is 6,400 to 7,200 feet. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 120 to 150 days.

Typical pedon of Penistaja loam, gently sloping, about 1,520 feet north and 1,520 feet east of the southwest corner of sec. 36, T. 31 N., R. 8 W.

A1—0 to 2 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 4/2) moist; weak medium platy structure parting to weak fine granular; soft, very friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

B1—2 to 5 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few fine roots; few fine and medium continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

B21t—5 to 12 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; thin continuous clay films; few fine and medium roots; few fine and medium continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

B22t—12 to 24 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; moderate medium prismatic structure parting to strong medium subangular blocky; very hard, firm, sticky and plastic; moderately thick continuous clay films; few fine and medium roots; few fine and medium continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

B3ca—24 to 38 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few fine roots; few fine discontinuous pores; common rounded medium-sized masses of segregated lime; strongly effervescent; mildly alkaline; clear smooth boundary.

C1ca—38 to 67 inches; light brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine discontinuous pores; common rounded medium-sized masses of segregated lime; strongly effervescent; moderately alkaline.

The solum is 25 to 60 inches thick.

The A horizon has hue of 5YR to 10YR, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 2 to 4 when dry or moist.

The B horizon is clay loam or sandy clay loam. It has hue of 5YR or 7.5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 2 to 4 when dry or moist.

The C horizon is clay loam or sandy clay loam and has thin strata of loam or clay in some pedons. It has hue of 5YR or 7.5YR, value 5 or 6 when dry and 4 or 5 when moist, and chroma of 3 to 6 when dry and 2 to 4 when moist.

Persayo series

The soils in the Persayo series are classified as Typic Torriorthents, loamy, mixed (calcareous), mesic, shallow. These shallow, well drained soils are on hills and breaks. The soils formed in residuum derived from weathered shale. Slope is 3 to 40 percent. Elevation is 5,200 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of a Persayo clay loam in an area of Farb-Persayo-Rock outcrop complex, moderately steep,

about 2,200 feet west and 160 feet south of the northeast corner of sec. 36, T. 30 N., R. 13 W.

A1—0 to 2 inches; light brownish gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/4) moist; weak fine granular structure; soft, friable, sticky and plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; abrupt smooth boundary.

C1—2 to 5 inches; light brownish gray (2.5Y 6/2) silty clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, firm, sticky and plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C2—5 to 15 inches; light brownish gray (2.5Y 6/2) silty clay loam, light olive brown (2.5Y 5/4) moist; massive; very hard, very firm, sticky and plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; strongly alkaline; abrupt smooth boundary.

Cr—15 inches; calcareous gray and yellow shale.

Shale is at a depth of 10 to 20 inches.

The A horizon has hue of 10YR to 5Y, value of 5 or 7 when dry and 5 or 6 when moist, and chroma of 2 to 4 when dry or moist.

The C horizon is clay loam and silty clay loam. It has hue of 10YR or 2.5Y, value of 5 or 6 when dry, and chroma of 2 to 4 when dry or moist.

Sheppard series

The soils in the Sheppard series are classified as Typic Torripsamments, mixed, mesic. These deep, somewhat excessively drained soils are on mesas and plateaus. The soils formed in eolian material. Slope is 0 to 40 percent. Elevation is 5,600 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of a Sheppard loamy fine sand in an area of Sheppard-Mayqueen-Shiprock complex, 0 to 8 percent slopes, about 2,045 feet south and 725 feet east of the northwest corner of sec. 16, T. 27 N., R. 11 W.

A1—0 to 1 inch; light brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 5/4) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; few fine continuous pores; noneffervescent; moderately alkaline; clear smooth boundary.

C1—1 to 28 inches; light brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 5/4) moist; single grained; loose dry and moist, few fine and medium roots; common fine interstitial pores; noneffervescent; moderately alkaline; clear smooth boundary.

C2—28 to 62 inches; light brown (7.5YR 6/4) fine sand, brown (10YR 5/4) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine and medium roots; few fine interstitial pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline.

The A horizon has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 4 to 6 when dry or moist.

The C horizon is loamy fine sand, loamy sand, or fine sand. It has value of 5 or 6 when dry and 4 or 5 when moist, and it has chroma of 4 to 6 when dry or moist.

Shiprock series

The soils in the Shiprock series are classified as Typic Haplargids, coarse-loamy, mixed, mesic. These deep, well drained soils are on mesas and plateaus. The soils formed in sandy eolian and alluvial material derived from sandstone and shale. Slope is 0 to 8 percent. Elevation is 5,600 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Shiprock fine sandy loam, 0 to 2 percent slopes, about 1,440 feet east of the southwest corner of sec. 16, T. 27 N., R. 11 W.

A1—0 to 2 inches; pale brown (10YR 6/3) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many fine roots; many fine interstitial pores; noneffervescent; moderately alkaline; clear smooth boundary.

B1—2 to 5 inches; pale brown (10YR 6/3) fine sandy loam, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine roots; many fine continuous pores; noneffervescent; moderately alkaline; clear smooth boundary.

B2t—5 to 14 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many fine and few medium roots; few fine and medium continuous pores; few thin continuous clay films; noneffervescent; moderately alkaline; clear smooth boundary.

C1ca—14 to 32 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; few fine and medium roots; few fine and medium continuous pores; calcium carbonate disseminated and as filaments; strongly effervescent; moderately alkaline; clear smooth boundary.

C2ca—32 to 48 inches; light yellowish brown (10YR 6/4) fine sandy loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; few fine continuous

pores; calcium carbonate disseminated and as filaments; strongly effervescent; moderately alkaline; gradual smooth boundary.

C3ca—48 to 60 inches; light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; few fine roots; few fine continuous pores; calcium carbonate disseminated and as filaments; strongly effervescent; moderately alkaline.

The solum is 10 to 26 inches thick.

The A horizon is fine sandy loam, sandy loam, or loamy fine sand. It has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 3 to 5 when dry and 2 to 4 when moist.

The B horizon is fine sandy loam or sandy loam. It has hue of 5YR or 7.5YR, value of 4 to 6 when dry and moist, and chroma of 4 to 6 when dry and 3 or 4 when moist.

The C horizon is sandy loam or fine sandy loam. It has value of 5 to 7 when dry and 4 to 6 when moist, and it has chroma of 3 to 6 when dry or moist.

Shiprock Variant

The Shiprock Variant soils are classified as Typic Haplargids, fine-loamy, mixed, mesic. These deep, well drained soils are on mesas and plateaus. The soils formed in calcareous alluvium derived from shale and sandstone. Slope is 0 to 3 percent. Elevation is 5,600 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Shiprock Variant fine sandy loam, about 198 feet west and 528 feet north of the southeast corner of sec. 27, T. 25 N., R. 14 W.

A1—0 to 3 inches; yellowish brown (10YR 5/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few fine roots; few fine continuous pores; noneffervescent; moderately alkaline; clear smooth boundary.

B1—3 to 8 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium prismatic structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; noneffervescent; moderately alkaline; clear smooth boundary.

B2tca—8 to 24 inches; light brown (7.5YR 6/4) sandy clay loam, brown (7.5YR 5/4) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C1ca—24 to 48 inches; very pale brown (10YR 8/3) sandy clay loam, very pale brown (10YR 7/3) moist; massive; hard, friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; violently effervescent; moderately alkaline; clear smooth boundary.

C2ca—48 to 68 inches; light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline.

The solum is 20 to 30 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 3 or 4 when dry or moist.

The B horizon is fine sandy loam, sandy loam, or sandy clay loam. It has hue of 10YR or 7.5YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 3 to 5 when dry or moist. It is noneffervescent to slightly effervescent.

The upper part of the C horizon is calcic. It is fine sandy loam, sandy loam, loam, or sandy clay loam. It has hue of 10YR or 7.5YR, value of 7 or 8 when dry and 6 to 8 when moist, and chroma of 3 or 4 when dry or moist. It is 20 to 35 percent calcium carbonate. The lower part of the C horizon is loamy sand, loamy fine sand, sandy loam, very fine sandy loam, or fine sandy loam. It has value of 6 or 7 when dry and 5 or 6 when moist, and it has chroma of 3 to 6 when dry or moist.

These soils constitute a variant to the Shiprock series because they have a fine-loamy control section.

Silver series

The soils in the Silver series are classified as Ustollic Haplargids, fine, mixed, mesic. These deep, well drained soils are on hilly uplands. The soils formed in alluvium and residuum derived from shale. Slope is 0 to 10 percent. Elevation is 6,400 to 7,200 feet. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 120 to 150 days.

Typical pedon of Silver cobbly silty clay loam in an area of Twick-Silver association, moderately sloping, about 3,028 feet south and 1,820 feet west of the northeast corner of sec. 11, T. 32 N., R. 8 W.

A1—0 to 2 inches; reddish gray (5YR 5/2) cobbly silty clay loam, dark reddish gray (5YR 4/2) moist; weak thin platy structure parting to weak fine granular; slightly hard, friable, sticky and plastic; few fine roots; few fine continuous pores; 25 percent cobbles; noneffervescent; moderately alkaline; clear smooth boundary.

B1—2 to 4 inches; reddish gray (5YR 5/2) cobbly silty clay loam, dark reddish gray (5YR 4/2) moist; weak

fine and medium subangular blocky structure; slightly hard, firm, sticky and plastic; thin patchy clay films; few fine and medium roots; few fine and medium continuous pores; 25 percent cobbles; noneffervescent; moderately alkaline; abrupt smooth boundary.

B21t—4 to 13 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; weak coarse prismatic structure parting to strong fine and medium subangular blocky; very hard, very firm, very sticky and very plastic; moderate continuous clay films; few fine and medium roots; few fine and medium continuous pores; noneffervescent; moderately alkaline; clear smooth boundary.

B22tca—13 to 36 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate fine and medium subangular blocky structure; very hard, very firm, very sticky and very plastic; thin continuous clay films; few fine and medium roots; few fine and medium continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; gradual smooth boundary.

C1—36 to 60 inches; reddish gray (5YR 5/2) clay, dark reddish gray (5YR 4/2) moist; massive; hard, firm, very sticky and very plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; moderately alkaline.

The solum is 24 to 40 inches thick. Coarse fragments make up 20 to 40 percent of the upper part of the solum.

The A horizon has hue of 5YR or 7.5YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 or 3 when dry or moist.

The upper part of the B horizon is cobbly silty clay loam or cobbly clay loam. It has hue of 5YR or 7.5YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 2 or 3 when dry or moist. The lower part of the B horizon is clay or silty clay. It has hue of 5YR or 7.5YR, value of 4 or 5 when dry or moist, and chroma of 3 or 4 when dry or moist.

The C horizon is clay or silty clay. It has hue of 5YR or 7.5YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

Stumble series

The soils in the Stumble series are classified as Typic Torripsamments, mixed, mesic. These deep, somewhat excessively drained soils are on sides of valleys and alluvial fans. The soils formed in coarse textured alluvium derived from sandstone and shale. Slope is 0 to 8 percent. Elevation is 4,800 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the frost-free season is 140 to 160 days.

Typical pedon of Stumble loamy sand, 0 to 3 percent slopes, about 2,300 feet west and 250 feet south of the northeast corner of sec. 31, T. 30 N., R. 12 W.

A1—0 to 5 inches; yellowish brown (10YR 5/4) loamy sand, dark yellowish brown (10YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few fine roots; common fine interstitial pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C1—5 to 15 inches; light yellowish brown (10YR 6/4) loamy sand, yellowish brown (10YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; common fine interstitial pores; disseminated calcium carbonate; slightly effervescent; strongly alkaline; clear smooth boundary.

C2—15 to 29 inches; pale brown (10YR 6/3) sand, yellowish brown (10YR 5/4) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; common medium interstitial pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C3—29 to 49 inches; brownish yellow (10YR 6/6) gravelly sand, light yellowish brown (10YR 6/4) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; common medium interstitial pores; noneffervescent; moderately alkaline; clear smooth boundary.

C4—49 to 81 inches; brownish yellow (10YR 6/6) sand, pale brown (10YR 6/3) moist; single grained; loose dry and moist, nonsticky and nonplastic; few fine roots; common fine interstitial pores; moderately alkaline; noneffervescent; clear smooth boundary.

The A horizon is sandy clay loam or loamy sand. It has hue of 2.5Y or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

The C horizon is loamy coarse sand, gravelly sand, sand, loamy sand, or loamy fine sand. It has hue of 10YR or 2.5Y, value of 5 to 7 when dry and 4 to 6 when moist, and chroma of 2 to 6 when dry or moist.

Torriorthents

Torriorthents are shallow to deep, well drained soils on ancient river terraces. The soils formed in alluvial material of mixed origin. Slope is 8 to 50 percent. Elevation is 4,800 to 7,200 feet. The average annual precipitation is 6 to 13 inches, the average annual air temperature is 48 to 55 degrees F, and the average frost-free season is 120 to 160 days.

Reference pedon of Torriorthents in an area of Haplargids-Blackston-Torriorthents complex, very steep, about 2,170 feet south and 334 feet east of the northwest corner of sec. 30, T. 32 N., R. 12 W.

A1—0 to 3 inches; light brownish gray (2.5Y 6/2) cobbly loam, grayish brown (2.5Y 5/2) moist; weak medium and fine granular structure; slightly hard, friable, slightly sticky and plastic; common fine and medium roots; few fine irregular pores; disseminated calcium

carbonate; slightly effervescent; strongly alkaline; clear smooth boundary.
C1—3 to 8 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, slightly sticky and plastic; few fine and medium roots; few fine and medium continuous pores; disseminated calcium carbonate; slightly effervescent; strongly alkaline; clear smooth boundary.
C2—8 to 15 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable, slightly sticky and plastic; few fine and medium roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; strongly alkaline; clear smooth boundary.
Cr—15 inches; shale.

Depth to bedrock is variable. The bedrock is shale, siltstone, or sandstone. Coarse fragments cover 80 to 90 percent of the surface and make up 0 to 90 percent of the underlying layers.

The A horizon is cobbly or gravelly. It has hue of 10YR to 5Y, value of 6 or 7 when dry and 5 or 6 when moist, and chroma of 2 to 4 when dry or moist.

The C horizon is loam, clay loam, sandy loam, sandy clay loam, cobbly loam, cobbly clay loam, cobbly sandy loam, or cobbly sandy clay loam. It has hue of 10YR to 5Y, value of 5 to 7 when dry or moist, and chroma of 2 or 3 when dry or moist.

Travessilla series

The soils in the Travessilla series are classified as Lithic Ustic Torriorthents, loamy, mixed (calcareous), mesic. These very shallow and shallow, well drained soils are on hilly uplands, breaks, and mesas. The soils formed in residuum derived from sandstone. Slope is 0 to 40 percent. Elevation is 6,400 to 7,200 feet. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 120 to 150 days.

Typical pedon of a Travessilla sandy loam in an area of Travessilla-Weska-Rock outcrop complex, moderately steep, on a mesa, about 2.5 miles north of the junction of San Juan County Road 18 and New Mexico State Highway 544, and 1.6 miles west on a dirt road, sec. 33, T. 32 N., R. 8 W.

A1—0 to 2 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few fine roots; few fine continuous pores; nonefferves-cent; mildly alkaline; clear smooth boundary.
C1—2 to 12 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine and medium roots; few fine and medium continuous pores; slightly effervescent in the lower 3 inches; mildly alkaline; clear smooth boundary.
R—12 inches; hard sandstone.

Bedrock is at a depth of 6 to 20 inches. The surface is 0 to 25 percent coarse fragments.

The A horizon is sandy loam or very fine sandy loam. It has hue of 7.5YR to 2.5Y, value of 5 to 7 when dry and 3 to 5 when moist, and chroma of 2 to 4 when dry or moist.

The C horizon is very fine sandy loam, fine sandy loam, sandy loam, or loam. It has hue of 7.5YR to 2.5Y, value of 5 to 7 when dry and 3 to 5 when moist, and chroma of 3 or 4 when dry or moist.

Turley series

The soils in the Turley series are classified as Typic Torriorthents, fine-loamy, mixed (calcareous), mesic. These deep, well drained soils are on valley sides and alluvial fans. The soils formed in moderately fine textured, stratified alluvium derived from sandstone and shale. Slope is 0 to 5 percent. Elevation is 4,800 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Turley clay loam, 0 to 1 percent slopes, about 2,500 feet south and 500 feet west of the northeast corner of sec. 5, T. 29 N., R. 13 W.

Ap—0 to 3 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; hard, friable, slightly sticky and plastic; few fine and medium roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; moderately alkaline; clear smooth boundary.
C1—3 to 10 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; few fine and medium roots; few fine and medium continuous pores; disseminated calcium carbonate; strongly effervescent; moderately alkaline; clear smooth boundary.
C2—10 to 57 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, firm, sticky and plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; moderately alkaline; clear wavy boundary.
C3—57 to 80 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; massive; hard, very firm, sticky and plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; strongly alkaline.

The A horizon has hue of 2.5Y or 10YR, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 2 to 4 when dry or moist.

The C horizon is silty clay loam, clay loam, and loam. It has hue of 10YR or 2.5Y, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

Twick series

The soils in the Twick series are classified as Ustollic Haplargids, clayey, mixed, mesic, shallow. These shallow, well drained soils are on hilly uplands. The soils formed in fine textured alluvium and residuum derived from shale. Slope is 0 to 25 percent. Elevation is 6,400 to 7,200 feet. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 120 to 150 days.

Typical pedon of a Twick cobbly silty clay loam in an area of Twick-Silver association, moderately sloping, on a hilly upland, from the junction of County Road 18 and New Mexico State Highway 544, about 5.7 miles north on New Mexico State Highway 544 and then 1.1 miles northwest on a dirt road, T. 32 N., R. 8 W.

A1—0 to 1 inch; brown (7.5YR 4/2) cobbly silty clay loam, dark brown (7.5YR 3/2) moist; weak fine granular structure; hard, firm, sticky and plastic; few fine roots; few fine continuous pores; 25 percent cobbles; disseminated calcium carbonate; slightly effervescent; moderately alkaline; abrupt smooth boundary.

B1—1 to 4 inches; brown (7.5YR 5/2) cobbly clay loam, dark brown (7.5YR 4/2) moist; weak medium and fine subangular blocky structure; hard, firm, sticky and plastic; thin patchy clay films; few fine and medium roots; few fine and medium continuous pores; 25 percent cobbles; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

B2t—4 to 17 inches; brown (7.5YR 5/2) clay, dark brown (7.5YR 4/4) moist; moderate medium and fine subangular blocky structure; very hard, very firm, very sticky and very plastic; thin continuous clay films; few fine and medium roots; few very fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

Cr—17 inches; fine textured, calcareous shale; soft; weathers to masses of shaly clay.

Thickness of the solum and depth to paralithic contact is 10 to 20 inches. Coarse fragments make up 20 to 35 percent of the upper part of the solum.

The A horizon has hue of 7.5YR or 10YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 2 to 4 when dry or moist.

The B horizon is cobbly clay loam over clay or cobbly silty clay loam over clay. It has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

Uffens series

The soils in the Uffens series are classified as Typic Natrargids, fine-loamy, mixed, mesic. These deep, well drained, sodium-affected soils are in valleys and on alluvial fans, mesas, and plateaus. The soils formed in alluvium derived from shale. Slope is 0 to 8 percent. Elevation is 5,600 to 6,400 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of an Uffens fine sandy loam in an area of Huerfano-Muff-Uffens complex, gently sloping, about 1,100 feet south and 2,000 feet west of the northwest corner of sec. 32, T. 32 N., R. 13 W.

A11—0 to 2 inches; pale brown (10YR 6/3) fine sandy loam, dark brown (10YR 4/3) moist and rubbed; weak very fine granular structure; loose, very friable, nonsticky and nonplastic; few fine and very fine roots; few fine continuous pores; noneffervescent; mildly alkaline; clear smooth boundary.

A12—2 to 8 inches; light yellowish brown (10YR 6/4) very fine sandy loam, dark yellowish brown (10YR 4/4) moist and rubbed; weak fine granular structure; slightly hard, very friable, nonsticky and nonplastic; few fine and medium roots; common medium and fine continuous pores; noneffervescent; moderately alkaline; abrupt smooth boundary.

A2—8 to 9 inches; light gray (10YR 7/2) very fine sandy loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine and medium roots; common fine and medium continuous pores; noneffervescent; moderately alkaline; abrupt smooth boundary.

B21t—9 to 12 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist and rubbed; moderate medium prismatic structure parting to moderate coarse subangular blocky; very hard, firm, sticky and plastic; common fine roots; common medium and few fine continuous pores; moderate continuous clay films; noneffervescent; strongly alkaline; clear smooth boundary.

B22tca—12 to 20 inches; light brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist and rubbed; moderate medium subangular blocky structure; very hard, firm, sticky and plastic; few fine roots; few fine continuous pores; thin continuous clay films; disseminated calcium carbonate; strongly effervescent; very strongly alkaline; gradual wavy boundary.

C1—20 to 33 inches; pale brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) moist and rubbed; massive; very hard, friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; very strongly alkaline; gradual smooth boundary.

C2—33 to 60 inches; pale brown (10YR 6/3) sandy clay loam, light olive brown (2.5Y 5/4) moist and rubbed;

massive; hard, friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; strongly effervescent; very strongly alkaline.

The solum is 10 to 25 inches thick. Depth to bedrock generally is 60 inches or more. Estimated content of exchangeable sodium is 25 to 75 percent.

The A horizon has value of 6 or 7 when dry and 4 or 5 when moist, and it has chroma of 2 to 4 when dry or moist.

The B horizon is sandy clay loam or clay loam. It has hue of 5YR to 2.5Y, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 3 to 5 when dry and 2 to 4 when moist.

The C horizon is sandy clay loam, silt loam, loam, clay loam, or silty clay loam. It has value of 5 to 7 when dry and 4 to 6 when moist, and it has chroma of 2 to 4 when dry or moist.

Walrees series

The soils in the Walrees series are classified as Aquic Ustifluvents, fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic. These moderately deep, somewhat poorly drained soils are on flood plains and river terraces. The soils formed in medium textured to moderately fine textured alluvium of mixed origin underlain by sand, gravel, and cobbles. Slope is 0 to 2 percent. Elevation is 4,800 to 6,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Walrees loam, about 990 feet west and 990 feet north of the southeast corner of sec. 8, T. 30 N., R. 11 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) loam, dark brown (10YR 3/3) moist; weak thin and medium platy structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; few fine and medium roots; many fine and few medium continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C1—6 to 18 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; few fine distinct yellowish brown (10YR 5/6) mottles, weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky and slightly plastic; many fine and medium roots; few fine and common medium continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; gradual smooth boundary.

C2—18 to 30 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; few fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable, slightly sticky and slightly plastic; many fine and medium roots; few fine and medium continuous pores; disseminated calcium carbonate; strongly effervescent; moderately alkaline; abrupt smooth boundary.

IIC3—30 to 81 inches; multicolored stratified sand, gravel, and cobbles.

Coarse fragments are at a depth of 20 to 40 inches. Depth to bedrock is 60 inches or more. Organic matter content is 1 to 2 percent and varies irregularly with depth. A seasonal high water table is at a depth of 2 to 5 feet.

The A horizon has value of 5 or 6 when dry and 3 to 5 when moist, and it has chroma of 2 to 3 when dry or moist.

The upper part of the C horizon is loam, clay loam, very fine sandy loam, or silty clay loam. It has value of 5 or 6 when dry and 3 to 5 when moist, and it has chroma of 1 to 3 when dry or moist. Mottles are few to common, fine to coarse, and faint to distinct. They are yellowish brown and strong brown.

Werlog series

The soils in the Werlog series are classified as Aquic Ustifluvents, fine-loamy, mixed (calcarous), mesic. These deep, somewhat poorly drained soils are on flood plains and low river terraces. The soils formed in mixed alluvium derived from sandstone and shale. Slope is 0 to 1 percent. Elevation is 4,800 to 6,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Werlog loam, about 1,150 feet west and 500 feet south of the northeast corner of sec. 15, T. 29 N., R. 13 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) loam, dark brown (10YR 3/3) moist; weak thin and medium platy structure parting to weak fine granular; slightly hard, friable, sticky and plastic; few fine and medium roots; many fine and few medium continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C1—6 to 18 inches; light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and plastic; many fine and medium roots; few fine and common medium continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; gradual smooth boundary.

C2—18 to 35 inches; light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; few fine distinct yellowish brown (10YR 5/6) mottles; massive; hard, friable, sticky and plastic; many fine and medium roots; few fine and medium continuous pores; disseminated calcium carbonate; strongly ef-

fervescent; moderately alkaline; gradual smooth boundary.

C3—35 to 49 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; common fine distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable, sticky and plastic; many fine and medium roots; few fine and medium continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C4—49 to 60 inches; brown (10YR 5/3) loam, dark yellowish brown (10YR 4/4) moist; common fine distinct yellowish brown (10YR 5/6) mottles; massive; soft, very friable, slightly sticky and slightly plastic; many fine and few medium roots; few fine and medium continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; abrupt wavy boundary.

IIC5—60 to 81 inches; stratified sand, gravel, and cobbles.

Organic matter content varies irregularly with depth. A seasonal high water table is at a depth of 2 to 5 feet.

The A horizon has value of 5 or 6 when dry and 3 to 5 when moist, and it has chroma of 2 or 3 when dry or moist.

The C horizon is loam, clay loam, silt loam, or silty clay loam. Strata of sandy loam, sand, and gravelly sand are at a depth of 40 to 60 inches in some places. The C horizon has value of 5 or 6 when dry and 3 to 5 when moist, and it has chroma of 1 to 4 when dry or moist. Mottles are few to common, fine to coarse, and faint to distinct. They are yellowish brown or strong brown.

Weska series

The soils in the Weska series are classified as Ustic Torriorthents, loamy, mixed (nonacid), mesic, shallow. These shallow and very shallow, well drained soils are on hilly uplands, breaks, and mesas. The soils formed in residuum derived from shale. Slope is 0 to 40 percent. Elevation is 6,400 to 7,200 feet. The average annual precipitation is 10 to 13 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free season is 120 to 150 days.

Typical pedon of a Weska silty clay loam in an area of Rock outcrop-Travessilla-Weska complex, extremely steep, from the junction of County Road 18 and New Mexico State Highway 544, about 2.5 miles north on New Mexico State Highway 544, and then 1.7 miles west on a dirt road, sec. 28, T. 32 N., R. 8 W.

A1—0 to 1 inch; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; soft, friable, sticky and plastic; few fine roots; few fine continuous pores; noneffervescent; moderately alkaline; abrupt smooth boundary.

C1—1 to 7 inches; grayish brown (2.5Y 5/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, friable, sticky and plastic; few fine and medium roots; many fine and medium continuous pores; noneffervescent; moderately alkaline; abrupt smooth boundary.

Cr—7 inches; shale.

Shale is at a depth of 6 to 20 inches. The A horizon is silty clay loam or clay loam. It has hue of 10YR to 5Y, value of 5 or 6 when dry and 3 to 5 when moist, and chroma of 2 to 4 when moist or dry. The C horizon is clay loam or silty clay loam. It has hue of 10YR to 5Y, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 4 when dry or moist.

Youngston series

The soils in the Youngston series are classified as Typic Torrifluvents, fine-loamy, mixed (calcareous), mesic. These deep, well drained soils are on flood plains and low river terraces. The soils formed in moderately fine textured and medium textured alluvium of mixed origin. Slope is 0 to 1 percent. Elevation is 4,800 to 6,000 feet. The average annual precipitation is 6 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free season is 140 to 160 days.

Typical pedon of Youngston clay loam, about 1,700 feet west and 100 feet south of the northeast corner of sec. 25, T. 30 N., R. 9 W.

A11—0 to 2 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak thin platy structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

A12—2 to 10 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, very friable, slightly sticky and slightly plastic; few fine and medium roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C1—10 to 20 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; few fine faint yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; many fine wormholes; slightly effervescent; moderately alkaline; clear smooth boundary.

C2—20 to 54 inches; brown (10YR 5/3) loam, dark grayish brown (10YR 4/2) moist; few fine faint yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; disseminated

calcium carbonate; slightly effervescent; moderately alkaline; clear smooth boundary.

C3—54 to 66 inches; pale brown (10YR 6/3) silt loam, dark grayish brown (10YR 4/2) moist; common medium distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; few fine continuous pores; disseminated calcium carbonate; slightly effervescent; moderately alkaline.

The A horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when dry or moist.

The C horizon is loam, clay loam, silt loam, or silty clay loam. Strata of fine sandy loam or loamy sand are at a depth of 40 to 60 inches in some places. The C horizon has value of 5 or 6 when dry and 3 or 4 when moist, and it has chroma of 2 or 3 when dry or moist. Mottles are strong brown to yellowish brown.

Formation of the soils

Soil is a natural body and is the result of interaction of the five soil-forming factors: climate, plants and animals, parent material, relief, and time. Each soil has three dimensions: thickness, breadth, and length. Individual areas of soils range from a few square yards to several hundred acres in size.

Climate and vegetation are considered the active factors in soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly alter the parent material into a natural formation that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the formation of diagnostic horizons.

The five factors of soil formation are briefly described in the following paragraphs.

Climate

San Juan County, Eastern Part, has an arid, continental climate. The average annual precipitation is 6 to 10 inches in about 85 percent of the area, but it is 10 to 13 inches in the northern and eastern parts. The average annual air temperature ranges from about 50 degrees F in the northern and eastern parts to about 53 degrees in the rest of the area.

Climate directly influences soil formation. The amount of precipitation and the temperature largely determine the kind and amount of vegetation that grows. The amount of precipitation determines the amount of leaching of bases and carbonates and of clay colloids in the soil. Warm, moist climate increases the rate at which organic matter decomposes and parent material weathers.

The sparse grassland vegetation in aridic areas produces little organic matter. The soils that formed in these areas, such as those of the Shiprock and Doak series, have a light colored surface layer that is less than 1 percent organic matter. The northern and eastern parts of the area receive more precipitation and thus produce more vegetation. Buckle soils formed in these parts of the area, and they have a dark colored surface layer that has 1 percent organic matter or more.

The amount of precipitation largely determines the amount and extent of downward leaching of calcium carbonate in a soil profile. Doak soils formed under 6 to 10 inches of precipitation and typically have a zone of lime accumulation beginning at a depth of 17 inches. Buckle soils, formed under 10 to 13 inches of precipitation, typically have a zone of lime accumulation beginning at a depth of 20 inches, and are considerably deeper than Doak soils.

Plants and animals

Plants help in the formation of soils by sending their roots into the parent material. Plant roots, even though small, are strong. They tend to granulate the soil, rearrange the soil particles, force openings in the lower part of the soil, and increase porosity.

Animals burrow beneath the surface and mix the soil material. Earthworms and prairie dogs are active in the soils of the survey area. When these animals die, their remains decay and form humus in the soil. This humus serves as a source of plant nutrients.

The native vegetation in the part of the survey area at an elevation of less than 6,400 feet consists mainly of short grasses and scattered pinyon and oneseed juniper. Above 6,400 feet, the vegetation is mainly pinyon and oneseed juniper.

The organic matter content of the soils in the area is relatively low, with a slight increase at an elevation of more than 6,400 feet. This is a result of more effective rainfall and more vegetation.

Parent material

The soils in the San Juan County, Eastern Part, formed in two major kinds of parent material: alluvial sediment and sedimentary rock.

The alluvial sediment is material that was deposited in river valleys and on mesas, plateaus, and ancient river terraces. The material has been mixed and sorted in transport and has a wide range in mineralogy and particle size. The areas in San Juan County, Eastern Part, in which alluvial sediment is dominant are in general soil map units 2, 3, and 4.

Sedimentary parent material consists mainly of sandstone and shale bedrock. It is present in the northeastern and southeastern parts of the survey area. It is dominant in general soil map units 1 and 7.

Relief

Relief is the inequalities and relative differences in elevation of a land surface. It influences soil formation by affecting surface runoff, internal drainage, erosion, and soil temperature. Variations in these factors cause differences in the thickness of the surface layer, depth of the solum, and the degree of horizon differentiation.

Sheppard, Mayqueen, and Shiprock soils, for example, are geographically associated. Typically, Shiprock soils are in concave areas and Sheppard and Mayqueen soils are in adjacent convex areas. As a result, Shiprock soils receive runoff from the Sheppard and Mayqueen soils, which contributes to a stronger degree of horizon differentiation.

Time

Time is required for soils to form from parent material. The length of time depends on the degree of expression of the other soil-forming factors. The soils in the survey area range from young soils that have little or no horizon differentiation to older soils that have distinct horizon differentiation.

Youngston and Werlog soils are young soils that formed in stratified, calcareous, loamy sediment along the flood plains of the San Juan, Animas, and La Plata Rivers. They have retained most of the characteristics of the parent material but have a slightly darker surface layer because more organic matter has accumulated.

Doak soils are older soils that formed in alluvium. Carbonates have been leached to a depth of about 17 inches, and a brown B2t horizon is at a depth of about 5 inches.

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) Anderson, R. Y. 1960. Cretaceous-Tertiary palynology of the eastern side of the San Juan Basin, New Mexico; New Mex. Inst. Min. and Tech., State Bur. Mines and Min. Res. Memoir 5.

(3) Austin, Morris E. 1965. Land resource regions and major land resource areas of the United States. U. S. Dep. Agric. Handb. 296, 82 pp., map.

(4) Cornelius, Oliver Frazier. 1933. "San Juan County Pioneer History and Reminiscences of the San Juan Basin."

(5) Dana, C. H. 1946. Stratigraphic relations of Eocene, Paleocene and latest cretaceous formations of eastern side of San Juan Basin, New Mexico: U. S. Geol. Surv. Prelim. Chart 24, Oil and Gas Invest.

(6) Hayes, P. T. 1957. U. S. Geol. Survey Geol. Quad Map Gq-98.

(7) Portland Cement Association. 1962. PCA soil primer. 52 pp., illus.

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

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

(10) United States Department of Agriculture. 1975. Soil Taxonomy: a basic system of soil classification for making and interpreting soil surveys. U. S. Dept. Agric. Handb. 436, 754 pp.

(11) United States Department of Commerce, Bureau of Census. 1967. "County and City Data Book 1967." pp. 252, 596.

Glossary

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	3.5
Low	3.5-5.0
Moderate	5.0-7.5
High	7.5-10
Very high	10

Badland. Steep or very steep, commonly nonstony barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

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 frequent flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly 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.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a fragment.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Coarse fragments. Mineral or rock particles 2 millimeters to 7.5 centimeters (3 inches) in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material or rock fragments, or both, moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A map unit of two or more kinds of soil occurring 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.

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.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

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 they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

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 from 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

B horizon.—A 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-form-

ing 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 from which the solum is presumed to have 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.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

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.

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. Inadequate strength for supporting loads.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Parent material. The unconsolidated organic and mineral material in which soil forms.

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. The slow movement of water through the soil adversely affecting the specified use.

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.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

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 be-

cause 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

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. (in tables). The slow movement of water into the soil.

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 that 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.

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.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

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.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

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 (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or " very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil, as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands 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.