

SOIL SURVEY OF

Fort Apache

Indian Reservation, Arizona

Parts of Apache, Gila,

and Navajo Counties

United States Department of Agriculture
Soil Conservation Service and
United States Department of the Interior
Bureau of Indian Affairs
In cooperation with
Arizona Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1963-67. Soil names and descriptions were approved in 1968. Unless otherwise indicated, statements in the publication refer to conditions on the Reservation in 1967. This survey was made cooperatively by the Soil Conservation Service, the Bureau of Indian Affairs, and the Arizona Agricultural Experiment Station.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, woodlands, and wildlife areas; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of the Fort Apache Indian Reservation are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suit-

ability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the range sites and woodland groups.

Foresters and others can refer to the section "Woodland" where the soils of the county are grouped according to their suitability for trees.

Wildlife managers and others can find information about soils and wildlife in the section "Wildlife."

Ranchers and others can find, under "Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain estimates of soil properties and information about soil features that affect engineering practices.

Scientists and others can read about the soils in the section "Formation and Classification of the Soils."

Newcomers in the area may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the Reservation given in the section "General Nature of the Area."

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Foreword

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

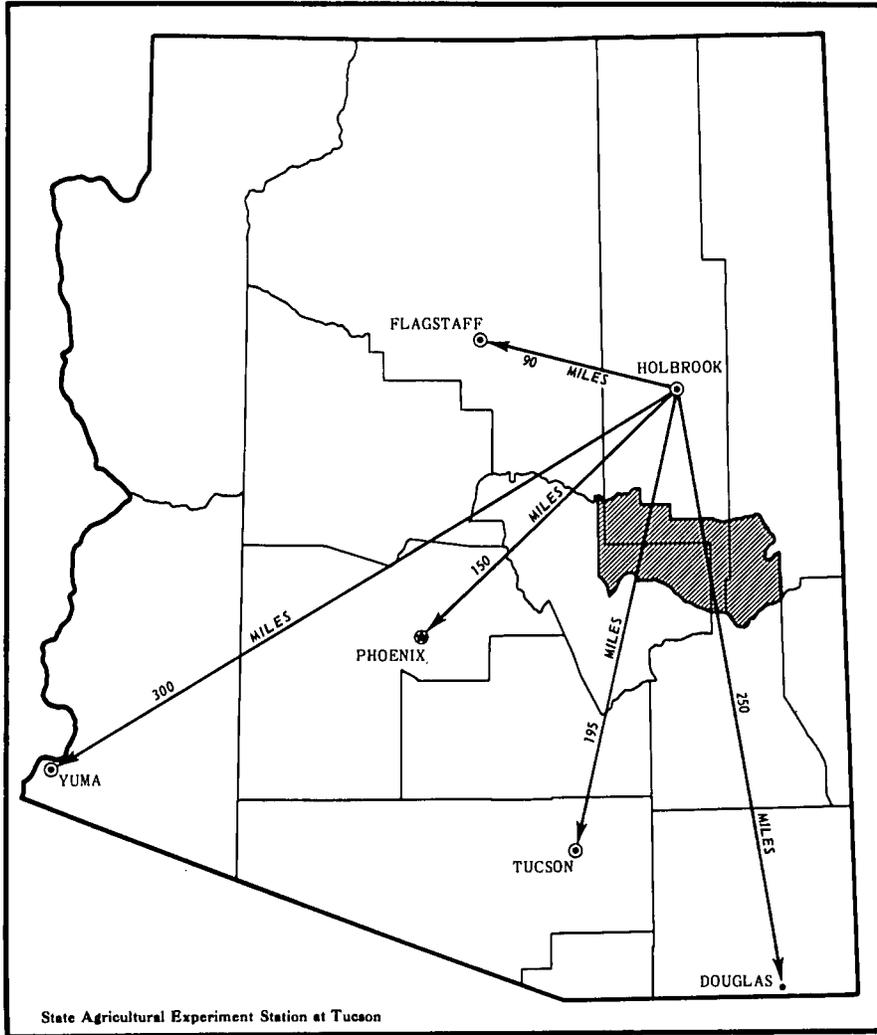
This soil survey is designed for many users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Additional soil survey data will be needed to determine the suitability of the soils for irrigated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

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

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



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Location of Fort Apache Indian Reservation in Arizona

SOIL SURVEY OF THE FORT APACHE INDIAN RESERVATION, ARIZONA PARTS OF APACHE, GILA, AND NAVAJO COUNTIES

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, AND THE UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF INDIAN AFFAIRS, IN COOPERATION WITH THE ARIZONA AGRICULTURAL EXPERIMENT STATION

FORT APACHE INDIAN RESERVATION: PARTS OF APACHE, GILA, AND NAVAJO COUNTIES (hereafter referred to as Fort Apache Indian Reservation) is in the east-central part of Arizona. (See map on facing page.) It has an area of 1,664,972 acres, or about 2,602 square miles. Whiteriver, the principal town on the Reservation, is 79 miles southwest of Holbrook and 131 miles northeast of Phoenix, Arizona.

U.S. Highway 60 (State Highway 77) crosses the northwestern part of the area. State Highways 73 and 260 serve the central and northern parts. An improved gravel road runs in an easterly direction from the town of Fort Apache to Maverick, Arizona. It is the main thoroughfare from Fort Apache to the eastern and southwestern parts of the Reservation. Many graded roads and trails give access to other parts of the Reservation.

The area is used mainly as pasture and range for cattle and horses, for commercial timber production, for recreation, and as wildlife habitat. The eastern part of the area is used intensively for recreational purposes, such as fishing, camping, hunting, and hiking. It is one of the main watershed areas for the Salt River. Limited acreage along some of the larger streams is used for cultivated crops.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the Fort Apache Indian Reservation, where they are located, and how they can be used. The soil scientists went into the area knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose 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 that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have a profile almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. Springerville and Showlow, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Showlow silt loam, 0 to 8 percent slopes, is one of several phases within the Showlow series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series or of different phases within one series. One such

kind of mapping unit—the soil complex—is shown on the soil map of Fort Apache Indian Reservation.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Thunderbird-Showlow complex, 15 to 30 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names, such as "Rock outcrop," which is a land type in the Fort Apache Indian Reservation.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

On the basis of yield and management tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the survey area. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in an association can occur in other associations, but in different patterns.

A map showing soil associations is useful to people who want to have a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide for broad planning on a watershed, a wooded tract, or a wildlife area or for broad planning of recreational facilities, community developments, and such engineering works as transportation corridors. It is not a suitable map for detailed planning for management of a farm or field or for selecting the exact

location of a road or building or other structure, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

Figure 1 shows the pattern of soil associations in the central part of the Fort Apache Indian Reservation. The numbers on the map correspond to those in the legend of the General Soil Map at the back of this survey.

The soil associations in this survey area have been grouped into general kinds of landscapes for broad interpretative purposes. Each of the broad groups and the soil associations in it are described on the following pages.

Soils on Igneous Material

Five soil associations are in this group. The soils in these associations formed in material derived from igneous rock. They are very shallow to deep. The associations are dominantly in the eastern and southeastern parts of the Reservation and are in two small areas located in the extreme western part. Elevation is mostly more than 8,000 feet but ranges from 3,000 to 11,404 feet. Precipitation ranges from 16 inches at the lower elevations to 30 or 40 inches at the higher elevations.

1. Baldy-Gordo association

Deep, moderately coarse textured to moderately fine textured, well drained soils; formed in material weathered from volcanic rock.

This association is mainly on undulating to rolling hills and steep mountains near Mount Baldy in the eastern part of the Fort Apache Indian Reservation (fig. 2). Some areas of this association are on very steep, highly dissected slopes adjacent to drainageways. The soils formed in alluvium and colluvium derived from volcanic rock, such as rhyolite, andesite, cinders, ash, and basalt. Elevation ranges from 9,000 to 11,404 feet. Annual precipitation is 30 to 40 inches, and the frost-free season ranges from 70 to 110 days.

This association makes up about 4 percent of the survey area. It is about 65 percent Baldy soils and about 20 percent Gordo soils. Cryorthents-Cryoborolls complex and Cryaquolls make up most of the remaining 15 percent.

Baldy soils are in the strongly sloping to steep areas in the vicinity of Mount Baldy. These light-colored soils are cobbly and are moderately coarse textured.

Gordo soils are on undulating to rolling hills and the lower slopes of the White Mountains. These dark-colored soils are medium textured and moderately fine textured.

The areas of this association are used mainly for recreation, as wildlife habitat, as woodland and range, and as a source of water supply. The headwaters of most of the streams in the eastern one-third of the Reservation are located in this association. Most of the water yield is provided by runoff during the spring thaw of the winter snowpack. This water is used downstream by the city of Phoenix and by farmers for irrigation in the Salt River Valley. The Cryaquolls on bottoms are well suited to use as sites for earth dams for lakes (fig. 3).

Vegetation consists of spruce, ponderosa pine, fir,

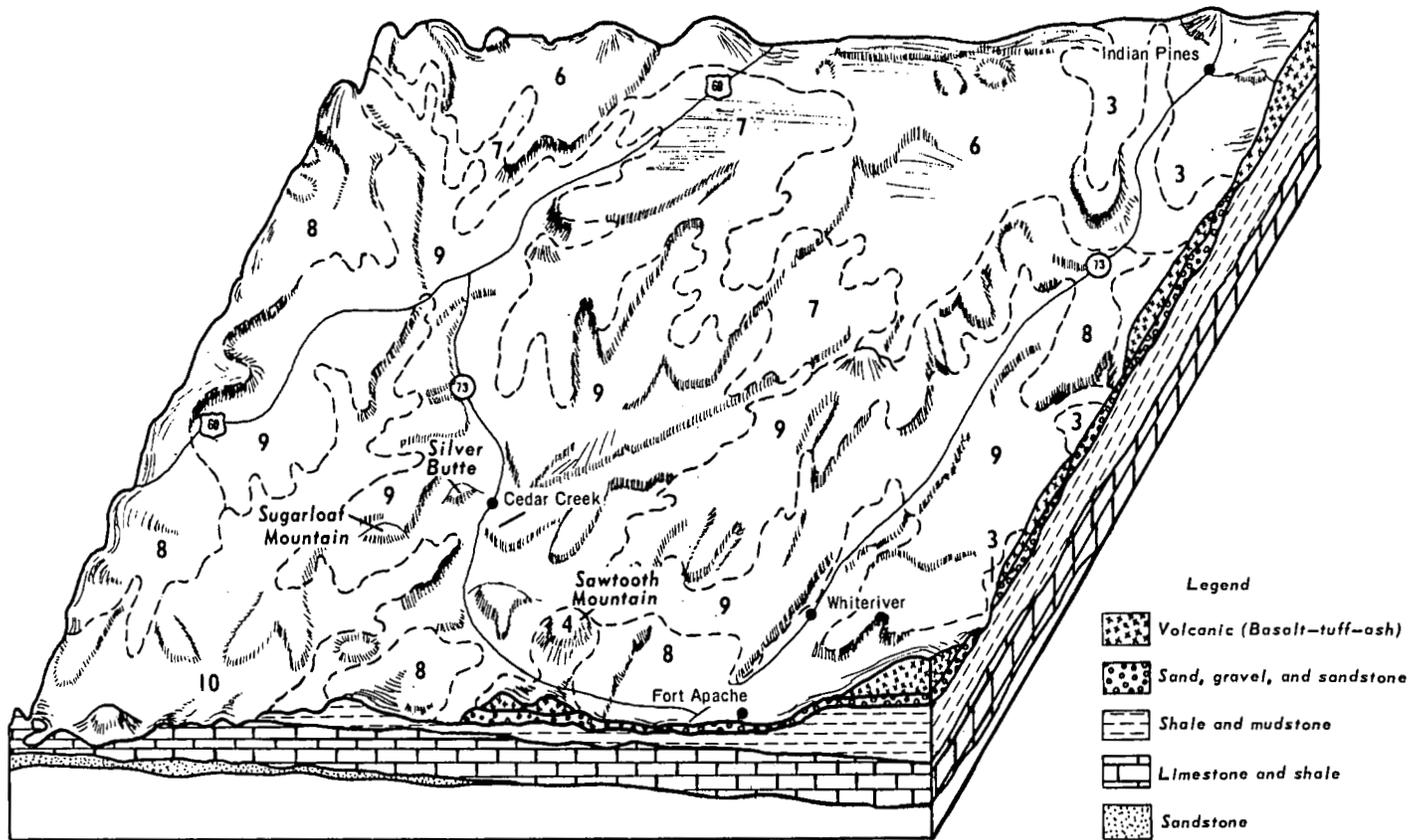


Figure 1.—Pattern of soil associations in the central part of the Fort Apache Indian Reservation.

and an understory of grasses. Spruce is the main tree species on the Baldy soils. The short growing season limits the production of timber and usable forage. Forage production is also limited by the dense canopy of trees. Areas of this association can be grazed for only 3 to 4 months during summer. The main species of wildlife are elk, deer, native trout, and blue grouse.

2. Gordo association

Deep, medium textured and moderately fine textured, well drained soils; formed in material weathered from basalt, cinders, and ash

This association is in a wide area below and around Mount Baldy in the eastern part of the Fort Apache Indian Reservation. This area is made up of nearly level plains, undulating to rolling hills, and moderately steep to steep mountains (fig. 4). Some areas of very steep soils are adjacent to drainageways. The soils formed in material derived from basalt, cinders, and ash. Elevation ranges from 8,000 to 9,000 feet. Annual precipitation is 24 to 30 inches, and the frost-free season ranges from 85 to 110 days.

This association makes up about 8 percent of the survey area. It is about 75 percent Gordo soils, 15 percent Tatiyee and Sizer soils and Cryorthents-Cryoborolls complex, and about 10 percent Ess soils.

Gordo soils are adjacent to drainageways that dissect

the area. These soils are nearly level to steep, deep, well drained, dark colored, and medium textured and moderately fine textured.

The areas of this association are used mainly for recreation, as wildlife habitat, as range, and as a source of water supply. These areas also produce large amounts of timber for commercial uses. Luna silt loam, wet variant, and Luna clay loam, wet variant, which are of minor extent and are along drainageways, are well suited to use as sites for earth-filled dams. The water yield is high in this association. Most of the runoff occurs during the spring thaw of the winter snowpack. The many campsites in the forest and along the rivers, streams, and lakes are used intensively for recreation.

Vegetation consists of mixed conifers, aspen, and an understory of grasses. Because of the short growing season, moderate amounts of forage are produced. This forage can be grazed by livestock and elk for only 3 or 4 months in summer. The main species of wildlife are elk, deer, and trout.

3. Sponseller-Ess association

Deep, medium textured and moderately fine textured, well drained soil; formed in material weathered from basic igneous rock

This association is in a wide belt extending from an area north of the town of McNary to the southeastern



Figure 2.—An area of Baldy-Gordo association.

part of the Reservation along the Black River. This area is made up of nearly level to rolling plains, moderately steep hills, and steep mountains (fig. 5). Many V-shaped drainageways dissect the area south of McNary. The soils formed in material weathered from basic igneous rock. Elevation ranges from 7,000 to 8,400 feet. Annual precipitation is 20 to 30 inches, and the frost-free season ranges from 90 to 125 days.

This association makes up about 13 percent of the survey area. It is about 45 percent Sponseller soils, 25 percent Ess soils, 15 percent Broliar soils, 10 percent Luna soils, and 5 percent very steep Cryorthents-Cryoborolls complex. Sizer soils are also of minor extent in this association.

Sponseller and Ess soils are deep, well drained, dark colored, and medium textured and moderately fine textured. They are more than 35 percent pebbles and cobbles.

The areas of this association are mainly used for recreation, as woodland, as wildlife habitat, as range, and as a source of water supply. These areas also produce most of the merchantable timber on the Reservation. Luna silt loam, wet variant, and Luna clay loam, wet variant, are well suited to use as sites for earth-filled dams. The water yield of this association is moderate. The many campsites in the forest and along the rivers, streams, and lakes are used intensively for recreation.

Vegetation is ponderosa pine, Gambel oak, and grasses. These areas produce moderate amounts of forage and browse for livestock and wildlife, and they provide the main summer grazing areas for livestock, elk, deer, and turkey. The main species of wildlife are elk, deer, turkey, and trout.

4. Thunderbird association

Moderately deep, moderately fine textured and fine textured, well drained soils; formed in material weathered from basic igneous rock

Most of this association is in Bonita Prairie in the extreme southern part of the Fort Apache Indian Reservation and north of the Black River. Two small areas are located west of the village of Fort Apache, and another long narrow area is along U.S. Highway 60 southwest of the village of Forestdale. The areas of this association are made up of nearly level to rolling plains and hills dissected by steep-sided V-shaped waterways (fig. 6). The soils formed in material weathered from basalt. Elevation ranges from 5,000 to 7,000 feet. Annual precipitation is 16 to 20 inches, and the frost-free season ranges from 120 to 160 days.

This association makes up about 12 percent of the survey area. It is 87 percent Thunderbird soils and 13 percent Cabezon, Springerville, Lynx, and Jacques soils and Haplustolls-Ustorthents complex.

Thunderbird soils are moderately deep to bedrock, are undulating to steeply sloping, and are on plains and on some of the steep sides of the V-shaped waterways. They are well drained, dark-colored, moderately fine textured and fine textured soils that formed in material weathered from basalt.

The areas of this association are used mainly as range and wildlife habitat. Lynx and Jacques soils are well suited to use as sites for earth-filled dams for water impoundment.

Vegetation consists of alligator juniper, oak, various shrubs, grama grasses and pine. These areas produce browse and forage for livestock and wildlife. The main species of wildlife are deer, pronghorn, antelope, turkey, javelina, and fish. Elk also occupy these areas during winter.

5. Barkerville-Haplustolls-Ustorthents association

Very shallow and shallow, moderately coarse textured, well drained soils; formed in material weathered from diabase or granite

This association is in the southwestern part of the Fort Apache Indian Reservation and is on moderately sloping to moderately steep hills and steep mountains (fig. 7). Many steep V-shaped drainageways dissect the area. The soils formed in granite or diabase. The elevation of most of the area ranges from 4,000 to 5,500 feet,

but narrow areas of Haplustolls-Ustorthents complex along the Salt River have elevations of 3,000 to 4,000 feet. Annual precipitation ranges from 14 to 18 inches, and the frost-free season ranges from 150 to 240 days.

This association makes up about 3 percent of the survey area. It is about 70 percent Haplustolls-Ustorthents complex and about 30 percent Barkerville soils. Minor in this association are very small areas of Showlow and Jacks soils that are on a few ridgetops.

The Haplustolls-Ustorthents complex is on highly dissected slopes of the V-shaped drainageways. It is very steep and very shallow and shallow.

Barkerville soils are on hills and mountains. They are well drained, shallow, moderately coarse textured, moderately sloping to steeply sloping soils that formed in material weathered from granite or diabase.

The areas of this association are used mainly as range and wildlife habitat. Vegetation consists of juniper, mesquite, oak, shrubs, and grasses. These areas produce small amounts of forage and browse for wildlife and livestock. The main species of wildlife are deer and javelina, and quail.

Soils on Sedimentary Rock or Old Gravelly Alluvium in the 14 to 24 Inch Precipitation Zone

Two soil associations are in this group. The soils in



Figure 3.—Recreation lake impounded behind earth-filled dam made with material from Gordo cobbly loam, 8 to 30 percent slopes.



Figure 4.—Recreation facility in a timbered area of Gordo association.

these associations have a light-colored surface layer and are very shallow to very deep. These associations are in the north-central and northwestern parts of the survey area in the vicinity of and along the Mogollon Rim. Elevation ranges from 5,500 to 7,300 feet but is dominant between 6,000 to 7,200 feet. Precipitation ranges from 16 inches at the lower elevations to 24 inches at the higher elevations.

6. Overgaard-Elledge association

Moderately deep to deep, mostly fine textured, well drained soils; formed in material weathered from sandstone and old gravelly alluvium

This association is in the northern and northwestern parts of the Reservation. It is nearly level to undulating and hilly and has many steep side slopes along the drainageways that dissect the area (fig. 8). Elevation ranges from 6,000 to 7,300 feet. Annual precipitation is 18 to 24 inches, and the frost-free season ranges from 110 to 130 days.

This association makes up about 11 percent of the survey area. It is about 55 percent Overgaard soils, 25 percent Haplustolls-Ustorthents complex, and 20 percent Elledge soils. Minor in this association are areas of Amos soils between the towns of Cedar Creek and Carrizo.

Overgaard soils are on nearly level to hilly, broad ridges, and in places these soils are steeply sloping. They

are gravelly, deep, light-colored, mostly fine textured, well drained soils that formed in old gravelly alluvium that overlies sandstone.

The Haplustolls-Ustorthents complex is made up of very steeply sloping soils that are adjacent to the intermittent streams that dissect the area.

The Elledge soils are on the lower part of the steep slopes that are adjacent to the drainageways. The soils are nearly level to steep, well drained, light colored, mostly fine textured, and moderately deep and formed in material weathered from sandstone.

The areas of this association are used mainly as wildlife habitat, as woodland, as range, and as a source of water supply. The water yield is moderate. Large amounts of timber are also produced in these areas.

Vegetation consists of ponderosa pine, Gambel oak, shrubs, and grasses. An understory in the timbered area is used as forage for livestock and wildlife. The main species of wildlife are deer, turkey, bear, and mountain lion.

7. Haplustolls-Ustorthents-Telephone-Elledge association

Very shallow to moderately deep, moderately coarse textured to fine textured, well drained soils; formed in material weathered from sandstone

This association is along breaks in the vicinity of the town of Forestdale and is west, south, and southwest

of that community. Many V-shaped drainageways dissect the area. These rolling, hilly, and steep soils formed mainly in material weathered from sandstone. Elevation ranges from 5,500 feet to 6,800 feet. Annual precipitation is 16 to 24 inches, and the frost-free season ranges from 110 to 130 days.

This association makes up about 6 percent of the survey area. It is 35 percent Haplustolls-Ustorthents complex, 25 percent Telephone soils, 25 percent Elledge soils, 10 percent Haplustolls-Torrifluvents complex, and 5 percent Lynx soils.

The Haplustolls-Ustorthents complex consists of very shallow and shallow, very steep soils that are in dissected areas along drainageways.

Telephone soils are on nearly level to moderately steep and steep breaks along the northern part of the area. They are light-colored, well drained, very cobbly, moderately coarse textured, shallow soils over sandstone.

Elledge soils are on nearly level to moderately steep and steep breaks along the northern part of the area. They are light-colored, well drained, fine textured, moderately deep soils over sandstone.

The areas of this association are used mainly as range, as woodland, and as wildlife habitat. These areas

produce ponderosa pine for commercial uses. The Haplustolls and Torrifuvents are well suited to use as sources of material for road fill.

Vegetation consists of ponderosa pine, Gambel oak, shrubs, and grasses. These areas produce moderate amounts of forage and browse for livestock and wildlife. The main species of wildlife are deer and turkey. A few elk inhabit the areas of this association during winter.

Soils on Sedimentary Rock or Old Gravelly Alluvium in the 16 to 20 Inch Precipitation Zone

Three soil associations are in this group. The soils in these associations have thick and thin, dark-colored surface layers. They are very shallow to deep soils formed in material weathered from interbedded sandstone, siltstone, and shale and in material weathered from limestone and gravelly alluvium. They are medium textured to fine textured and have variable amounts of pebbles and cobbles. These associations are in the central, southern, and western parts of the Reservation, and one small area is in the extreme southwestern part of the survey area. Elevation is mainly 4,500 to 6,000 feet but ranges from 4,200 to 6,600 feet.



Figure 5.—An area of Sponseller-Ess association.

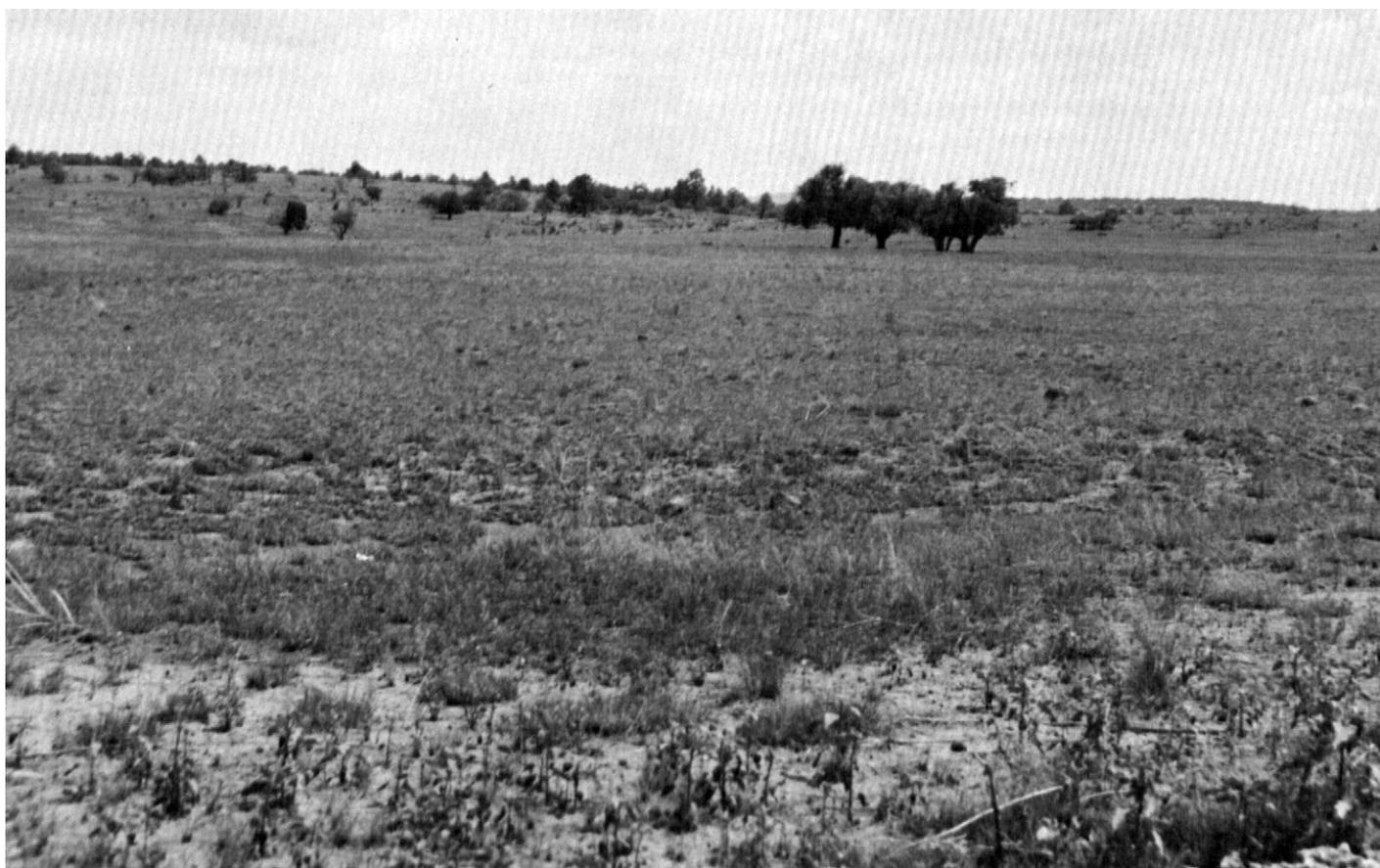


Figure 6.—An area of Thunderbird association.

Precipitation ranges from about 14 inches at the lower elevations to 20 inches at the higher elevations.

8. *Showlow-Cibeqe association*

Deep, mostly medium textured to fine textured, well drained soils; formed in material weathered from old gravelly alluvium

This association is in several areas in the south-central and southwestern parts of the Reservation. The nearly level to hilly soils are on old alluvial fans that are dissected by steep V-shaped drainageways (fig. 9). The soils formed in old gravelly alluvium of mixed origin. Elevation ranges from 3,400 to 6,600 feet. Annual precipitation is about 15 to 20 inches, and the frost-free season ranges from 110 to 240 days.

This association makes up about 11 percent of the survey area. It is about 60 percent Showlow soils, 20 percent Cibeqe soils, 15 percent Haplustolls-Ustorthents complex, and 5 percent Tours soils.

The Showlow soils are mainly nearly level to hilly. They are deep, dark-colored, gravelly, well drained, and mostly fine textured soils.

The Cibeqe soils are gently rolling to steep and are adjacent to the drainageways. They are deep, dark-colored, gravelly, well drained, and mostly medium textured soils.

The areas of this association are mainly used as

range and wildlife habitat. The Showlow and Cibeqe soils are good sources of material for road fill. The Showlow and Tours soils are fairly well suited to use as sites for earth-filled dams for the impoundment of water.

Vegetation consists of juniper, shrubs, and grama grasses. Some ponderosa pine that grows at an elevation of more than 6,000 feet is harvested. Large amounts of forage and browse for livestock and wildlife are produced. The main species of wildlife are deer, turkey, and javelina.

9. *Haplustolls-Ustorthents-Jacks-Chevelon association*

Very shallow to deep, fine textured and moderately fine textured, well drained soils; formed in material weathered from sandstone, siltstone, or shale

This association is in several scattered areas extending from the town of Whiteriver to the western boundary of the Reservation (fig. 10, see page 14). The nearly level to rolling soils are on plains and hills that are dissected by V-shaped drainageways that have steep side slopes. The soils formed in material weathered from interbedded sandstone, siltstone, and shale. Elevation ranges from 4,500 to 6,000 feet. Annual precipitation is 16 to 20 inches, and the frost-free season ranges from 120 to 170 days.

This association makes up about 23 percent of the

survey area. It is about 40 percent Haplustolls-Ustorthents complex, 20 percent Jacks soils, 20 percent Chevelon soils, and 20 percent Tortugas, Roundtop, Rond, Tours, and Navajo soils.

The Haplustolls-Ustorthents complex consists of very steeply sloping soils that are on side slopes adjacent to the drainageways and small bottoms. These soils are very shallow and shallow.

Jacks soils are fine textured and moderately deep to deep. Chevelon soils are moderately fine textured and moderately deep to bedrock. Both of these soils are on nearly level to rolling plains, moderately steep hills, and some of the steep slopes adjacent to the drainageways. Also, both are well drained, light-colored soils that formed in interbedded siltstone and sandstone.

The areas of this association are used mainly as range and wildlife habitat. The Tours soils are fairly well suited to use as sites for earth-filled dams.

Vegetation consists of pinon pine, juniper, shrubs, and grasses. These areas produce large amounts of browse and moderate amounts of forage for livestock and wildlife. The main species of wildlife are deer, turkey, and javelina.

10. Haplustolls-Ustorthents-Tortugas-Roundtop association

Very shallow to moderately deep, gravelly to very cobbly, medium textured to fine textured, well drained soils; formed in material weathered from limestone

This association is in the western part of the Reser-

vation north of the Salt River and along the tributaries of the Salt River (fig. 11, see page 15). The steeply sloping soils are on both sides of the major drainageways that dissect these areas. The soils formed in material weathered from limestone. Elevation ranges from 4,000 to 6,000 feet. Annual precipitation is 16 to 20 inches, and the frost-free season ranges from 120 to 170 days.

This association makes up about 9 percent of the survey area. It is about 50 percent Haplustolls-Ustorthents complex, 30 percent Tortugas soils, and 20 percent Roundtop soils.

The Haplustolls-Ustorthents complex consists of very steep, very shallow and shallow soils on the side slopes along the Salt River and its tributaries.

The Tortugas soils are nearly level to very steep soils on the hills and side slopes adjacent to and above the drainageways. These soils are well drained, dark-colored, very cobbly, medium textured, and shallow to bedrock.

The Roundtop soils are on nearly level to rolling plains, on moderately steep hills, and on steep side slopes adjacent to the major drainageways. These soils are well drained, dark-colored, gravelly, fine textured, and moderately deep to limestone.

The areas of this association are used mainly as range and wildlife habitat. Vegetation consists of pinon pine, juniper, shrubs, grasses, and scattered pines that are at the higher elevations. These areas produce large

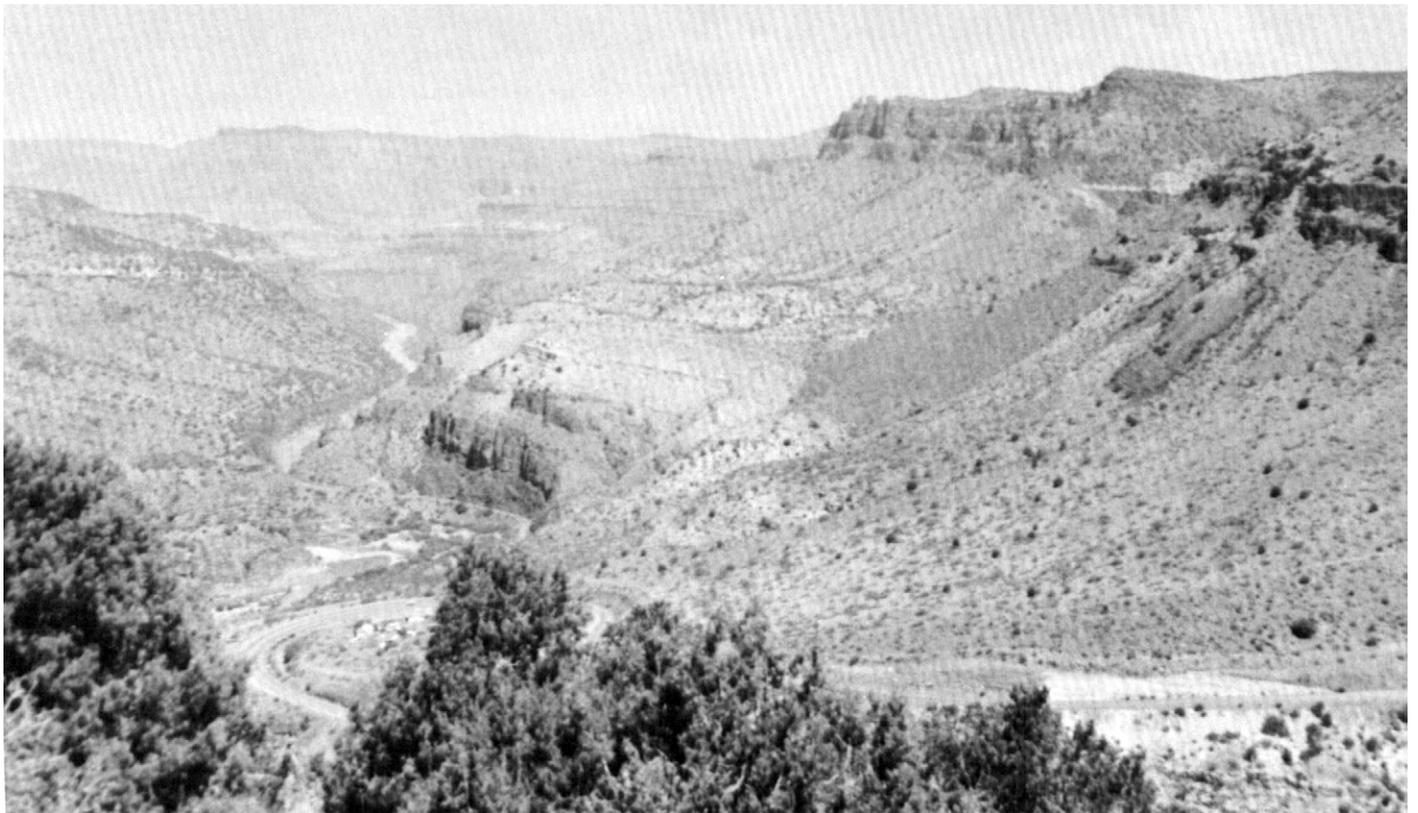


Figure 7.—An area of Barkerville-Haplustolls-Ustorthents association.



Figure 8.—An area of Overgaard-Elledge association.

amounts of browse and small amounts of forage for livestock. The main species of wildlife are deer, bear, javelina, and turkey.

Descriptions of the Soils

This section describes the soil series and mapping units in Fort Apache Indian Reservation. Each soil series is described in detail, and then, briefly, each mapping unit in that series is described. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile; that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for dry soil unless otherwise stated. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing

the mapping unit, or they are differences that are apparent in the name of the mapping unit.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Haplustolls-Ustorthents complex, for example, is not a member of a soil series but, nevertheless, is listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and, where applicable, the woodland suitability group in which the mapping unit has been placed.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (5).¹

Amos Series

The Amos series consists of well drained soils on hills. These soils formed in material weathered from shale, siltstone, or soft calcareous sandstone. Slopes are 8 to 15 percent. Elevation ranges from 6,000 to 6,800

¹ Italic numbers in parentheses refer to Literature Cited, p. 94.

TABLE 1.—Approximate acreage and proportionate extent of the soils

Map symbol	Soil	Acres	Percent	Map symbol	Soil	Acres	Percent
1C	Amos clay loam, 8 to 15 percent slopes	8,325	0.5	36B	Gordo silt loam, 0 to 8 percent slopes	7,020	0.4
2D	Baldy cobbly fine sandy loam, 8 to 30 percent slopes	8,608	.5	37C	Gordo silt loam, 8 to 15 percent slopes	7,889	.5
3E	Baldy cobbly fine sandy loam, 30 to 50 percent slopes	36,629	2.2	38B	Gordo gravelly silt loam, 0 to 8 percent slopes	9,422	.6
4D	Barkerville cobbly sandy loam, 15 to 30 percent slopes, eroded	1,892	.1	39B	Gordo cobbly silt loam, 0 to 8 percent slopes	1,600	.1
5E	Barkerville cobbly sandy loam, 30 to 50 percent slopes, eroded	6,835	.4	40B	Haplustolls-Torrifuvents complex	9,748	.6
6C	Barkerville-Showlow complex, 8 to 15 percent slopes, eroded	2,105	.1	41E	Haplustolls-Ustorthents complex	349,467	20.8
7B	Brolliar silt loam, 0 to 8 percent slopes	6,203	.4	42C	Jacks very fine sandy loam, 8 to 15 percent slopes	4,995	.3
8B	Brolliar cobbly silt loam, 0 to 8 percent slopes	3,330	.2	43B	Jacks loam, 0 to 8 percent slopes	4,063	.2
9D	Brolliar cobbly silt loam, 8 to 30 percent slopes	16,650	1.0	44D	Jacks cobbly loam, 15 to 30 percent slopes	13,728	.8
10D	Brolliar cobbly clay loam, 15 to 30 percent slopes	3,097	.2	45E	Jacks cobbly loam, 30 to 50 percent slopes	18,134	1.1
11E	Brolliar-Cryorthents-Cryoborolls complex, 30 to 50 percent slopes	1,775	.1	46C	Jacks gravelly clay loam, 8 to 15 percent slopes, eroded	3,057	.2
12E	Cabezon-Rock outcrop complex, 30 to 50 percent slopes	6,367	.4	47D	Jacks cobbly clay loam, 8 to 30 percent slopes, eroded	15,420	.9
13B	Chevelon silt loam, 0 to 8 percent slopes, eroded	1,594	.1	48B	Jacques clay loam	2,552	.2
14D	Chevelon cobbly clay loam, 8 to 30 percent slopes, eroded	38,294	2.3	49B	Jacques clay loam, eroded	1,166	.1
15D	Chevelon cobbly clay loam, 15 to 30 percent slopes, severely eroded	3,872	.2	50D	Luna cobbly silt loam, 15 to 30 percent slopes	8,325	.5
16E	Chevelon cobbly clay loam, 30 to 50 percent slopes, eroded	19,424	1.2	51E	Luna cobbly silt loam, 30 to 50 percent slopes	5,060	.3
17D	Chevelon-Jacks cobbly clay loams, 15 to 30 percent slopes, eroded	1,242	.1	52D	Luna clay loam, 15 to 30 percent slopes	1,960	.1
18D	Cibeque gravelly loam, 8 to 30 percent slopes	7,698	.5	53E	Luna clay loam, 30 to 50 percent slopes	2,960	.2
19E	Cibeque gravelly loam, 30 to 50 percent slopes, eroded	24,975	1.5	54B	Luna silt loam, wet variant	1,300	.1
20E	Cibeque-Chevelon complex, 30 to 50 percent slopes, eroded	9,990	.6	55B	Luna clay loam, wet variant	1,693	.1
21B	Cryaquolls, nearly level	415	(¹)	56B	Lynx loam, eroded	7,043	.4
22E	Cryorthents-Cryoborolls complex	28,305	1.7	57B	Navajo clay loam, eroded	2,272	.1
23B	Elledge sandy loam, 0 to 8 percent slopes	2,705	.2	58B	Navajo clay loam, severely eroded	1,185	.1
24E	Elledge sandy loam, 30 to 50 percent slopes	8,274	.5	59B	Overgaard gravelly fine sandy loam, 0 to 8 percent slopes	2,297	.1
25B	Elledge cobbly sandy loam, 0 to 8 percent slopes	900	.1	60D	Overgaard gravelly fine sandy loam, 8 to 30 percent slopes	21,645	1.3
26C	Elledge cobbly sandy loam, 8 to 15 percent slopes, eroded	15,081	.9	61B	Overgaard gravelly loam, 0 to 8 percent slopes	7,662	.5
27D	Elledge cobbly sandy loam, 15 to 30 percent slopes	2,846	.2	62D	Overgaard gravelly loam, 15 to 30 percent slopes	14,200	.9
28C	Elledge-Rock outcrop complex, 8 to 15 percent slopes	1,435	.1	63E	Overgaard gravelly loam, 30 to 50 percent slopes	34,098	2.0
29E	Elledge-Overgaard-Rock outcrop complex, 30 to 50 percent slopes	46,619	2.8	64D	Overgaard-Elledge complex, 15 to 30 percent slopes	7,086	.4
30B	Ess cobbly loam, 0 to 8 percent slopes	5,735	.4	65D	Overgaard-Telephone complex, 15 to 30 percent slopes	3,330	.2
31D	Ess cobbly loam, 8 to 30 percent slopes	36,629	2.2	66B	Rond loam, 0 to 8 percent slopes	5,162	.3
32E	Ess cobbly loam, 30 to 50 percent slopes	29,653	1.8	67C	Rond loam, 8 to 15 percent slopes	1,303	.1
33D	Gordo loam, 0 to 30 percent slopes	2,113	.1	68B	Rond gravelly loam, 0 to 8 percent slopes	1,242	.1
34D	Gordo cobbly loam, 8 to 30 percent slopes	53,279	3.2	69D	Rond gravelly loam, 8 to 30 percent slopes	4,610	.3
35E	Gordo cobbly loam, 30 to 50 percent slopes	31,585	1.9	70B	Roundtop clay loam, 0 to 8 percent slopes	6,658	.4
				71B	Roundtop gravelly clay loam, 0 to 8 percent slopes, eroded	2,160	.1
				72D	Roundtop gravelly clay loam, 15 to 30 percent slopes	4,410	.3
				73D	Roundtop-Rock outcrop complex, 8 to 30 percent slopes, eroded	24,975	1.5
				74E	Roundtop-Rock outcrop complex, 30 to 50 percent slopes, eroded	659	(¹)
				75D	Roundtop-Jacks-Rock outcrop complex, 15 to 30 percent slopes, eroded	14,485	.9

TABLE 1.—Approximate acreage and proportionate extent of the soils—Continued

Map symbol	Soil	Acres	Percent	Map symbol	Soil	Acres	Percent
76E	Roundtop-Tortugas-Rock outcrop complex, 30 to 50 percent slopes -----	5,822	0.4	97B	Thunderbird gravelly clay loam, 0 to 8 percent slopes -----	8,166	0.5
77B	Showlow silt loam, 0 to 8 percent slopes -----	2,828	.2	98B	Thunderbird cobbly clay loam, 0 to 8 percent slopes -----	59,939	3.6
78C	Showlow silt loam, 8 to 15 percent slopes -----	1,700	.1	99D	Thunderbird cobbly clay loam, 8 to 30 percent slopes -----	53,741	3.2
79D	Showlow cobbly silt loam, 15 to 30 percent slopes -----	1,387	.1	100E	Thunderbird cobbly clay loam, 30 to 50 percent slopes -----	16,650	1.0
80B	Showlow gravelly clay loam, 0 to 8 percent slopes -----	6,589	.4	101B	Thunderbird-Rock outcrop complex, 0 to 8 percent slopes --	17,172	1.0
81D	Showlow gravelly clay loam, 8 to 30 percent slopes, eroded -----	74,924	4.5	102D	Thunderbird-Rock outcrop complex, 15 to 30 percent slopes -----	13,347	.8
82E	Showlow gravelly clay loam, 30 to 50 percent slopes -----	13,282	.8	103E	Thunderbird-Chevelon-Rock outcrop complex, 30 to 50 percent slopes, eroded -----	3,330	.2
83E	Showlow-Barkerville complex, 30 to 50 percent slopes, eroded -----	13,320	.8	104E	Thunderbird-Roundtop-Rock outcrop complex, 30 to 50 percent slopes, eroded -----	1,592	.1
84D	Showlow-Chevelon complex, 15 to 30 percent slopes, eroded -----	3,803	.2	105D	Thunderbird-Showlow complex, 15 to 30 percent slopes -----	2,893	.2
85B	Sizer gravelly silt loam, 0 to 8 percent slopes -----	1,160	.1	106D	Tortugas cobbly loam, 15 to 30 percent slopes -----	19,950	1.2
86D	Sizer gravelly silt loam, 8 to 30 percent slopes -----	7,200	.4	107E	Tortugas-Rock outcrop complex, 30 to 50 percent slopes -----	21,645	1.3
87E	Sizer gravelly silt loam, 30 to 50 percent slopes -----	3,864	.2	108E	Tortugas-Chevelon-Rock outcrop complex, 30 to 50 percent slopes -----	16,382	1.0
88B	Sponseller cobbly loam, 0 to 8 percent slopes -----	24,975	1.5	109E	Tortugas-Roundtop-Rock outcrop complex, 30 to 50 percent slopes -----	27,046	1.6
89D	Sponseller cobbly loam, 8 to 30 percent slopes -----	30,027	1.8	110E	Tortugas-Showlow-Rock outcrop complex, 30 to 50 percent slopes -----	2,033	.1
90E	Sponseller cobbly loam, 30 to 50 percent slopes -----	16,845	1.0	111B	Tours fine sandy loam, 0 to 8 percent slopes, eroded -----	8,325	.5
91B	Sponseller gravelly silt loam, 0 to 8 percent slopes -----	21,505	1.3	112B	Tours silt loam, 0 to 8 percent slopes -----	3,505	.2
92B	Springerville cobbly clay -----	5,509	.3	113B	Tours silt loam, 0 to 8 percent slopes, eroded -----	15,325	.9
93B	Tatiyee gravelly loam, 0 to 8 percent slopes -----	6,155	.4	114B	Tours complex -----	1,589	.1
94D	Telephone very sandy loam, 8 to 30 percent slopes -----	6,150	.4		Total -----	1,664,972	100.0
95D	Telephone very cobbly sandy loam, 15 to 30 percent slopes -----	7,050	.4				
96E	Telephone-Rock outcrop complex, 30 to 50 percent slopes -----	7,227	.4				

¹ Less than 0.05 percent.

feet. Vegetation is ponderosa pine, Gambel oak, and an understory of shrubs and grasses. Annual precipitation is 16 to 22 inches, and mean annual temperature is about 50° F. The frost-free season ranges from 110 to 130 days.

In a representative profile the surface layer is brown clay loam 3 inches thick. The subsoil is brown and yellowish brown clay and heavy clay loam 38 inches thick. The substratum is weathered shale and siltstone.

These soils are slowly permeable. The water supplying capacity is 12 to 16 inches. Available water capacity is high. Effective rooting depth is 40 to 56 inches. Reaction is neutral to moderately alkaline.

Amos soils are used for the production of timber, as wildlife habitat, and as a source of water supply. They produce an understory of forage for wildlife and livestock.

Representative profile of Amos clay loam, 8 to 15 percent slopes, NW $\frac{1}{4}$ sec. 3, T. 8 N, R. 22 E.:

A1—0 to 3 inches, brown (10YR 5/3) clay loam,

brown (10YR 4/3) moist; weak very fine granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; many fine roots; common very fine interstitial pores; neutral; gradual smooth boundary.
B21t—3 to 10 inches, brown (10YR 4/3, dry or moist) clay; moderate fine subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; abundant fine and very fine and few coarse roots; few fine interstitial and tubular pores; common moderately thick clay films on peds; neutral; gradual wavy boundary.

B22t—10 to 25 inches, yellowish-brown (10YR 5/4) clay, dark yellowish-brown (10YR 4/4) moist; few fine distinct reddish-yellow (7.5YR 6/6) mottles; strong medium subangular blocky structure; very

hard when dry, very firm when moist, sticky and plastic when wet; few very fine and abundant coarse roots; few fine interstitial and tubular pores; many moderately thick clay films on pedes; slightly effervescent; mildly alkaline; gradual wavy boundary.

B3t—25 to 41 inches, yellowish-brown (10YR 5/4) heavy clay loam, dark yellowish-brown (10YR 4/4) moist; common medium distinct reddish-yellow (7.5YR 6/6) mottles; weak medium subangular blocky structure; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; few very fine and few coarse roots; few fine interstitial and tubular pores; few thin clay films line pores; common horizontal pressure faces; slightly effervescent; moderately alkaline; diffuse wavy boundary.

C1—41 to 50 inches, light yellowish-brown (10YR 6/4) and reddish-yellow (5YR 6/5) weathered finely stratified shale and siltstone, yellowish-brown (10YR 5/4) and yellowish-red (5YR 5/6) moist; very few very fine roots along cleavage planes.

C2—50 to 56 inches, stratified shale and siltstone.

Bedrock is at a depth of 40 to 56 inches. The A1 horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 3 or 4. It is

loam or clay loam. The B2t horizon has hue of 7.5YR or 10YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 3 or 4. The C horizon is finely stratified shale, siltstone, or calcareous sandstone.

1C—Amos clay loam, 8 to 15 percent slopes. This gently rolling to rolling soil is on hills in a few small areas west of the town of Lakeside.

Runoff is medium, and the hazard of erosion is moderate.

The soil produces small amounts of timber for commercial uses and an understory of forage for livestock and wildlife. Capability unit VIe-8; woodland suitability group 7c1.

Baldy Series

The Baldy series consists of well drained soils that are strongly sloping to steep on Mount Baldy. These soils formed in alluvium and colluvium derived from rhyolite or andesite and some ash. Slopes are 8 to 50 percent. Elevation ranges from 9,000 to 11,500 feet. Vegetation is spruce-fir at higher elevations and mixed conifer forest at lower elevations. The amount of herbaceous ground cover depends on the density of the forest canopy. Annual precipitation is 30 to 40 inches, and mean annual temperature is 37° F. The frost-free season ranges from 70 to 85 days.

In a representative profile the surface layer is a light brownish gray cobbly fine sandy loam 4 inches thick. The underlying layer is pinkish gray, very pale



Figure 9.—An area of Showlow-Cibeque association.

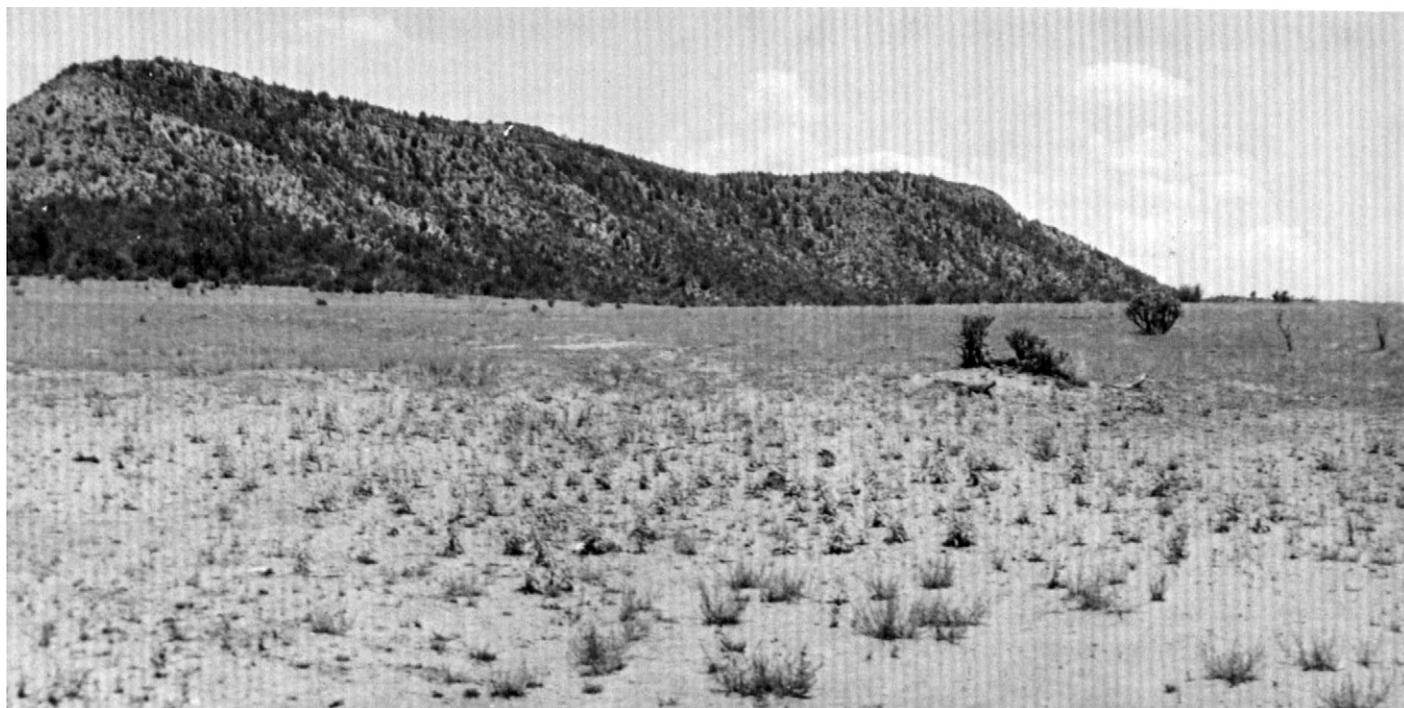


Figure 10.—An area of Haplustolls-Ustorthents-Jacks-Chevelon association.

brown, light gray, and yellowish brown cobbly and gravelly fine sandy loam and sandy loam to a depth of 60 inches or more.

These soils are moderately rapidly permeable. The water supplying capacity is 20 to 28 inches. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Reaction is medium acid.

Baldy soils are used mainly as woodland, as wildlife habitat, and as a source of water supply. They produce an understory of forage for livestock and wildlife.

Representative profile of Baldy cobbly fine sandy loam, 30 to 50 percent slopes, $\frac{1}{4}$ mile east of Hurricane Lake, SE $\frac{1}{4}$ sec. 12, T. 5 N., R. 26 E.:

O1—1 inch to 0, spruce, aspen, and fir litter.

A1—0 to 4 inches, light brownish gray (10YR 6/2) cobbly fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak medium and fine granular structure; soft when dry, very friable when moist, nonsticky and slightly plastic when wet; many fine roots; many fine interstitial pores; 20 percent coarse fragments; medium acid; clear smooth boundary.

C1—4 to 12 inches, pinkish gray (7.5YR 7/2) cobbly fine sandy loam, dark brown (7.5YR 4/2) when moist; weak medium granular structure; soft when dry, very friable when moist, nonsticky and slightly plastic when wet; many fine and very fine and few coarse roots; common fine interstitial pores; 20 percent coarse fragments; medium acid; gradual wavy boundary.

C2—12 to 18 inches, very pale brown (10YR 7/3) cobbly fine sandy loam, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine and coarse roots; common fine interstitial and tubular pores; 25 percent coarse fragments; medium acid; gradual wavy boundary.

C3—18 to 32 inches, light gray (10YR 7/2) gravelly sandy loam, brown (10YR 5/3) when moist, few fine faint yellowish-brown (10YR 5/6) mottles; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine and coarse roots; common fine tubular pores; 30 percent coarse fragments; medium acid; gradual wavy boundary.

C4—32 to 60 inches, yellowish brown (10YR 5/4) cobbly sandy loam, dark yellowish brown (10YR 4/4) when moist, few fine faint yellowish brown (10YR 5/6) mottles; massive; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; abundant coarse roots; common fine interstitial and tubular pores; 40 percent coarse fragments; medium acid.

The profile is 15 to 35 percent coarse fragments. It is medium acid to slightly acid. The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 2 or 3. The C horizon is

gravelly, cobbly, or stony fine sandy loam or sandy loam.

2D—Baldy cobbly fine sandy loam, 8 to 30 percent slopes. This strongly sloping to moderately steep soil is on the lower slopes of Mount Baldy.

Included with this soil in mapping are small areas of nearly level Gordo silt loam in swales, Cryorthents-Cryoborolls complex, and Rock outcrop. These areas make up about 5 percent of this mapping unit.

Runoff is medium, and the hazard of erosion is slight.

This soil is used mainly as woodland, as wildlife habitat, and as a source of water supply. It produces an understory of grass and browse that is foraged by livestock and wildlife. Capability unit VIe-6; woodland suitability groups 4f1, 4f2, and 4f3.

3E—Baldy cobbly fine sandy loam, 30 to 50 percent slopes. This steep soil is on Mount Baldy. It has the profile described as representative of the series. The areas of this soil are dissected by a few deeply entrenched drainageways. Smooth rounded cobbles and stones cover 15 to 25 percent of the surface.

Included with this soil in mapping are 10 percent Baldy soils that have slopes of less than 30 percent, 5 percent Cryorthents-Cryoborolls complex and Rock outcrop that have very steep slopes, and 3 percent Gordo silt loam in nearly level swales.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used mainly as woodland, as wildlife habitat, and as a source of water supply. An understory of grass and browse is foraged by wildlife and livestock. Capability unit VIIe-6; woodland suitability groups 4f1, 4f2, and 4f3.

Barkerville Series

The Barkerville series consists of well drained soils on hills and mountains. These soils formed in material weathered from granite or diabase. Slopes are 8 to 50 percent. Elevation ranges from 3,000 to 5,500 feet. Vegetation is desert scrub and grama grass scrub. Annual precipitation is 14 to 18 inches, and mean annual temperature is about 57° F. The frost-free season ranges from 150 to 240 days.

In a representative profile the surface layer is a dark brown cobbly sandy loam 10 inches thick. The underlying layer is 10 inches of brown gravelly sandy loam that rests on weathered diabase.

These soils are moderately rapidly permeable. The water supplying capacity is 10 to 15 inches, and available water capacity is very low. Effective rooting depth is 10 to 20 inches. Reaction is neutral.



Figure 11.—An area of Haplustolls-Ustorthents-Tortugas-Roundtop association.

Barkerville soils are used as range, as wildlife habitat, and as a source of water supply.

Representative profile of Barkerville cobbly sandy loam, 15 to 30 percent slopes, eroded, NW $\frac{1}{4}$ sec. 23, T. 7 N., R. 15- $\frac{1}{2}$ E.:

A1—0 to 10 inches, dark brown (10YR 4/3) cobbly sandy loam, dark brown (10YR 3/3) when moist; weak fine granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; common very fine roots; common very fine interstitial pores; 20 percent cobbles; neutral; clear wavy boundary.

C1—10 to 20 inches, brown (10YR 5/3) gravelly sandy loam, dark brown (10YR 4/3) when moist; massive; very hard when dry, friable when moist, nonsticky and nonplastic when wet; common very fine roots; few fine interstitial pores; 20 percent pebbles; neutral; gradual wavy boundary.

C2—20 to 40 inches, weathered diabase.

The profile has weathered diabase or granite at a depth of 10 to 20 inches. The profile is slightly acid or neutral. The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. The C horizon has hue of 7.5YR to 10YR, value of 4 or 5 when dry, and chroma of 3 or 4.

4D—Barkerville cobbly sandy loam, 15 to 30 percent slopes, eroded. This soil is on hills and is dissected by common shallow gullies. Rounded cobbles and stones and some boulders cover 15 to 25 percent of the surface layer. This soil has the profile described as representative of the series.

Included with this soil in mapping are 10 percent Jacks cobbly loam on ridgetops and 2 percent Rock outcrop.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as range and wildlife habitat. It has fair potential for livestock grazing. The main range plants are bush muhly, side-oats grama, and shrub liveoak. Range seeding of depleted areas by conventional methods is not feasible because of stoniness. Capability unit VIe-5.

5E—Barkerville cobbly sandy loam, 30 to 50 percent slopes, eroded. This steep soil is on slopes of mountains. It mainly formed in weathered granite, but a few small areas formed in material weathered from diabase. Shallow gullies are common in this soil. It has a profile similar to the one described as representative for the series, but the surface layer is 6 to 8 inches thick.

Runoff is rapid, and the hazard of erosion is high.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has fair potential for livestock grazing. The main range plants are bush muhly, side-oats grama, and shrub liveoak. Range seeding of depleted areas by conventional methods is not feasible because of slope and stoniness. Capability unit VIIe-5.

6C—Barkerville-Showlow complex, 8 to 15 percent slopes, eroded. This complex consists of moderately sloping to strongly sloping soils on hills. It is 60 percent Barkerville cobbly sandy loam and 30 percent Showlow gravelly clay loam. The Showlow soil is on narrow ridgetops, and the Barkerville soil is on side slopes.

These soils are dissected by common shallow gullies and a few deep gullies, mainly on the side slopes.

Included with these soils in mapping are 5 percent Jacks cobbly loam; 3 percent Cibique gravelly loam; and 2 percent Navajo clay loam, Tours silt loam, and Jacques clay loam. These soils are nearly level and are on bottoms and in swales.

Runoff is medium, and the hazard of erosion is moderate.

The soils in this complex are used as range and wildlife habitat. They have fair potential for livestock grazing. The main range plants on the Barkerville soil are bush muhly, side-oats grama, and shrub liveoak. The main range plants on the Showlow soil are side-oats grama, molina, and Utah juniper. Range seeding of depleted areas by conventional methods is not feasible because of stoniness. Capability unit VIe-5.

Brolliar Series

The Brolliar series consists of well drained soils that are level to rolling on plains, moderately steep on hills, and steep on sides of canyons. These soils formed in material weathered from basic igneous rock. Slopes are 0 to 50 percent. Elevation ranges from 6,800 to 8,000 feet. Vegetation is ponderosa pine and an understory of browse and grasses. Annual precipitation is 20 to 28 inches, and mean annual temperature is about 44° F. The frost-free season ranges from 90 to 130 days.

In a representative profile the surface layer is brown cobbly silt loam 4 inches thick. The subsoil is reddish brown cobbly clay loam and cobbly clay 32 inches thick. The substratum is 12 inches of reddish brown and yellowish red very stony clay loam that overlies fractured basalt.

These soils are slowly permeable. The water supplying capacity is 14 to 17 inches. Available water capacity is moderate or high. Effective rooting depth is 30 to 50 inches. Reaction is slightly acid to neutral.

Brolliar soils are used mainly as woodland, as wildlife habitat, and as a source of water supply. These soils produce an understory of grass and browse that is foraged by livestock and wildlife.

Representative profile of Brolliar cobbly silt loam, 8 to 30 percent slopes, SW $\frac{1}{4}$ sec. 17, T. 8 N., R. 24 E.:

O1—1 inch to 0, pine litter.

A1—0 to 4 inches, brown (7.5YR 4/2) cobbly silt loam, dark brown (7.5YR 3/2) when moist; weak very fine granular structure; soft when dry, very friable when moist, slightly sticky and nonplastic when wet; many fine roots; common very fine interstitial pores; 20 percent cobbles; slightly acid; clear smooth boundary.

B1—4 to 14 inches, reddish brown (5YR 4/3) cobbly light clay loam, dark reddish brown (5YR 3/3) when moist; weak medium subangular blocky structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; common fine and few coarse roots; common fine interstitial and tubular pores; 20 percent cobbles; slightly acid; clear wavy boundary.

B21t—14 to 25 inches, reddish brown (5YR 4/3) cobbly light clay, dark reddish brown (5YR 3/3) when moist; moderate medium subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; common fine and coarse roots; few fine interstitial and tubular pores; 25 percent cobbles and pebbles; common moderately thick clay films on peds; neutral; gradual wavy boundary.

B22t—25 to 36 inches, reddish brown (5YR 4/4) cobbly clay, dark reddish brown (5YR 3/4) when moist; moderate medium angular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few fine and coarse roots; few fine interstitial and tubular pores; 30 percent cobbles and pebbles; many moderately thick clay films on peds; neutral; abrupt irregular boundary.

C—36 to 48 inches, variegated reddish brown (5YR 4/4) and yellowish red (5YR 4/6) very stony clay loam, dark reddish brown (5YR 3/4) and yellowish red (5YR 4/6) when moist; massive; slightly hard when dry, firm when moist, slightly sticky and slightly plastic when wet; few very fine roots; 60 percent coarse fragments; few thin clay films in pores and on coarse fragments; neutral; abrupt wavy boundary.

R—48 inches, basalt.

Basalt is mainly at a depth of 30 to 40 inches, but it is as deep as 50 inches in some places. The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. It is silt loam, cobbly silt loam, and stony silt loam or cobbly loam, stony loam, and cobbly clay loam. The B2t horizon 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. The B2t horizon is clay loam and clay; gravelly, cobbly, or stony clay loam; or gravelly, cobbly, or stony clay.

The depth to bedrock is greater in most areas than is defined as within the range for the Brolliar series, but the use and management of these soils are similar.

7B—Brolliar silt loam, 0 to 8 percent slopes. This level to gently rolling soil is in areas around hills. It has a profile similar to the one described as representative for the series, but it has a 10- to 14-inch-thick surface layer that is 10 to 15 percent gravel and a few cobbles. Included with this soil in mapping are small areas of soils that have cobbles and stones on the surface layer.

Runoff is slow, and the hazard of erosion is slight.

This soil is used as woodland, as wildlife habitat, and for watershed. Forage of grass and browse is produced as an understory. Capability unit VI_s-8; woodland suitability group 4c1.

8B—Brolliar cobbly silt loam, 0 to 8 percent slopes. This level to gently rolling soil is in a few small areas. It has a profile similar to the one described as representative for the series, but the surface layer is 10 to 14 inches thick. Included with this soil in mapping is about 2 percent Rock outcrop of basalt.

Runoff is slow, and the hazard of erosion is slight.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. Forage of grass and browse is produced as an understory. Capability unit VI_s-6; woodland suitability group 4c1.

9D—Brolliar cobbly silt loam, 8 to 30 percent slopes. This rolling and hilly soil is dissected by a few deeply entrenched drainageways. It has the profile described as representative for the series. Included with this soil in mapping are about 15 percent Sponseller cobbly loam on ridgetops and 2 percent Rock outcrop of basalt.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. Forage of grass and browse is produced as an understory. Capability unit VI_e-6; woodland suitability group 4c1.

10D—Brolliar cobbly clay loam, 15 to 30 percent slopes. This moderately steep soil is on hills. It has a profile similar to the one described as representative of the series, but the surface layer is clay loam. Included with this soil in mapping is about 2 percent Rock outcrop of basalt.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. Forage of grass and browse is produced as an understory. Capability unit VI_e-6; woodland suitability group 4c1.

11E—Brolliar-Cryorthents-Cryoborolls complex, 30 to 50 percent slopes. This complex consists of soils in a few long narrow areas on steep side slopes adjacent to drainageways. It is 50 percent Brolliar cobbly silt loam and 30 percent Cryorthents and Cryoborolls. The Brolliar soil generally is on the upper part of the steep side slopes, and the Cryorthents and Cryoborolls are on the lower part, but in places they are intermingled. The Cryorthents and Cryoborolls have a profile that is similar to the one for the Cryorthents-Cryoborolls complex, but 20 percent of the surface layer is covered by stones.

Included with these soils in mapping are 10 percent Elledge rocky sandy loam, 5 percent Luna cobbly silt loam, and 5 percent Sponseller cobbly loam.

Runoff is rapid, and the hazard of erosion is high.

These soils are used as woodland, as wildlife habitat, and as a source of water supply. An understory of grass and browse is produced. Capability unit VII_e-6; Brolliar soil in woodland suitability group 4c2, Cryorthents and Cryoborolls in woodland suitability group 5x1.

Cabazon Series

The Cabazon series consists of well drained, shallow soils on steep side slopes adjacent to drainageways. These soils formed in material weathered from basic igneous rock. Slopes are 30 to 50 percent. Elevation ranges from 5,500 to 7,000 feet. Vegetation is pinon pine, juniper, shrubs, and grasses. Annual precipitation is 16 to 20 inches, and the mean annual temperature is about 52° F. The frost-free season ranges from 120 to 160 days.

In a representative profile the surface layer is a dark grayish brown cobbly silt loam 4 inches thick. The sub-

soil is 12 inches of dark brown cobbly clay and cobbly clay loam that rests on fractured basalt.

These soils are slowly permeable. The water supplying capacity is 12 to 15 inches. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Reaction is mildly alkaline to neutral.

These soils are used as range, as wildlife habitat, and as a source of water supply.

Representative profile of Cabezon cobbly silt loam in an area of Cabezon-Rock outcrop complex, 30 to 50 percent slopes, in the east-central part of sec. 21, T. 3 N., R. 22 E.:

A1—0 to 4 inches, dark grayish brown (10YR 4/2) cobbly silt loam, very dark brown (10YR 2/2) when moist; weak and moderate, fine and medium granular structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; common very fine and fine roots; many fine interstitial pores; 15 percent cobbles; mildly alkaline; clear wavy boundary.

B2t—4 to 12 inches, dark brown (7.5YR 4/2) cobbly light clay, dark brown (7.5YR 3/2) when moist; weak to moderate, fine and medium subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few very fine roots; common fine interstitial and few fine tubular pores; 20 percent cobbles; common thin clay films on peds and in tubular pores; neutral; clear wavy boundary.

B3t—12 to 16 inches, dark brown (7.5YR 4/2) cobbly heavy clay loam, dark brown (7.5YR 3/2) when moist; moderate fine and medium subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; very few very fine and fine roots; common fine interstitial pores; 20 percent cobbles; few thin clay films on peds; neutral; abrupt irregular boundary.

R—16 to 20 inches, fractured, extremely hard basalt.

Basalt is at a depth of 10 to 20 inches. The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. The A horizon is cobbly silt loam, stony silt loam, and silt loam. The Bt horizon has hue of 5YR or 7.5YR, value of 3 or 4 when dry or moist, and chroma of 2 or 3. The Bt horizon is cobbly clay loam, stony clay loam, cobbly clay, or stony clay. The R horizon is extremely hard fractured basalt.

12E—Cabezón-Rock outcrop complex, 30 to 50 percent slopes. This complex consists of steeply sloping soils on side slopes adjacent to the Black River and its tributaries. It is about 65 percent Cabezon cobbly silt loam and 10 percent Rock outcrop. The Cabezon soil has the profile described as representative of the Cabezon series.

Included with this complex in mapping are about 20 percent gently sloping Thunderbird cobbly clay loam and about 5 percent very steep Haplustolls-Ustorthents complex on side slopes along drainageways.

Runoff is rapid, and the hazard of erosion is high.

These soils are used as range, as wildlife habitat, and as a source of water supply. The Cabezon soil has good potential for livestock grazing, but the Rock outcrop is not suited to grazing. The main range plants on the Cabezon soil are side-oats grama, shrub liveoak, and alligator juniper. Range seeding of depleted areas is not feasible by conventional methods because of stoniness and slope. Capability unit VIIe-5.

Chevelon Series

The Chevelon series consists of well drained soils that are nearly level to rolling on upland plains, moderately steep on hills, and steep on the sides of drainageways. These soils formed in material weathered from interbedded shale, from siltstone, and from soft calcareous sandstone. Slopes are 0 to 50 percent. Elevation ranges from 4,500 to 6,000 feet. Vegetation is mainly grasses. Annual precipitation is 16 to 20 inches, and mean annual temperature is about 55° F. The frost-free season ranges from 120 to 160 days.

In a representative profile the surface layer is reddish brown silt loam 5 inches thick. The subsoil is 25 inches of reddish brown silty clay loam that rests on interbedded reddish brown and gray shale.

These soils are moderately slowly permeable. The water supplying capacity is 12 to 14 inches. Available water capacity is low to moderate. Effective rooting depth is 20 to 40 inches. Reaction is neutral to moderately alkaline.

Chevelon soils are used as range, as wildlife habitat, and as a source of water supply.

Representative profile of Chevelon silt loam, 0 to 8 percent slopes, eroded, in the east-central part of sec. 21, T. 3 N., R. 22 E.:

A11—0 to 2 inches, reddish brown (5YR 5/4) silt loam, dark reddish brown (5YR 3/4) when moist; weak thick platy structure parting to weak fine granular; soft when dry, very friable when moist, slightly sticky and nonplastic when wet; common fine roots; common very fine interstitial and vesicular pores; neutral; clear smooth boundary.

A12—2 to 5 inches, reddish brown (5YR 4/4) heavy silt loam, dark reddish brown (5YR 3/4) when moist; weak thick platy structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine and very fine roots; common very fine interstitial pores; neutral; abrupt smooth boundary.

B1—5 to 10 inches, reddish brown (5YR 4/3) light silty clay loam, dark reddish brown (5YR 3/3) when moist; weak fine subangular blocky structure; slightly hard when dry, firm when moist; slightly sticky and slightly plastic when wet; common fine and very fine roots; few fine interstitial and common fine tubular pores; few thin clay films line tubular and interstitial pores; neutral; gradual wavy boundary.

B21t—10 to 23 inches, reddish brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) when moist; moderate fine subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; common fine and very fine roots; few fine interstitial and common fine tubular pores; common moderately thick clay films on peds; mildly alkaline; gradual wavy boundary.

B22t—23 to 30 inches, reddish brown (2.5YR 5/4) light silty clay loam, dark reddish brown (2.5YR 3/4) when moist; moderate medium subangular blocky structure; slightly hard when dry, firm when moist, slightly sticky and slightly plastic when wet; few very fine roots; few fine interstitial and tubular pores; 20 percent soft shale pebbles; few moderately thick clay films on peds; slightly effervescent; mildly alkaline; clear wavy boundary.

C—30 to 36 inches, stratified reddish brown (2.5YR 5/4) and light gray (2.5YR 7/2) shale, dark reddish brown (2.5YR 3/4) and light reddish brown (5YR 6/3) when moist; bottom sides of shale fragments have thin coatings of lime.

Shale is at a depth of 20 to 40 inches. The A horizon has hue of 5YR or 7.5YR and value of 3 or 4 when moist. The A horizon is loam, cobbly clay loam, and silt loam. The B2t horizon has hue of 2.5YR or 5YR. The B2t horizon ranges from loam or silt loam to clay loam or silty clay loam. The C horizon is hard shale, siltstone, or calcareous sandstone.

13B—Chevelon silt loam, 0 to 8 percent slopes, eroded. This level to moderately sloping soil is on plains. It is in a few small areas that are dissected by common shallow gullies. The soil has the profile described as representative of the series.

Included with this soil in mapping are 10 percent Jacks loam in depressions and 5 percent Tours silt loam along drainageways and on small bottoms.

Runoff is medium, and the hazard of erosion is moderate.

This soil produces forage for livestock and small amounts of browse for wildlife. It has good potential for livestock grazing. The main range plants are blue grama, sideoats grama, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIe-5.

14D—Chevelon cobbly clay loam, 8 to 30 percent slopes, eroded. This soil is on hills. It has a profile similar to the one described as representative of the series, but 15 to 30 percent of the surface layer is covered with sandstone cobbles and stones, and the texture is clay loam. A network of shallow gullies is common in this soil.

Included with this soil in mapping are about 10 percent Tours silt loam and 5 percent Navajo clay loam that are on nearly level bottoms along drainageways. Also included is about 2 percent Rock outcrop.

Runoff is medium, and the hazard of erosion is moderate.

This soil produces grasses and browse for livestock

and wildlife. It is used as a source of water supply. It has fair potential for livestock grazing. The main range plants are blue grama, sideoats grama, and Utah juniper. Range seeding of depleted areas is not feasible by conventional methods because of stoniness. Capability unit VIe-5.

15D—Chevelon cobbly clay loam, 15 to 30 percent slopes, severely eroded. This moderately steep soil is on hills that are underlain by sandstone. It has a profile similar to the one described as representative of the series, but the surface layer is cobbly clay loam.

Included with this soil in mapping is about 10 percent Tours silt loam and Navajo clay loam in drainageways. Also included is about 5 percent Rock outcrop.

Runoff is rapid, and the hazard of erosion is high.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has fair potential for livestock grazing. The main range plants are blue grama, Utah juniper, and pinon pine. Range seeding of depleted areas is not feasible by conventional methods because of stoniness. Capability unit VIe-5.

16E—Chevelon cobbly clay loam, 30 to 50 percent slopes, eroded. This steeply sloping soil is in long narrow areas adjacent to drainageways. Shallow gullies are common in these areas. This soil has a profile similar to the one described as representative of the series, but the surface layer is cobbly clay loam.

Included with this soil in mapping is about 10 percent Haplustolls-Ustorthents complex in areas above and adjacent to drainageways, 5 percent Tours silt loam on narrow, nearly level bottoms, and 3 percent Rock outcrop of sandstone.

Runoff is rapid, and the hazard of erosion is high.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has poor potential for livestock grazing. The main range plants are blue grama, Utah juniper, and pinon pine. Range seeding of depleted areas is not feasible because of slope and stoniness. Capability unit VIIe-5.

17D—Chevelon-Jacks cobbly clay loams, 15 to 30 percent slopes, eroded. This complex consists of moderately steep soils that are underlain by sandstone. It is about 40 percent Chevelon cobbly clay loam and 40 percent Jacks cobbly clay loam. The Chevelon soil is on ridges. It has a profile similar to the one described as representative of the series, but the surface layer is cobbly clay loam. The Jacks soil is on the sides of hills. Shallow gullies are common in areas of this complex.

Included with these soils in mapping are about 17 percent Tours and Navajo soils in narrow, nearly level swales and on bottoms and 3 percent Rock outcrop of sandstone.

Runoff is rapid, and the hazard of erosion is high.

These soils are used as range, as wildlife habitat, and as a source of water supply. They have fair potential for livestock grazing. The main range plants on the Chevelon soil are blue grama, Utah juniper, and pinon pine; on the Jacks soil they are side-oats grama, shrub liveoak, and Utah juniper. Range seeding of depleted areas is not feasible by conventional methods because of stoniness. Capability unit VIe-5.

Cibeque Series

The Cibeque series consists of well drained, gently

rolling to steep soils on old dissected alluvial fans. These soils formed in old gravelly alluvium. Slopes are 8 to 50 percent. Elevation ranges from 3,200 to 5,500 feet. Vegetation is juniper, oak, gramagrass, beargrass, and shrubs. Annual precipitation is 14 to 20 inches, and annual temperature is 55° to 59° F. The frost-free season ranges from 120 to 270 days.

In a representative profile the surface layer is dark grayish brown and dark yellowish brown gravelly loam 9 inches thick. The underlying layer is light yellowish brown, white, and pinkish gray gravelly loam and gravelly sandy loam to a depth of 60 inches.

These soils are moderately permeable. The water supplying capacity is 12 to 14 inches. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Reaction is moderately alkaline.

Cibeque soils are used mainly as range, as wildlife habitat, and as a source of water supply.

Representative profile of Cibeque gravelly loam, 30 to 50 percent slopes, eroded, in the south-central part of sec. 13, T. 5 N., R. 18 E., ½ mile northwest of Chalk Tank:

A11—0 to 2 inches, dark grayish brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet, many fine roots; many fine interstitial pores; 25 percent pebbles and 5 percent cobbles; strongly effervescent; mildly alkaline; clear smooth boundary.

A12—2 to 9 inches, dark yellowish brown (10YR 4/4) gravelly loam, dark yellowish brown (10YR 3/4) when moist; massive; soft when dry, friable when moist, nonsticky and nonplastic when wet; many fine and very fine roots; common fine interstitial pores; 25 percent pebbles and 5 percent cobbles; violently effervescent; moderately alkaline; gradual wavy boundary.

C1ca—9 to 18 inches, light yellowish brown (10YR 6/4) gravelly loam, yellowish brown (10YR 5/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common very fine and a few coarse roots; few fine interstitial and tubular pores; 20 percent pebbles and 5 percent cobbles; violently effervescent; moderately alkaline; gradual wavy boundary.

C2ca—18 to 42 inches, white (10YR 8/2) and yellowish brown (10YR 5/4) gravelly loam, very pale brown (10YR 7/3) and yellowish brown (10YR 5/4) when moist; massive; hard when dry, firm when moist, slightly sticky and nonplastic when wet; few very fine and coarse roots; few fine tubular pores; 25 percent pebbles and 5 percent cobbles; violently effervescent; moderately alkaline; gradual wavy boundary.

C3ca—42 to 60 inches, pinkish gray (7.5YR 7/2)

and yellowish brown (10YR 5/4) gravelly heavy sandy loam, light brown (7.5YR 6/4) and yellowish brown (10YR 5/4) when moist; massive; slightly hard when dry, firm when moist, nonsticky and nonplastic when wet; very few very fine roots; few fine interstitial pores; 40 percent pebbles and 5 percent cobbles; strongly to violently effervescent; moderately alkaline.

Coarse-fragment content varies from 15 to 45 percent throughout the soil. Reaction is mildly alkaline or moderately alkaline. The A horizon has hue of 5YR through 10YR and value of 4 or 5 when dry and 2 or 3 when moist. The A horizon is gravelly loam or gravelly silt loam. The C horizon has hue of 7.5YR and 10YR and value of 4 to 8 when moist. The C horizon is gravelly loam, gravelly sandy loam, gravelly light sandy clay loam, or gravelly light clay loam.

18D—Cibeque gravelly loam, 8 to 30 percent slopes. This moderately sloping to moderately steep soil is in areas at the bottom of slopes and on tops of ridges. It has a profile similar to the one described as representative for the series, but it contains less gravel and is less eroded. Included with this soil in mapping are about 15 percent Showlow gravelly loam in small concave areas and about 5 percent Tours silt loam in small areas on the nearly level bottoms.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has good potential for wildlife habitat. The main range plants are black grama and molina. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIe-1.

19E—Cibeque gravelly loam, 30 to 50 percent slopes, eroded. This steeply sloping soil is on dissected old alluvial fans. It formed in a fairly thick mantle of old gravelly alluvium. It has a profile described as representative of the series. This mantle overlies sandstone and limestone that crops out in places near the bottom of the slopes along drainageways. Shallow gullies commonly dissect this soil.

Included with this soil in mapping are 10 percent Showlow gravelly clay loam in depressions and 5 percent Lynx and Jacques soils on nearly level bottoms along drainageways.

Runoff is medium, and the hazard of erosion is moderate.

This soil is a fair source of material for road fill. It produces forage for livestock and browse for wildlife. It has fair potential for livestock grazing. The main range plants are black grama and Nolina. Range seeding of depleted areas is not feasible because of slope. Capability unit VIIe-1.

20E—Cibeque-Chevelon complex, 30 to 50 percent slopes, eroded. This complex consists of soils in long irregularly shaped areas on steep breaks between upper old alluvial fans and lower sandstone hills. It is 50 percent Cibeque gravelly loam and 35 percent Chevelon cobbly clay loam. The Cibeque soil is on the upper part of the slopes and ridgetops. The Chevelon soil is on the steep lower slopes adjacent to drainageways. It has a

profile similar to the one described as representative of the series, but the surface layer is cobbly clay loam. Shallow gullies commonly dissect these soils.

Included with these soils in mapping is 15 percent Rock outcrop of sandstone.

Runoff is rapid, and the hazard of erosion is high.

These soils produce forage for livestock and browse for wildlife, and they are used as range, as wildlife habitat, and as a source of water supply. These soils have fair potential for livestock grazing. The main range plants on the Cibique soil are black grama and Nolina; on the Chevelon soil they are blue grama, Utah juniper, and pinon pine. Range seeding of depleted areas is not feasible because of slope. Capability unit VIIe-1.

Cryaquolls, Nearly Level

21B—Cryaquolls, nearly level, consists of poorly drained soils. These soils formed in alluvium derived from basalt, ash, and cinders in mountain meadows. Slopes are 0 to 1 percent. Elevation is 8,000 to 9,200 feet. Vegetation is mainly sedges and rushes and some alpine timothy, reedgrass, hairgrass, and meadow foxtail. Annual precipitation is about 33 inches, and mean annual temperature is about 37°F. The frost-free season ranges from 75 to 95 days.

In a representative profile the surface layer is gray and dark grayish brown loam and silt loam 15 inches thick. The underlying material, to a depth of 60 inches or more, is gray silt loam. In places this underlying material is mottled and gravelly and is yellowish red and reddish brown.

These soils are moderately slowly permeable. The water supplying capacity is more than 33 inches. The water table is at or near the surface of the soil most of the year. Effective rooting depth is 60 inches or more. Runoff is very slow, and the hazard of erosion is slight. Reaction is medium acid to neutral.

These soils are used as range and as wildlife habitat. They have good potential for livestock grazing. The main range plants are tufted hairgrass, bluejoint reedgrass, and sedge. Range seeding of depleted areas is not feasible because of wetness. Capability unit Vw-8.

Cryorthents-Cryoborolls Complex

22E—Cryorthents-Cryoborolls complex consists of well drained, very steep soils that are highly dissected by many, narrow, V-shaped valleys and sharp divides. It is 60 percent Cryorthents and 30 percent Cryoborolls. The soils are in long areas adjacent to drainageways and are on the very steep slopes of mountains. They are moderately extensive in the northeastern part of the Reservation. A vertical rock outcrop escarpment commonly forms the upper boundary of this complex. The thin mantle of soil material is medium textured to fine textured. It is shallow to moderately deep over basalt, rhyolite, or andesite. Stones and boulders cover 3 to 25 percent of the surface layer.

Included with these soils in mapping are about 8 percent alluvial material along drainageways and 2 percent Rock outcrop.

Vegetation on these soils is mainly mixed conifers and grasses. Elevation ranges from 8,000 to 11,404 feet. The water supplying capacity is 14 to 28 inches. Annual precipitation ranges from 20 to 40 inches, and the frost-free period is 70 to 120 days. Average annual temperature is about 37°F.

Runoff is rapid, and the hazard of erosion is severe. Soil slipping is common on the very steep slopes.

The soils produce some timber and an understory of grass and browse for livestock and wildlife. They are used as woodland, as wildlife habitat, and as a source of water supply. Capability unit VIIe-6; woodland suitability group 5x1.

Elledge Series

The Elledge series consists of well drained soils that are nearly level to rolling on hills and steep on mountains. These soils formed in material weathered from sandstone. Slopes are 0 to 50 percent. Elevation ranges from 6,000 to 6,600 feet. Vegetation is ponderosa pine, Gambel oak, and grasses. Annual precipitation is 20 to 25 inches, and mean annual temperature is about 49°F. The frost-free season ranges from 110 to 130 days.

In a representative profile the surface layer is grayish brown cobbly sandy loam 2 inches thick. The sub-surface layer is light gray cobbly sandy loam 5 inches thick. The subsoil is 23 inches of reddish brown and brownish yellow cobbly clay that rests on light yellowish brown sandstone.

These soils are slowly permeable. The water supplying capacity is 15 to 18 inches. Available water capacity is low to moderate. Effective rooting depth is 20 to 40 inches.

Elledge soils are used as wildlife habitat, as woodland, and as a source of water supply. They produce an understory of grass and browse.

Representative profile of Elledge cobbly sandy loam, 8 to 15 percent slopes, eroded, NE $\frac{1}{4}$ of sec. 11, T. 9 N., R. 21 E.:

- O1—1 inch to 0, pine litter and oak leaves.
- A1—0 to 2 inches, grayish brown (10YR 5/2) cobbly sandy loam, dark grayish brown (10YR 4/2) when moist; weak medium platy structure parting to weak fine granular; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; common fine roots; common very fine interstitial and tubular pores; 20 percent cobbles and pebbles; neutral; clear smooth boundary.
- A2—2 to 7 inches, light gray (10YR 7/2) cobbly sandy loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, friable when moist, nonsticky and slightly plastic when wet; common fine and medium roots; few fine tubular pores; 10 percent cobbles and pebbles; slightly acid; abrupt wavy boundary.
- B21t—7 to 11 inches, reddish brown (5YR 5/4) cobbly clay, reddish brown (5YR 4/4) when moist; moderate medium subangular blocky structure; hard when dry,

firm when moist, sticky and plastic when wet; few very fine and medium roots; few fine and medium interstitial and tubular pores; 20 percent cobbles and pebbles; common thin to moderately thick clay films on peds; slightly acid; clear wavy boundary.

B22t—11 to 26 inches, reddish brown (5YR 5/4) cobbly clay, dark reddish brown (5YR 3/4) when moist; few fine distinct brownish yellow (10YR 6/6) mottles, yellowish-brown (10YR 5/6) when moist; moderate medium and coarse subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; few very fine and medium roots; few fine and medium interstitial and tubular pores; 25 percent cobbles; many moderately thick clay films on peds and in pores; slightly acid; clear wavy boundary.

B3t—26 to 30 inches, brownish yellow (10YR 6/6) cobbly clay, yellowish brown (10YR 5/6) when moist; common fine distinct yellowish red (5YR 5/8) mottles, yellowish red (5YR 4/6) when moist; weak coarse subangular blocky structure; very hard when dry, firm when moist; sticky and plastic when wet; few very fine and medium roots; few fine interstitial and tubular pores; 25 percent cobbles; common thin clay films on peds; slightly acid; abrupt irregular boundary.

R—30 to 36 inches, light yellowish brown (10YR 6/4) extremely hard sandstone.

Bedrock is at a depth of 20 to 40 inches. The A horizon ranges from strongly acid to neutral. The A1 horizon has hue of 7.5YR and 10YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 2 or 3. The A2 horizon has hue of 7.5YR or 10YR and value of 5 to 7 when dry and 3 to 5 when moist. The A1 and A2 horizons are cobbly loam, sandy loam, and cobbly or stony sandy loam. The Bt horizon has hue of 5YR to 10YR, value of 5 to 7 when dry and 3 to 5 when moist, and chroma of 4 to 6. The Bt horizon has few or common brownish yellow, yellowish red, or red mottles. It is clay, cobbly clay, clay loam, and cobbly clay loam. The lower part of the B horizon is slightly acid to alkaline. The profile is slightly effervescent from calcium carbonate in places where it approaches a depth of 40 inches.

23B—Elledge sandy loam, 0 to 8 percent slopes. This nearly level to moderately sloping soil is in areas surrounded by Elledge cobbly sandy loam on hills. It has a profile similar to the one described as representative of the series, but it has a surface layer 14 to 20 inches thick, is more gently sloping, and has fewer cobbles and pebbles. Sandstone bedrock is at a depth of 30 to 40 inches.

Included with this soil in mapping is about 10 percent Elledge cobbly sandy loam.

Runoff is medium, and the hazard of erosion is moderate.

Elledge soils produce fair amounts of merchantable timber and an understory of grass and browse for

livestock and wildlife. Capability unit VI_s-8; woodland suitability group 4d1.

24E—Elledge sandy loam, 30 to 50 percent slopes. This steep soil is in a few long narrow areas on side slopes adjacent to drainageways. It has a profile similar to the one described as representative for the series, but it has fewer cobbles.

Included with this soil in mapping are about 5 percent Haplustolls-Ustorthents complex on very steep slopes and 5 to 10 percent Rock outcrop.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used for timber production, as wildlife habitat, and as a source of water supply. Forage of grass and browse is produced as an understory. Capability unit VII_e-8; woodland suitability group 6c1.

25B—Elledge cobbly sandy loam, 0 to 8 percent slopes. This soil is in valleys surrounded by large areas of Elledge cobbly sandy loam that has slopes of more than 8 percent. It has a profile similar to the one described as representative of the series, but it has a surface layer and subsurface layer that are 12 to 18 inches thick. It also is 10 to 20 percent cobbles and stones. Included with this soil in mapping is 10 percent Elledge cobbly sandy loam, 8 to 15 percent slopes.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as wildlife habitat and for timber production. Forage of grass and browse is produced as an understory. Capability unit VI_s-6; woodland suitability group 4d1.

26C—Elledge cobbly sandy loam, 8 to 15 percent slopes, eroded. This soil is on rolling hills dissected by common shallow gullies. It has a profile described as representative for the series. The surface layer is covered with 15 to 25 percent scattered cobbles and stones.

Included with this soil in mapping are 10 percent Telephone cobbly sandy loam on ridgetops, 5 percent Overgaard gravelly fine sandy loam on small ridgetops, and 2 percent Rock outcrop.

Runoff is medium, and the hazard of erosion is moderate.

This soil produces small amounts of merchantable timber and an understory of forage made up of grass and browse. It is also used as wildlife habitat. Capability unit VI_e-6; woodland suitability group 6c1.

27D—Elledge cobbly sandy loam, 15 to 30 percent slopes. This moderately steep soil is in a few large areas on hills. It has a profile similar to the one described as representative for the series, but it is less eroded; also, 25 to 30 percent of its surface is covered with cobbles and stones.

Included with this soil in mapping are 10 percent Elledge cobbly sandy loam, 8 to 15 percent slopes, and 5 percent Lynx loam, eroded, in few long narrow areas along small bottoms.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as woodland, wildlife habitat, and watershed. Forage of grass and browse is produced as an understory. Capability unit VI_e-6; woodland suitability group 6c1.

28C—Elledge-Rock outcrop complex, 8 to 15 percent slopes. This complex is about 90 percent Elledge sandy

loam and 10 percent Rock outcrop. The Elledge soil has a profile similar to the one described as representative for the series, but it is less eroded and has fewer cobbles.

Runoff is medium, and the hazard of erosion is moderate.

This complex is used for timber production, as wildlife habitat, and as a source of water supply. Forage of grass and browse is produced as an understory. Capability unit VIe-6; woodland suitability group 6c1; Rock outcrop not assigned to woodland suitability group.

29E—Elledge-Overgaard-Rock outcrop complex, 30 to 50 percent slopes. This complex consists of steep soils that are between large areas of Overgaard soils at higher elevations and large areas of Elledge soils at lower elevations. It occurs in breaks in the vicinity of the Mogollon Rim. It is 40 percent Elledge sandy loam, 20 percent Overgaard gravelly loam, and 10 percent Rock outcrop. The steep Elledge sandy loam is adjacent to waterways. It has a profile similar to the one described as representative of the series, but it has bedrock at a depth of about 20 to 24 inches and has fewer cobbles. The steep Overgaard gravelly loam is on ridgetops and on the upper part of side slopes.

Included with these soils in mapping are 10 percent Telephone very cobbly loam, 10 percent Showlow gravelly clay loam, and 10 percent very steep Haplustolls-Ustorthents complex in areas adjacent to drainageways.

Runoff is rapid, and the hazard of erosion is severe.

These soils are used as woodland, as wildlife habitat, and as a source of water supply. Forage of grass and browse is produced as an understory. Capability unit VIIe-5; Elledge soil in woodland suitability group 6c1, Overgaard soil in woodland suitability group 5c1; Rock outcrop not assigned to woodland suitability group.

Ess Series

The Ess series consists of well drained soils that are nearly level to rolling on plains and moderately steep and steep on mountains. These soils formed in material weathered from basic igneous rock. Slopes are 0 to 50 percent. Elevation ranges from 7,200 to 8,400 feet. Vegetation is ponderosa pine, Gambel oak, and grasses. Annual precipitation is 20 to 30 inches, and mean annual temperature is about 43°F. The frost-free season ranges from 90 to 120 days.

In a representative profile the surface layer is dark brown cobbly loam and cobbly silt loam 11 inches thick. The subsoil is brown very cobbly silt loam and clay loam to a depth of 60 inches or more.

These soils are moderately permeable. The water supplying capacity is 15 to 23 inches. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Reaction is medium acid or slightly acid.

Ess soils are used mainly as woodland, as wildlife habitat, and as a source of water supply. Forage of grass and browse is produced as an understory.

Representative profile of Ess cobbly loam, 30 to 50 percent slopes, 6 miles southwest of Tonto Lake on Tonto Creek, in NW $\frac{1}{4}$ sec. 23, T. 4 N., R. 25 E.:

O1—1 inch to 0, thin covering of partially decayed pine needles and oak leaves.

A11—0 to 4 inches, dark brown (10YR 4/3) cobbly loam, very dark grayish brown (10YR 3/2) when moist; moderate fine granular structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; many fine and very fine roots; common very fine interstitial pores; 20 percent pebbles, cobbles, and stones; medium acid; clear smooth boundary.

A12—4 to 11 inches, dark brown (10YR 4/3) cobbly silt loam, very dark grayish brown (10YR 3/2) when moist; moderate very fine and fine granular structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine and very fine roots and few coarse roots; common very fine tubular pores; 30 percent pebbles, cobbles, and stones; slightly acid; clear wavy boundary.

B21t—11 to 24 inches, brown (7.5YR 5/4) very cobbly heavy silt loam, dark brown (7.5YR 4/4) when moist; weak fine subangular blocky structure; slightly hard when dry, friable when moist; slightly sticky and slightly plastic when wet; common very fine and coarse roots; common fine tubular and interstitial pores; few thin clay films on peds and lining tubular or interstitial pores; 50 percent pebbles, cobbles, and stones; slightly acid; gradual wavy boundary.

B22t—24 to 38 inches, brown (7.5YR 5/4) very cobbly light clay loam, dark brown (7.5YR 4/4) when moist; weak fine subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common very fine roots and few coarse roots; few fine tubular and interstitial pores; few thin clay films on peds and lining pores; 60 percent pebbles, cobbles, and stones; slightly acid; gradual wavy boundary.

B3—38 to 60 inches, brown (7.5YR 5/4) very cobbly light clay loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard to hard when dry, friable when moist; slightly sticky and slightly plastic when wet; few very fine and coarse roots; few fine interstitial pores; 70 percent pebbles, cobbles, and stones; slightly acid.

The A horizon has hue of 7.5YR or 10YR and value of 4 or 5 when dry and 2 or 3 when moist. It is gravelly loam, cobbly loam, stony loam, silt loam, gravelly silt loam, or cobbly silt loam. The B2t horizon has hue of 5YR to 10YR but is dominantly 5YR or 7.5YR, has value of 4 to 6 when dry and 3 or 4 when moist, and chroma of 3 or 4. The B2t horizon is very gravelly, very cobbly, or very stony silt loam or very gravelly, very cobbly, or very stony clay loam. The B3t horizon is very cobbly loam, very stony loam, very cobbly clay loam, or very stony clay loam. The B3 horizon is at a depth of 29 to 50 inches. Coarse fragments, ranging

from pebbles to stones, make up 35 to 90 percent of the B horizon, but they average 50 to 60 percent.

30B—Ess cobbly loam, 0 to 8 percent slopes. This level to gently rolling soil is on upland plains. Included with this soil in mapping are 10 percent Sponseller cobbly loam, 5 percent Broliar cobbly silt loam, 5 percent Ess cobbly loam that has slopes of slightly more than 8 percent, and 2 percent Rock outcrop.

Runoff is slow, and the hazard of erosion is slight.

This soil produces merchantable timber and an understory of grass and browse for livestock and wildlife. Capability unit VI_s-6; woodland suitability group 4f4.

31D—Ess cobbly loam, 8 to 30 percent slopes. This rolling and hilly soil is in many large areas. Included with this soil in mapping are 5 percent Ess soils that have slopes of more or less than 8 to 30 percent, 5 percent Sponseller cobbly loam, and 2 percent Rock outcrop of basalt.

Runoff is medium, and the hazard of erosion is moderate.

This soil has limited use as a source of water supply. It produces merchantable timber and an understory of grass and browse for livestock and wildlife. Capability unit VI_e-6; woodland suitability group 4f4.

32E—Ess cobbly loam, 30 to 50 percent slopes. This steep soil is in many large areas on mountains and on side slopes adjacent to waterways. It has the profile described as representative of the series. The surface is covered with 15 to 20 percent basalt pebbles, cobbles, and stones.

Included with this soil in mapping are 10 percent Cryorthents-Cryoborolls complex, 5 percent Sponseller cobbly loam, 3 percent Broliar cobbly silt loam in small depressions, and 2 percent Rock outcrop of basalt.

Runoff is medium, and the hazard of erosion is moderate.

This soil produces merchantable timber and an understory of grass and browse for livestock and wildlife. It is also used as a source of water supply. Capability unit VII_e-6; woodland suitability group 5f1.

Gordo Series

The Gordo series consists of well drained soils that are nearly level on plains, undulating to rolling on hills, and moderately steep and steep on mountains. These soils formed in material weathered from basalt, cinders, and ash and andesite and rhyolite. These soils are extensive and form a wide belt below and surrounding Mount Baldy. Slopes are 0 to 50 percent. Elevation ranges from 8,000 to 10,400 feet. Vegetation is mixed conifers, aspen, an understory of grasses, and some open areas of grass. Annual precipitation is 24 to 35 inches, and mean annual temperature is about 38°F. The frost-free season ranges from 85 to 110 days.

In a representative profile the surface layer is a dark brown silt loam 20 inches thick. The subsoil is reddish brown gravelly heavy loam 20 inches thick. The substratum, to a depth of 60 inches, is very gravelly weathered basalt and cinders coated with reddish brown clay loam.

The soils are moderately permeable. The water supplying capacity is 16 to 20 inches. Available water

capacity is high. Effective rooting depth is 48 to 60 inches or more. Reaction is medium acid to slightly acid.

Gordo soils are used mainly for the production of timber, as range, as wildlife habitat, for recreation, and as a source of water supply. Timbered areas produce usable forage consisting of an understory of grass and browse.

Representative profile of Gordo silt loam, 8 to 15 percent slopes, SE¹/₄ of sec. 1, T. 7 N., R. 25 E.:

O1—1 inch to 0, mixed conifer litter and aspen leaves.

A11—0 to 8 inches, dark brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; strong fine granular structure; soft when dry, friable when moist, non-sticky and slightly plastic when wet; many very fine, fine, and medium roots; many very fine interstitial pores; slightly acid; clear wavy boundary.

A12—8 to 20 inches, dark brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) when moist; moderate fine and very fine granular structure; soft when dry, friable when moist, slightly sticky and plastic when wet; many very fine, fine, and medium roots; many very fine interstitial pores; medium acid; clear wavy boundary.

B21t—20 to 28 inches, reddish brown (5YR 4/3) gravelly heavy loam, dark reddish brown (5YR 3/3) when moist; weak fine and medium subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; common coarse roots; many fine interstitial and common fine tubular pores; 20 percent pebbles and cobbles; few moderately thick clay films line tubular pores and root channels; few thin clay films on peds; slightly acid; clear smooth boundary.

B22t—28 to 40 inches, reddish brown (5YR 4/4) gravelly heavy loam, dark reddish brown (5YR 3/4) when moist; weak fine subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; many coarse and medium roots; common fine interstitial and tubular pores; 25 percent pebbles and cobbles; few thin clay films on peds and thin clay films line tubular pores; slightly acid; clear wavy boundary.

C—40 to 60 inches, reddish brown (5YR 5/4) very gravelly clay loam, reddish brown (5YR 4/4) when moist; massive; hard when dry, firm when moist, sticky and plastic when wet; common fine roots; 70 percent reddish brown (5YR 5/4) weathered basalt and cinder pebbles; slightly acid.

The profile is medium acid to neutral. The content of organic matter in the A horizon ranges from 4 to 15 percent. The A horizon is 12 to 20 inches thick. It has hue of 7.5YR or 10YR, value of 4 or 5 when dry,

and chroma of 2 or 3. It is silt loam, loam, cobbly loam, cobbly silt loam, or gravelly silt loam. The Bt horizon has hue of 5YR or 2.5YR and value of 4 or 5 when dry. It is silt loam, loam, clay loam, gravelly loam, cobbly loam, and gravelly or cobbly clay loam. The C horizon is very gravelly or very cobbly, weathered basalt and cinders with coatings of reddish brown clay loam. In some places the profile is underlain by fractured bedrock at a depth of 48 to 60 inches.

33D—Gordo loam, 0 to 30 percent slopes. This nearly level to hilly soil is in mountain meadows in large areas north of Mount Baldy. About 30 percent of this soil has slopes of 0 to 8 percent, 40 percent has slopes of 8 to 15 percent, and 15 percent has slopes of 15 to 30 percent. This soil has a profile similar to the one described as representative of the series, but it does not have litter on the surface, the surface layer is loam, and the subsoil is 34 to 51 inches thick.

Included with this soil in mapping are about 10 percent Cryorthents-Cryoborolls complex and 5 percent Luna soils in small areas in swales. Some areas that have a few stones and boulders scattered on the surface and a few small areas of Rock outcrop are also included.

Runoff is medium, and the hazard of erosion is moderate.

This soil is well suited to use as a site for earth-filled dams for recreational lakes. It produces forage for livestock and wildlife during summer. It has good potential for livestock grazing. The main range plants are fescue, tufted hairgrass, and sedge. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIe-1.

34D—Gordo cobbly loam, 8 to 30 percent slopes. This gently rolling to hilly soil is on convex basalt plains. It has a profile similar to the one described as representative of the series, but the surface layer is cobbly. The surface layer is covered with 15 to 25 percent pebbles, cobbles, and stones.

Included with this soil in mapping are about 2 percent Rock outcrop and some small areas covered by basalt boulders.

Runoff is medium, and the hazard of erosion is moderate.

This soil produces good quantities of merchantable timber and an understory of grass and browse. The swales in areas of this soil are well suited to use as sites for earth-filled dams. Capability unit VIe-6; woodland suitability group 4o1.

35E—Gordo cobbly loam, 30 to 50 percent slopes. This steep soil is on mountains. It has a profile similar to the one described as representative of the series, but the surface layer is 12 to 14 inches thick. Included with this soil in mapping is 5 percent Cryorthents-Cryoborolls complex on very steep slopes.

Runoff is rapid, and the hazard of erosion is high.

This soil is used as a source of water supply and as woodland. It produces an understory of forage, mainly grasses and browse. Capability unit VIIe-6; woodland suitability group 4r1.

36B—Gordo silt loam, 0 to 8 percent slopes. This nearly level to gently rolling soil is on plains. Included with this soil in mapping are 5 percent Gordo cobbly and gravelly loam that has slopes of more than 8 percent and 3 percent Sizer gravelly silt loam.

Runoff is slow, and the hazard of erosion is slight.

This soil is used for timber production, as wildlife habitat, and as a source of water supply. Forage of grass and browse is produced as an understory. Capability unit VIc-1; woodland suitability group 4o1.

37C—Gordo silt loam, 8 to 15 percent slopes. This gently rolling to rolling soil is in many large and small areas between Mount Baldy and the town of McNary. About 10 percent of the surface layer is covered with basalt gravel. This soil has the profile described as representative of the series.

Included with this soil in mapping are about 10 percent Gordo gravelly silt loam and cobbly loam, 5 percent Sizer gravelly silt loam, and 2 percent large boulders and Rock outcrop.

Runoff is medium, and the hazard of erosion is moderate.

This soil produces large amounts of merchantable timber and an understory of some grass and browse for livestock and wildlife during summer. Capability unit VIe-1; woodland suitability group 4o1.

38B—Gordo gravelly silt loam, 0 to 8 percent slopes. This undulating and gently rolling soil is on mountains. It has a profile similar to the one described as representative for the series, but the surface layer is only 10 to 14 inches thick, and the soil has 15 to 25 percent pebbles scattered on the surface layer. Included with the soil in mapping are 1 to 2 percent stones, boulders, and Rock outcrop of basalt.

Runoff is slow, and the hazard of erosion is slight.

This soil is used for timber production, as wildlife habitat, and as a source of water supply. Forage of grass and browse is produced as an understory. Capability unit VIc-6; woodland suitability group 4o1.

39B—Gordo cobbly silt loam, 0 to 8 percent slopes. This undulating soil is in a few large areas in mountain meadows north of Mount Baldy. It has a profile that is similar to the one described as representative of the series, but it has a cobbly silt loam surface layer, and it has dusky red and dark red mottles in the substratum.

Included with this soil in mapping are 10 percent Gordo silt loam and Gordo cobbly loam, 8 to 30 percent slopes.

Runoff is slow, and the hazard of erosion is slight.

This soil is used for grazing, as wildlife habitat, and as a source of water supply. Forage of grass and browse is produced as an understory. It has good potential for livestock grazing. The main range plants are Arizona fescue, mountain muhly, and pine dropseed. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIc-6.

Haplustolls-Torrifluents Complex

40B—Haplustolls-Torrifluents complex consists of well drained, stratified, unconsolidated gravelly, cobbly, or stony soils. They formed in recent alluvium derived from a wide variety of rocks and deposited along the drainageways in the area. Slopes are 0 to 8 percent. Haplustolls make up about 40 percent of the mapping unit and Torrifluents 35 percent. Elevation is 4,000 to 8,000 feet. Vegetation is dominantly sycamore,

willows, cottonwood, and grasses below 6,000 feet, and it is juniper, boxelder, scattered ponderosa pine, and grasses above 6,000 feet. Precipitation is 15 to 24 inches or more, and mean annual temperature ranges from 39° to 57°F. The frost-free season is 120 to 210 days.

Included with this complex in mapping are areas of Lynx and Jacques soils and of gravelly, cobbly, and stony unconsolidated material.

In a representative profile the soils are pale brown to dark brown, stratified gravelly, cobbly, or stony loams, sandy loams, loamy sands, and sands to a depth of 40 inches or more.

The water supplying capacity is 15 to 24 inches or more. Effective rooting depth is 40 inches or more. Runoff is medium, and the hazard of erosion is moderate. Sedimentation is a problem in some areas.

This complex is used for grazing, as wildlife habitat, as a source of road fill, and as a source of sand and gravel in some areas. These soils have poor potential for livestock grazing. The main range plants are western wheatgrass, sand dropseed, and bottlebrush squirreltail. Range seeding of depleted areas by conventional methods is not feasible because of stoniness and droughtiness. Capability unit VI_s-6.

Haplustolls-Ustorthents Complex

41E—The Haplustolls-Ustorthents complex consists of gently rolling to very steep, well drained soils that are deeply dissected by many narrow, V-shaped valleys and sharp divides. It is in long areas adjacent to the drainageways and is on the very steep slopes of mountains. It is in extensive areas in the southern, southwestern, and western parts of the Reservation. Stones and boulders cover 3 to 25 percent of the surface layer. Haplustolls make up about 45 percent of the unit and Ustorthents about 40 percent. Soil slipping is common, and the very steep slopes have a succession of short vertical rock outcrops. Very shallow and shallow, moderately coarse textured to fine-textured soil material is on the moderate slopes of catsteps. Slopes range from 5 to 50 percent or more. Shallow gullies are common in areas of this mapping unit. Parent rocks are mainly limestone, sandstone, shale, basalt, or granite.

Included with this complex in mapping are areas of Tortugas and Telephone soils and shallow soils over shale, basalt, or granite and about 5 percent rock outcrop.

The water supplying capacity of these soils is 12 to 15 inches. Precipitation ranges from 15 to 20 inches, and the mean annual temperature from 44° to 54°F. The frost-free season from 120 to 270 days. Elevation ranges from 3,000 to about 7,000 feet. Along the Salt River, areas of this complex have elevations of 3,000 to 4,000 feet. Vegetation below an elevation of about 6,000 feet is mainly juniper, pinon pine, and desert shrub. Vegetation above 6,000 feet is mainly ponderosa pine.

Runoff is very rapid, and the hazard of erosion is high.

This complex produces an understory of small amounts of forage for livestock and moderate amounts of browse for wildlife. Above 6,000 feet small amounts of timber are produced. These soils are used as a

source of water supply. Capability unit VII_e-5; woodland suitability group 7x1.

Jacks Series

The Jacks series consists of well drained soils that are nearly level to rolling on plains and hills and are steep on side slopes adjacent to drainageways. These soils formed in material weathered from interbedded sandstone, siltstone, shale, and quartzite. Slopes are 0 to 50 percent. Elevation ranges from 4,500 to 6,000 feet. Vegetation is mainly pinon woodland, juniper, and oak and scattered ponderosa pine at the highest elevations. Annual precipitation is 16 to 20 inches, and mean annual temperature is about 55°F. The frost-free season is 120 to 170 days.

In a representative profile the surface layer is dark reddish gray cobbly clay loam 4 inches thick. The subsoil is 41 inches of reddish brown cobbly clay loam, cobbly clay, and clay that overlies fine-grained sandstone.

These soils are slowly permeable. The water supplying capacity is 12 to 15 inches. Available water capacity is moderate or high. Effective rooting depth is 38 to 48 inches. The soils are noneffervescent to a depth of 30 inches and slightly effervescent below a depth of 30 inches. Reaction is slightly acid to moderately alkaline.

These soils are used as range, as wildlife habitat, and as a source of water supply. Some areas at the higher elevations produce small amounts of scattered ponderosa pine that have little commercial value.

Representative profile of Jacks cobbly clay loam, 8 to 30 percent slopes, eroded, NE $\frac{1}{4}$ of sec. 35, T. 7 N., R. 20 E.:

- A1—0 to 4 inches, dark reddish gray (5YR 4/2) cobbly clay loam, dark reddish brown (5YR 3/2) when moist; moderate fine granular structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; many very fine interstitial pores; 20 percent cobbles and pebbles; slightly acid; clear smooth boundary.
- B1t—4 to 9 inches, reddish brown (5YR 4/4) cobbly clay loam, dark reddish brown (5YR 3/4) when moist; weak fine subangular blocky structure; slightly hard when dry, firm when moist, sticky and plastic when wet; common fine and very fine roots; common fine interstitial pores; 20 percent cobbles and pebbles; few thin clay films on peds and lining pores; slightly acid; gradual wavy boundary.
- B21t—9 to 30 inches, reddish brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) when moist; moderate coarse angular blocky structure parting to moderate fine subangular blocky; hard when dry, firm when moist, sticky and very plastic when wet; common very fine and a few coarse roots; few fine interstitial and tubular pores; 10 percent cobbles; many thick clay films on peds; neutral; gradual wavy boundary.

B2t—30 to 38 inches, reddish brown (2.5YR 5/4) clay, reddish brown (2.5YR 4/4) when moist; moderate medium subangular blocky structure; hard when dry, firm when moist, sticky and very plastic when wet; few very fine and coarse roots; few fine interstitial and tubular pores; 15 percent cobbles and pebbles; common moderately thick clay films on peds; very slightly effervescent; mildly alkaline; gradual wavy boundary.

B3—38 to 45 inches, reddish brown (2.5YR 5/4) cobbly clay, reddish brown (2.5YR 4/4) when moist; massive; hard when dry, sticky and plastic when wet; few very fine and coarse roots; few fine interstitial and tubular pores; 35 percent cobbles and pebbles of sandstone; few thin clay films lining pores; very slightly effervescent; moderately alkaline; clear wavy boundary.

R—45 to 50 inches, fine-grained sandstone.

Bedrock is at a depth of 28 to 48 inches. The B horizon is 5 to 35 percent coarse fragments. The A horizon has value of 4 or 5 when dry and chroma of 2 or 3. The A horizon is very fine sandy loam, loam, cobbly loam, cobbly clay loam, and gravelly clay loam. The B2t horizon has hue of 2.5YR or 5YR and chroma of 3 to 6. The B2t horizon ranges from clay loam or clay to gravelly, cobbly, or stony clay.

42C—Jacks very fine sandy loam, 8 to 15 percent slopes. This rolling soil is on hills around Grasshopper Butte. It has a profile similar to the one described as representative of the series, but it has fewer coarse fragments, has a very fine sandy loam surface layer, and is less eroded.

Included with this soil in mapping are 10 percent Chevelon cobbly clay loam, 5 percent Tours silt loam, 5 percent Navajo clay loam, 3 percent Chevelon silt loam, and 2 percent Rock outcrop of sandstone.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has fair potential for livestock grazing. The main range plants are side-oats grama, shrub liveoak, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIe-8.

43B—Jacks loam, 0 to 8 percent slopes. This nearly level and undulating soil is in a few small areas in depressions. It has a profile similar to the one described as representative for the series, but it has a light brown or brown loam surface layer that has weak, thick, platy structure, and it lacks cobbles and stones throughout the profile.

Included with this soil in mapping are 10 percent Chevelon cobbly clay loam, 10 percent Tours silt loam, 5 percent Chevelon silt loam, and 2 percent Navajo clay loam.

Runoff is slow, and the hazard of erosion is slight.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has fair potential for livestock grazing. It produces a small amount of scattered ponderosa pine at the higher elevations. The main

range plants are side-oats grama, shrub liveoak, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIs-8.

44D—Jacks cobbly loam, 15 to 30 percent slopes. This soil is moderately steep on hills and is in a few areas that are dissected by a few shallow gullies. It has a profile similar to the one described as representative for the series, but it has a brown loam surface layer 5 to 7 inches thick that is covered with 15 to 25 percent cobbles and stones.

Included with this soil in mapping are about 10 percent Showlow gravelly clay loam and 1 to 2 percent Rock outcrop of quartzite.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has fair potential for livestock grazing. The main range plants are side-oats grama, shrub liveoak, and Utah juniper. Range seeding of depleted areas is not feasible by conventional methods because of stoniness. Capability unit VIe-6.

45E—Jacks cobbly loam, 30 to 50 percent slopes. This steep soil is in long narrow areas on side slopes adjacent to drainageways. It has a profile similar to the one described as representative for the series, but the surface layer is cobbly loam.

Included with this soil in mapping are 10 percent Jacks cobbly loam that has slopes of less than 30 percent, 5 percent Barkerville cobbly sandy loam, and 2 percent Rock outcrop of quartzite.

Runoff is rapid, and the hazard of erosion is high.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has poor potential for livestock grazing. The main range plants are side-oats grama, shrub liveoak, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIIe-8.

46C—Jacks gravelly clay loam, 8 to 15 percent slopes, eroded. This soil is on sandstone hills in large, irregularly shaped areas. It has a profile similar to the one described as representative for the series, but it lacks sandstone cobbles and stones in the surface layer. About 25 percent of the surface layer is covered by gravel.

Included with this soil in mapping are 10 percent Chevelon cobbly clay loam, 5 percent Tours silt loam, 5 percent Navajo clay loam, 2 percent Chevelon silt loam, and 2 percent sandstone outcrop.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has fair potential for livestock grazing. The main range plants are side-oats grama, shrub liveoak, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIe-8.

47D—Jacks cobbly clay loam, 8 to 30 percent slopes, eroded. This moderately sloping to moderately steep soil is on hills and is dissected by common shallow gullies. It has the profile described as representative of the series. The surface layer is covered with 15 to 25 percent cobbles and stones.

Included with this soil in mapping are 10 percent Chevelon cobbly clay loam on ridges, 10 percent Navajo clay loam and Tours silt loam along bottoms, and 1 to 2 percent sandstone outcrop on side slopes and escarpments.

Runoff is rapid, and the hazard of erosion is high.

This soil is used as a source of water supply. It produces forage for livestock and browse for wildlife. It has fair potential for livestock grazing. The main range plants are shrub liveoak, side-oats grama, and Utah juniper. Range seeding of depleted areas by conventional methods is not feasible because of stoniness. Capability unit VIe-8.

Jacques Series

The Jacques series consists of well drained soils that are nearly level in swales and on bottoms and gently sloping on fans. These soils formed in mixed alluvium weathered from basalt, shale, and sandstone. Slopes are 0 to 8 percent. Elevation ranges from 5,000 to 7,000 feet. Vegetation is mainly grasses. Annual precipitation is 15 to 20 inches, and mean annual temperature is about 50° F. The frost-free season ranges from 115 to 160 days.

In a representative profile the surface layer is dark grayish brown clay loam 10 inches thick. The underlying layer is dark brown and dark yellowish brown clay to a depth of 60 inches or more.

These soils are slowly permeable. The water supplying capacity is 15 to 20 inches or more. Available water capacity is high. Effective rooting depth is 60 inches or more. These soils are frequently flooded for brief periods. They are noneffervescent. Reaction is neutral to moderately alkaline.

Representative profile of Jacques clay loam in NW $\frac{1}{4}$ of sec. 36, T. 4 $\frac{1}{2}$ N., R. 22 E.:

A11—0 to 2 inches, dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate fine granular structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; common fine and medium roots; many fine interstitial pores; neutral; clear wavy boundary.

A12—2 to 10 inches, dark grayish brown (10YR 4/2) clay loam, very dark grayish-brown (10YR 3/2) when moist; weak fine sub-angular blocky structure; slightly hard when dry, firm when moist, sticky and plastic when wet; common fine and medium roots; many very fine interstitial and few fine tubular pores; neutral; clear wavy boundary.

C1—10 to 24 inches, dark brown (7.5YR 4/2) light clay, very dark grayish brown (10YR 3/2) when moist; massive; hard when dry, firm when moist, sticky and plastic when wet; few fine roots; common very fine tubular and few fine interstitial pores; a few pressure faces; neutral; abrupt wavy boundary.

C2—24 to 60 inches, dark yellowish brown (10YR 4/4) clay, dark yellowish brown (10YR

3/4) when moist; massive; hard when dry, firm when moist, sticky and plastic when wet; few fine roots; common very fine tubular and few fine interstitial pores; a few pressure faces; mildly alkaline.

The profile is mainly free of gravel, but in places it is 5 to 10 percent gravel. The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. The A horizon is loam or clay loam. The C horizon has value of 4 or 5 when dry and 2 or 3 when moist. The C horizon is clay loam or clay. It has few to common pressure faces.

48B—Jacques clay loam. This nearly level to gently sloping soil is on bottoms along waterways. It is in many long, narrow areas. Slopes range from 0 to 3 percent. One shallow to deep gully that is the main drainage channel commonly dissects the soil. This soil has the profile described as representative of the series.

Included with this soil in mapping are 5 percent Lynx clay loam in bottoms, 5 percent Thunderbird gravelly loam on gentle side slopes, and 2 to 3 percent Showlow gravelly clay loam on low, undulating fans.

Runoff is slow, and the hazard of erosion is slight.

This soil is well suited to use as a site for earth-filled dams for water storage. It produces forage for livestock and small amounts of browse for wildlife. It has good potential for livestock grazing. The main range plants are western wheatgrass, side-oats grama, and junegrass. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIw-1.

49B—Jacques clay loam, eroded. This nearly level to moderately sloping soil is on bottoms and alluvial fans and is in a few long, narrow, and rounded areas. It has a profile similar to the one described as representative of the series, but the surface layer is thinner. Slopes range from 0 to 8 percent. A few deep gullies and common shallow gullies are in this soil.

Included with this soil in mapping are 5 percent Lynx clay loam, 5 percent Thunderbird gravelly clay loam, and 3 percent Showlow gravelly clay loam.

Runoff is medium, and the hazard of erosion is moderate.

This soil produces forage for livestock and a small amount of browse for wildlife. It has good potential for livestock grazing. The main range plants are western wheatgrass, junegrass, and side-oats grama. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIw-1.

Luna Series

The Luna series consists of well drained soils that are moderately steep on hills and steep on mountains. These soils formed in material weathered from ash or tuff and some cinders and basalt. Slopes are 15 to 50 percent. Elevation ranges from 7,000 to 8,600 feet. Vegetation is ponderosa pine, Douglas-fir, Gambel oak, and an understory of grasses. Annual precipitation is 20 to 30 inches, and mean annual temperature is about 43° F. The frost-free season ranges from 85 to 120 days.

In a representative profile the surface layer is very dark grayish brown clay loam 3 inches thick. The subsoil is dark grayish brown clay loam, brown gravelly clay, and pinkish gray gravelly clay loam 27 inches thick. The substratum is 10 inches of pinkish gray loam that overlies tuff.

These soils are slowly permeable. The water supplying capacity is 14 to 20 inches, and available water capacity is moderate or low. Effective rooting depth is 20 to 40 inches. Reaction is medium acid to slightly acid.

Luna soils are used as woodland, as wildlife habitat, and as a source of water supply.

Representative profile of Luna clay loam, 30 to 50 percent slopes, in the NW $\frac{1}{4}$ of sec. 6, T. 7 N., R. 25 E.:

- O1— $\frac{1}{2}$ inch to 0, pine and oak litter.
- A1—0 to 3 inches, very dark grayish brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) when moist; weak fine granular structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine and very fine roots; common very fine interstitial pores; medium acid; clear smooth boundary.
- B1—3 to 7 inches, dark grayish brown (10YR 4/2) heavy clay loam, very dark brown (10YR 2/2) when moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard when dry, friable when moist, sticky and plastic when wet; common fine and very fine roots; many very fine interstitial pores; few thin clay films line interstitial pores; medium acid; clear smooth boundary.
- B21t—7 to 18 inches, brown (7.5YR 5/2) gravelly clay, dark brown (7.5YR 3/2) when moist; moderate fine subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; common very fine and a few coarse roots; few very fine interstitial and tubular pores; many moderately thick clay films on peds; 30 percent weakly to strongly cemented fragments of tuff; few large very dark grayish brown (10YR 3/2) krotovinas; medium acid; clear wavy boundary.
- B22t—18 to 30 inches, pinkish gray (7.5YR 6/2) gravelly clay loam, brown (7.5YR 5/2) when moist; weak fine subangular blocky structure; hard when dry, firm when moist; slightly sticky and plastic when wet; few very fine and coarse roots; few very fine interstitial and tubular pores; few thin clay films on peds; 30 percent weakly to strongly cemented tuff fragments; few dark brown organic stains on peds; few large very dark grayish brown (10YR 3/2) krotovinas; medium acid; gradual wavy boundary.
- C—30 to 40 inches, pinkish gray (7.5YR 6/2) loam, brown (7.5YR 5/2) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic

when wet; few very fine and coarse roots; few very fine tubular pores; slightly acid; diffuse wavy boundary.

R—40 to 44 inches, pinkish gray (7.5YR 6/2) weathered tuff, few pockets of calcareous loam in cracks.

Ash or tuff is at a depth of 20 to 40 inches. The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 when dry and 2 or 3 when moist. It is loam, cobbly silt loam, and clay loam. The upper part of the B horizon has hue of 7.5YR or 10YR, value of 3 to 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. The lower part of the Bt horizon has hue of 7.5YR or 10YR and value of 4 to 6 when dry. The C horizon has hue of 7.5YR or 10YR, value of 5 to 8 when dry and 4 to 7 when moist, and chroma of 1 or 2. The R horizon ranges from weakly cemented to moderately cemented ash or tuff mixed with fragments of strongly cemented tuff.

50D—Luna cobbly silt loam, 15 to 30 percent slopes.

This moderately steep soil is on hills. It has a profile similar to the one described as representative for the series, but it has a brown cobbly silt loam surface layer and 15 to 25 percent of the surface is covered with scattered basalt cobbles and stones.

Included with this soil in mapping are 10 to 20 percent Broliar soils and 5 percent exposed areas of cemented tuff or ash.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. An understory of grass and browse furnishes some forage for livestock and wildlife. Capability unit VIe-6; woodland suitability group 5c1.

51E—Luna cobbly silt loam, 30 to 50 percent slopes.

This steep soil is in a few long, irregularly shaped areas on mountains. It has a profile similar to the one described as representative for the series, but the surface layer is cobbly silt loam.

Included with this soil in mapping are 10 percent very steep Cryorthents-Cryoborolls complex that is above the waterways and 5 percent exposed areas of tuff or cemented ash.

Runoff is rapid, and the hazard of erosion is high.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. An understory of grass and browse furnishes some forage for livestock and wildlife. Capability unit VIIe-6; woodland suitability group 5c1.

52D—Luna clay loam, 15 to 30 percent slopes. This moderately steep soil is in a few rounded areas on hills near Whiteriver. Included with this soil in mapping are 10 percent Broliar soils and 5 percent Cryorthents-Cryoborolls complex.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. An understory of grass and browse furnishes some forage for livestock and wildlife. Capability unit VIe-8; woodland suitability group 5c1.

53E—Luna clay loam, 30 to 50 percent slopes. This steep soil is on mountains in a few small and large,

long, irregularly shaped areas. It has the profile described as representative of the series.

Included with this soil in mapping are 10 percent Broliar soils and 5 percent very steep Cryorthents-Cryoborolls complex on side slopes of drainageways.

Runoff is rapid, and the hazard of erosion is high.

This soil produces moderate amounts of good merchantable timber and an understory of forage and browse for livestock and wildlife. It is also used as a source of water supply. Capability unit VIIe-8; woodland suitability group 5c1.

Luna Variant

The Luna variant consists of poorly drained soils that are level to gently sloping in swales that are in mountain meadows. These soils formed in alluvium weathered from basalt, rhyolite, andesite, ash, and cinders. Slopes are 0 to 3 percent. Elevation ranges from 7,200 to 9,000 feet. Vegetation is grasses and sedges. Annual precipitation is 20 to 30 inches, and mean annual temperature is about 43° F. The frost-free season ranges from 85 to 110 days.

In a representative profile the surface layer is very dark gray silt loam 3 inches thick. The subsoil is a very dark gray, dark reddish brown, and reddish gray clay and gravelly clay 29 inches thick. The substratum is reddish gray gravelly clay loam to a depth of 60 inches or more.

These soils are slowly permeable. Effective rooting depth is 60 inches or more. The water supplying capacity is 20 to 30 inches or more, and available water capacity is high. The water table is at or near the surface during winter and spring, but it drops to a depth of about 50 inches late in summer and in fall.

The Luna variant soils are used as range, as wildlife habitat, and for recreation.

Representative profile of Luna silt loam, wet variant, in the SE $\frac{1}{4}$ of sec. 15, T. 8 N., R. 24 E., in the center of Haystack Cienaga:

A1—0 to 3 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; moderate fine granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine and very fine roots; common very fine interstitial pores; medium acid; clear smooth boundary.

B1—3 to 10 inches, very dark gray (10YR 3/1) light clay, black (10YR 2/1) when moist; weak fine subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; common fine and very fine roots; few fine interstitial and tubular pores; medium acid; gradual wavy boundary.

B21t—10 to 15 inches, dark reddish brown (5YR 3/2) clay, dark reddish brown (5YR 2/2) when moist; moderate fine and medium subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; common fine and very fine roots; few fine interstitial and tubular pores; common moderately thick

clay films on peds; slightly acid; gradual wavy boundary.

B22t—15 to 23 inches, reddish gray (5YR 5/2) light clay, dark reddish brown (5YR 3/2) when moist, common fine distinct yellowish red (5YR 4/8) mottles; weak fine and medium subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few fine and very fine roots; few fine interstitial and tubular pores; slightly acid; gradual wavy boundary.

B3t—23 to 32 inches, reddish gray (5YR 5/2) gravelly light clay, dark reddish brown (5YR 3/2) when moist; many fine distinct gray (5YR 5/1) and common fine distinct yellowish red (5YR 4/8) when moist mottles; weak fine and medium subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few fine roots; few fine interstitial and tubular pores; few thin clay films on peds and in pores; 25 percent basalt pebbles; slightly acid; clear wavy boundary.

C—32 to 60 inches, reddish gray (5YR 5/2) gravelly clay loam, dark reddish brown (5YR 3/2) when moist; common fine distinct gray (5YR 5/1) and many fine distinct yellowish red (5YR 4/8) mottles, black (5YR 2/1) and yellowish red (5YR 4/8) when moist; massive; slightly hard when dry, firm when moist, slightly sticky and slightly plastic when wet; few fine roots; few fine interstitial and tubular pores; 20 percent basalt pebbles; slightly acid.

Gravelly soil material is at a depth of 20 to 36 inches. The A horizon has value of 2 or 3 when dry and chroma of 1 or 2. It is silt loam, loam, and clay loam. The B2t horizon has hue of 5YR or 7.5YR and chroma of 2 or 3. It has few to many yellowish red (5YR 4/8; 4/6), moist mottles. It is clay loam or clay. The B3t horizon has hue of 5YR or 7.5YR, value of 4 or 5 when dry, and chroma of 2 or 3. The B3t and C horizons have few to many very dark gray, dark gray, gray, black, and yellowish red mottles. The B3t and C horizons are commonly gravelly clay loam or gravelly light clay, but strata of gravelly sandy loam occur in some profiles.

54B—Luna silt loam, wet variant. This nearly level to gently sloping soil is in small mountain meadows. Slopes range from 0 to 3 percent. This soil has the profile described as representative of the Luna variant.

Included with this soil in mapping are 10 percent Gordo cobbly silt loam that has undulating slopes around the edges of the meadows and 10 percent Cryaquolls, nearly level, in bottoms.

Runoff is slow, and the hazard of erosion is slight.

This soil produces large amounts of forage for livestock and wildlife. It is well suited to use as sites for earth filled dams for recreational lakes. It has good potential for livestock grazing. The main range plants are Arizona fescue, spike muhly, and sedges. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit Vw-8.

55B—Luna clay loam, wet variant. This nearly level to gently sloping soil is in many small areas in meadows. Slopes range from 0 to 3 percent. The soil has a profile similar to the one described as representative for the Luna variant, but it has a clay loam surface layer and depth to the water table ranges from 10 to 50 inches.

Included with this soil in mapping are 10 percent Gordo cobbly silt loam around the edges of the meadows and 5 to 10 percent Cryaquolls, nearly level, on bottoms.

Runoff is slow, and the hazard of erosion is slight.

This soil is used as range, as wildlife habitat, and for recreation. It has good potential for livestock grazing. The main range plants are Arizona fescue, spike muhly, and sedges. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit Vw-8.

Lynx Series

Lynx series consists of well drained soils that are nearly level in swales and on bottoms. These soils formed in alluvium derived from basalt and schist and from some sandstone and limestone. Slopes are 0 to 2 percent. Elevation ranges from 5,000 to 6,500 feet. Vegetation is mainly grasses. Annual precipitation is 16 to 24 inches, and mean annual temperature is about 55° F. The frost-free season is 120 to 190 days.

In a representative profile the soil is dark brown and brown stratified loam and clay loam to a depth of 60 inches or more.

These soils are moderately slowly permeable. The water supplying capacity is 16 to 20 inches or more. Available water capacity is high. Effective rooting depth is 60 inches or more. The soils are frequently flooded for brief periods. Reaction is neutral to mildly alkaline.

Lynx soils are used as range, as wildlife habitat, and as a source of water supply. They are well suited to use as sites for earthen dams.

Representative profile of Lynx loam, eroded, NW $\frac{1}{4}$ of sec. T. 4 N., R. 23 E.:

A11—0 to 4 inches, dark brown (7.5YR 4/2) loam, very dark brown (10YR 2/2) when moist; weak fine granular structure; slightly hard when dry, friable when moist, nonsticky and slightly plastic when wet; many fine roots; common very fine interstitial pores; neutral; clear smooth boundary.

A12—4 to 18 inches, dark brown (7.5YR 4/2) light clay loam, dark brown (7.5YR 3/2) when moist; weak fine subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; common fine roots; common fine tubular and few fine interstitial pores; mildly alkaline; clear wavy boundary.

A13—18 to 36 inches, brown (7.5YR 5/2) clay loam, dark brown (7.5YR 3/2) when moist; weak fine subangular blocky structure; hard when dry, friable when

moist, slightly sticky and plastic when wet; common fine roots; common fine tubular and few fine interstitial pores; mildly alkaline; clear wavy boundary.

A14—36 to 60 inches, dark brown (7.5YR 4/2) heavy loam, very dark brown (10YR 2/2) when moist; massive; hard when dry, friable when moist, slightly sticky and plastic when wet; few fine roots; common fine tubular and few fine interstitial pores; mildly alkaline.

Lynx soils are very deep. The soil has 1 to 10 percent pebbles throughout the profile or occurring as thin strata at various depths in the profile. A few to common lime segregations are in the lower part of the A1 horizon. The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 when dry, and chroma of 2 or 3. It is loam and clay loam.

56B—Lynx loam, eroded. This nearly level soil is on long, narrow bottoms along drainageways. A few deep gullies and common shallow gullies dissect this soil. Included with this soil in mapping is 5 to 10 percent Thunderbird gravelly clay loam in swales.

Runoff is medium, and the hazard of erosion is moderate.

This soil can be used as a site for earth-filled dams for water storage. It produces large amounts of forage for livestock and small amounts of browse for wildlife. It has good potential for livestock grazing. The main range plants are blue grama, spike muhly, and bottlebrush squirreltail. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIw-1.

Navajo Series

The Navajo series consists of well drained soils that are nearly level in swales and on bottoms and gently sloping on alluvial fans. These soils formed in alluvium derived from limestone, sandstone, shale, and basalt. Slopes are 0 to 5 percent. Elevation ranges from 4,300 to 5,700 feet. Vegetation is mainly grasses. Annual precipitation is 15 to 18 inches, and mean annual temperature is about 55° F. The frost-free season is 120 to 200 days.

In a representative profile the surface layer is reddish brown clay loam 3 inches thick. The underlying layer is dark red and red silty clay and clay to a depth of 60 inches or more.

These soils are very slowly permeable. The water supplying capacity is 15 to 18 inches or more, and available water capacity is high. The effective rooting depth is 60 inches or more. These soils are frequently flooded for brief periods. Reaction is mildly alkaline to moderately alkaline.

Navajo soils are used as range, as wildlife habitat, and as a source of water supply.

Representative profile of Navajo clay loam, eroded, SE $\frac{1}{4}$ of sec. 2, T. 5 N., R. 20 E.:

A1—0 to 3 inches, reddish brown (2.5YR 4/4) clay loam, reddish brown (2.5YR 4/4) when moist; moderate fine granular structure; hard when dry, firm when moist, sticky and plastic when wet; few

fine and medium roots; many very fine interstitial pores; strongly effervescent; mildly alkaline; abrupt smooth boundary.

C1—3 to 24 inches, dark red (2.5YR 3/6) silty clay, dark red (2.5YR 3/6) when moist; massive; hard when dry, firm when moist, sticky and plastic when wet; few fine and medium roots; many fine and medium tubular pores; strongly effervescent; moderately alkaline; gradual smooth boundary.

C2—24 to 60 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) when moist; massive; very hard when dry, very firm when moist, sticky and plastic when wet; few fine roots; many fine tubular pores; violently effervescent; moderately alkaline.

The A1 horizon has hue of 7.5YR to 2.5YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 3 to 6. It is clay loam, clay, or silty clay. The C horizon has hue of 2.5YR or 5YR, value of 3 to 6 when dry and moist, and chroma of 2 to 6 when dry and 3 to 6 when moist. Fine strata of silty clay loam, silt loam, or clay loam are in places in the C horizon. Soft segregations of lime, ranging from few to many, are in the C horizon.

57B—Navajo clay loam, eroded. This nearly level soil is in long, narrow swales and bottoms and is gently sloping on eroded alluvial fans. Slope ranges from 0 to 5 percent. Common shallow to deep gullies caused by runoff from higher lying soils dissect this soil. This soil has the profile described as representative of the series.

Included with this soil in mapping is about 5 percent gently sloping Roundtop clay loam along the edges of areas of this Navajo soil.

Runoff is slow, and the hazard of erosion is high.

This soil produces forage for livestock and wildlife. It has good potential for livestock grazing. The main range plants are side-oats grama, western wheatgrass, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIw-1.

58B—Navajo clay loam, severely eroded. This nearly level soil is in swales and long narrow areas along drainageways. Slope ranges from 0 to 5 percent. It is dissected by many shallow to deep gullies caused by runoff from higher lying soils.

Runoff is medium, and the hazard of erosion is very high.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has good potential for livestock grazing. The main range plants are side-oats grama, western wheatgrass, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIw-1.

Overgaard Series

The Overgaard series consists of well drained soils that are nearly level to hilly along the Mogollon Rim and steep on the sides of drainageways that traverse the area. These soils formed in gravelly alluvium de-

rived from sandstone, quartzite, and granite. Slopes are 0 to 50 percent. Elevation ranges from 6,400 to 7,300 feet. Vegetation is ponderosa pine, Gambel oak, shrubs, and grasses. Annual precipitation is 20 to 25 inches, and mean annual temperature is about 46° F. The frost-free season ranges from 110 to 130 days.

In a representative profile the surface layer is grayish brown gravelly loam 2 inches thick. The subsurface layer is light brownish gray gravelly loam 10 inches thick. The subsoil is brown and reddish brown gravelly clay 30 inches thick. The substratum is mottled brown and reddish brown very gravelly clay loam to a depth of 60 inches or more.

These soils are slowly permeable. The water supplying capacity is 12 to 16 inches, and available water capacity is moderate. Effective rooting depth is 60 inches or more. Reaction is medium acid to neutral.

Overgaard soils are used mainly as woodland, as wildlife habitat, and as a source of water supply. Forage of grass and browse for wildlife and livestock is produced as an understory.

Representative profile of Overgaard gravelly loam, 15 to 30 percent slopes, SW $\frac{1}{4}$ of sec. 9, T. 7 N., R. 22 E., $\frac{1}{2}$ mile south of Dry Lake:

O1—1 inch to 0, pine and oak litter.

A1—0 to 2 inches, grayish brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; common fine roots; common very fine interstitial pores; 20 percent pebbles; medium acid; clear smooth boundary.

A2—2 to 12 inches, light brownish gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) when moist; massive; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; common fine and a few coarse roots; common very fine vesicular pores; 20 percent pebbles; medium acid; abrupt smooth boundary.

B21t—12 to 20 inches, brown (7.5YR 5/4) gravelly light clay, dark brown (7.5YR 4/4) when moist; moderate medium subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; common fine and a few coarse roots; common fine interstitial and tubular pores; 25 percent pebbles; many moderately thick clay films on peds; common organic stains on peds; slightly acid; gradual wavy boundary.

B22t—20 to 31 inches, reddish brown (5YR 5/4) gravelly clay, reddish brown (5YR 4/4) when moist; moderate medium subangular and angular blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; few fine and coarse roots; common fine interstitial and tubular pores; 25 percent pebbles; continuous thick clay films on peds; neutral; gradual wavy boundary.

B3t—31 to 42 inches, reddish brown (5YR 5/4) gravelly light clay, yellowish red (5YR 4/6) when moist; few medium distinct brown (7.5YR 5/4) mottles, dark reddish brown (5YR 3/4) when moist; weak medium subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few very fine roots; few fine interstitial and tubular pores; 20 percent pebbles; common moderately thick clay films on pedis; neutral; gradual wavy boundary.

C—42 to 60 inches, mottled brown (7.5YR 5/4) and reddish brown (5YR 5/4) dry and moist, very gravelly clay loam; massive; slightly hard when dry, firm when moist, slightly sticky and slightly plastic when wet; very few very fine roots; few fine interstitial and tubular pores; 60 percent pebbles; neutral.

Coarse fragments in the profile range from 15 to 60 percent but are mainly 15 to 30 percent. The A horizon is medium acid to neutral. The A1 horizon has hue of 10YR or 7.5YR and value of 4 or 5 when dry and 2 to 4 when moist. The A2 horizon has hue of 10YR or 7.5YR, value of 5 to 7 when dry and 4 to 6 when moist, and chroma of 2 or 3. The A1 and A2 horizons are gravelly fine sandy loam, gravelly loam, or gravelly sandy loam. The Bt horizon has value of 4 and 5 when dry and 3 to 5 when moist and chroma of 4 to 6. It is gravelly clay loam or gravelly clay.

59B—Overgaard gravelly fine sandy loam, 0 to 8 percent slopes. This nearly level to gently rolling soil is along the top of the Mogollon Rim. It has a profile similar to the one described as representative for the series, but it has a surface layer of gravelly fine sandy loam 7 to 10 inches thick, and the subsoil has few to common dark red mottles.

Included with this soil in mapping are about 10 percent Elledge cobbly sandy loam and 5 percent Cryorthents-Cryoborolls complex.

Runoff is slow, and the hazard of erosion is slight.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. It has an understory of grass and browse that furnishes some forage for livestock and wildlife. Capability unit VIs-8; woodland suitability group 6c1.

60D—Overgaard gravelly fine sandy loam, 8 to 30 percent slopes. This strongly sloping and moderately steep soil is adjacent to drainageways. It has a profile similar to the one described as representative for the series, but the surface layer is 4 to 7 inches of gravelly fine sandy loam.

Included with this soil in mapping are 10 percent Elledge cobbly sandy loam along the crests of ridges and 2 percent Rock outcrop of sandstone.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. It has an understory of grass and browse that furnishes some forage for wildlife and livestock. Capability unit VIe-8; woodland suitability group 6c1.

61B—Overgaard gravelly loam, 0 to 8 percent slopes.

This soil is on long narrow spur ridges below the Mogollon Rim. Included with this soil in mapping are about 10 percent Elledge cobbly sandy loam and 5 percent Cryorthents-Cryoborolls complex.

Runoff is slow, and the hazard of erosion is slight.

The soil is used as woodland, as wildlife habitat, and as a source of water supply. It has an understory of grass and browse that furnishes some forage for livestock and wildlife. Capability unit VIs-8; woodland suitability group 6c1.

62D—Overgaard gravelly loam, 15 to 30 percent slopes. This hilly soil crops out in places along the side slopes of drainageways. It formed in a mantle of gravelly alluvium overlying sandstone. Rounded gravel covers 15 to 30 percent of the surface layer. This soil has the profile described as representative of the series.

Included with this soil in mapping are about 10 percent Elledge cobbly sandy loam along the crests of long ridges and 5 percent Cryorthents-Cryoborolls complex on the very steep side slopes adjacent to the waterways.

Runoff is medium, and the hazard of erosion is moderate.

This soil is a good source of material for road fill. It is forested and has an understory of grasses and browse for livestock and wildlife. Capability unit VIe-8; woodland suitability group 6c1.

63E—Overgaard gravelly loam, 30 to 50 percent slopes. This steep soil is in a long, wide, irregular band adjacent to drainageways. It has a profile similar to the one described as representative for the series, but the surface layer is only 4 to 7 inches thick.

Included with this soil in mapping are 10 percent Elledge soils along the crests of ridges and 5 percent very steep Cryorthents-Cryoborolls complex on side slopes above waterways.

Runoff is rapid, and the hazard of erosion is high.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. It produces merchantable timber of good quality and an understory of grass and browse that furnishes some forage for livestock and wildlife. Capability unit VIIe-8; woodland suitability group 5c1.

64D—Overgaard-Elledge complex, 15 to 30 percent slopes. This complex consists of moderately steep soils in irregularly shaped areas on old alluvial fans that overlie sandstone. It is 45 percent Overgaard gravelly loam and 35 percent Elledge cobbly sandy loam. The Overgaard soil is on the alluvial fans, and the Elledge soil is on the side slopes of the alluvial fans adjacent to drainageways.

Included with these soils in mapping are about 15 percent Telephone very cobbly sandy loam along the crests of ridges and 5 percent Lynx loam on nearly level bottoms along waterways.

Runoff is medium, and the hazard of erosion is moderate.

The soils in this complex are used as woodland, as wildlife habitat, and as a source of water supply. They produce an understory of grass and browse that provides some forage for livestock and wildlife. Capability unit VIe-8; woodland suitability group 6c1.

65D—Overgaard-Telephone complex, 15 to 30 percent slopes. This complex consists of moderately steep

soils on hills. It is 55 percent Overgaard gravelly loam and 25 percent Telephone sandy loam. The Overgaard soil is on ridgetops, and the Telephone soil is on side slopes. The Telephone soil has a profile similar to the one described as representative of the Telephone series, but it does not have cobbles on the surface.

Included with these soils in mapping is 20 percent Elledge soils on side slopes adjacent to waterways, Haplustolls-Torrifluvents complex on bottoms along drainageways, and small areas of Rock outcrop of sandstone.

Runoff is medium, and the hazard of erosion is moderate.

The soils in this complex are used as woodland, as wildlife habitat, and as a source of water supply. They produce an understory of grass and browse that provides some forage for livestock and wildlife. Capability unit VIe-8; Overgaard soil in woodland suitability group 6c1, Telephone soil in woodland suitability group 7x1.

Rond Series

The Rond series consists of well drained soils that are level on plains and moderately steep adjacent to drainageways. These soils formed in limestone. Slopes are 0 to 30 percent. Elevation ranges from 4,500 to 6,000 feet. Vegetation is mainly pinon pine, juniper, grasses, and shrubs, but some scattered ponderosa pine is at an elevation of 5,800 to 6,000 feet. Annual precipitation is 16 to 20 inches, and mean annual temperature is about 53° F. The frost-free season ranges from 120 to 170 days.

In a representative profile the surface layer is brown gravelly loam 3 inches thick. The subsoil is dark reddish gray gravelly clay loam and reddish brown and yellowish red gravelly clay 45 inches thick. The substratum, to a depth of 54 inches, is weak red gravelly clay loam that overlies limestone.

These soils are slowly permeable. The water supplying capacity is 12 to 15 inches, and available water capacity is high or moderate. Effective rooting depth is 40 to 60 inches. The soils are noneffervescent in the surface layer, but they become violently effervescent in the substratum. Reaction is neutral to moderately alkaline.

Rond soils are used mainly as range, as wildlife habitat, and as a source of water supply.

Representative profile of Rond gravelly loam, 0 to 8 percent slopes, NW $\frac{1}{4}$ of sec. 3, T. 6 N., R. 16 E., 1 mile north of Cottontail tank:

A1—0 to 3 inches, brown (7.5YR 5/3) gravelly loam, dark brown (7.5YR 3/2) when moist; weak thin and medium platy structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; common fine roots; many fine vesicular pores; 20 percent chert pebbles; neutral; clear smooth boundary.

B1t—3 to 14 inches, dark reddish gray (5YR 4/2) gravelly heavy clay loam, dark reddish brown (5YR 3/2) when moist; weak fine subangular blocky structure parting to weak fine granular; slightly hard when dry, friable when moist, sticky and plas-

tic when wet; common fine and few coarse roots; common very fine interstitial pores; few thin clay films on peds and in pores; 15 percent chert pebbles; mildly alkaline; clear wavy boundary.

B21t—14 to 20 inches, reddish brown (5YR 5/4) gravelly clay, reddish brown (5YR 4/4) when moist; moderate medium angular blocky structure; hard when dry, firm when moist, sticky and very plastic when wet; common fine and a few coarse roots; few fine interstitial and tubular pores; many moderately thick clay films on peds and in pores; 20 percent chert pebbles; slightly effervescent; mildly alkaline; gradual wavy boundary.

B22t—20 to 34 inches, yellowish red (5YR 4/6) gravelly clay, yellowish red (5YR 4/6) when moist; strong medium angular blocky structure; very hard when dry, firm when moist, sticky and very plastic when wet; few fine and very fine roots; few fine interstitial and tubular pores; thick clay films on peds; few small slickensides; 30 percent chert pebbles; slightly effervescent; mildly alkaline; gradual wavy boundary.

B23t—34 to 48 inches, yellowish red (5YR 4/6) gravelly clay, yellowish red (5YR 4/6) when moist; moderate medium angular blocky structure; very hard when dry, firm when moist, sticky and very plastic when wet; few very fine roots; few fine interstitial pores; many moderately thick clay films on peds; 30 percent chert pebbles; slightly effervescent; mildly alkaline; gradual wavy boundary.

Cca—48 to 54 inches, gravelly clay loam, variegated weak red (2.5YR 4/2), pinkish gray (5YR 7/2), and yellowish red (5YR 5/8) when moist; massive; hard when dry, firm when moist, sticky and plastic when wet; few very fine roots; few thin clay films line pores; 30 percent chert pebbles; violently effervescent; moderately alkaline; clear wavy boundary.

R—54 to 56 inches, extremely hard limestone.

Bedrock is at a depth of 40 to 60 inches. The Cca horizon is at a depth of 36 to 50 inches. The A1 horizon has hue of 5YR to 10YR and value of 4 or 5 when dry and 2 or 3 when moist. It is loam, silt loam, gravelly silt loam, very fine sandy loam, gravelly loam, clay loam, gravelly clay loam, and cobbly clay loam. The B1 horizon has hue of 5YR or 7.5YR, value of 4 or 5 when dry, and chroma of 2 or 3. The B2 horizon has hue of 5YR or 2.5YR, value of 3 or 4 when moist, and chroma of 3 to 6. It is heavy clay loam, heavy gravelly clay loam, cobbly clay loam, clay, gravelly clay, and cobbly clay.

66B—Rond loam, 0 to 8 percent slopes. This nearly level to gently rolling soil is on level benches of limestone hills. It has a profile similar to the one described as representative for the series, but it has a surface layer of loam, a $\frac{1}{2}$ - to 1-inch cover of partially decayed litter on the surface, and less than 5 percent pebbles.

Included with this soil in mapping are 5 percent Roundtop gravelly clay loam, 5 percent Navajo clay loam, and 5 percent Jacks cobbly clay loam.

Runoff is slow, and the hazard of erosion is slight.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has good potential for livestock grazing. The main range plants are side-oats grama, blue grama, and alligator juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VI_s-8.

67C—Rond loam, 8 to 15 percent slopes. This gently rolling soil is on limestone hills. It has a profile similar to the one described as representative for the series, but it has a surface layer of loam, ½ to 1 inch of litter on the surface, and less than 5 percent pebbles.

Included with this soil in mapping is about 5 percent Roundtop gravelly clay loam and 5 percent Jacks cobbly clay loam.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has good potential for livestock grazing. The main range plants are side-oats grama, blue grama, and alligator juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VI_e-8.

68B—Rond gravelly loam, 0 to 8 percent slopes. This nearly level and gently rolling soil is in a few long narrow areas on ridgetops in the western part of the Reservation. It has the profile described as representative for the series. Included with this soil in mapping are 5 percent Roundtop gravelly loam, 5 percent Navajo clay, and 5 percent Jacks cobbly clay loam.

Runoff is slow, and the hazard of erosion is slight.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has good potential for livestock grazing. The main range plants are side-oats grama, blue grama, and alligator juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VI_s-8.

69D—Rond gravelly loam, 8 to 30 percent slopes. This moderately sloping to moderately steep soil is on limestone hills. Included with this soil in mapping are 5 percent Roundtop gravelly loam and 5 percent Jacks cobbly clay loam.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has good potential for livestock grazing. The main range plants are side-oats grama, blue grama, and alligator juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VI_e-8.

Roundtop Series

The Roundtop series consists of well drained soils that are nearly level to rolling on plains, moderately steep on hills, and steep on side slopes adjacent to drainageways. These soils formed in limestone. Slopes are 0 to 50 percent. Elevation ranges from 4,500 to

6,000 feet. Vegetation is pinon pine, juniper, shrubs, and grasses. Annual precipitation is 16 to 20 inches, and mean annual temperature is about 54° F. The frost-free season ranges from 120 to 170 days.

In a representative profile the surface layer is dark reddish gray gravelly clay loam 3 inches thick. The subsoil, to a depth of 36 inches, is reddish brown gravelly clay loam and gravelly clay that overlies limestone.

These soils are slowly permeable. The water supplying capacity is 12 to 15 inches, and available water capacity is moderate to low. Effective rooting depth is 20 to 40 inches. Reaction is neutral to moderately alkaline.

Roundtop soils are mainly used as range, as wildlife habitat, and as a source of water supply.

Representative profile of Roundtop gravelly clay loam, 15 to 30 percent slopes, SE¼ of sec. 26, T. 7 N., R. 16 E., south of the town of Grasshopper, on Salt Draw:

A1—0 to 3 inches, dark reddish gray (5YR 4/2) gravelly clay loam, dark reddish brown (5YR 3/2) when moist; moderate fine granular structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; many fine interstitial pores; 20 percent pebbles and cobbles; neutral; clear smooth boundary.

B1t—3 to 8 inches, reddish brown (5YR 4/3) gravelly heavy clay loam, dark reddish brown (5YR 3/3) when moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard when dry, firm when moist, sticky and plastic when wet; common fine and very fine roots; common fine interstitial pores; 20 percent pebbles and cobbles; few thin clay films on peds and lining interstitial pores; neutral; gradual wavy boundary.

B21t—8 to 15 inches, reddish brown (5YR 4/3) gravelly clay, dark reddish brown (5YR 3/3) when moist; moderate medium angular blocky structure; very hard when dry, firm when moist, sticky and very plastic when wet; common very fine and a few coarse roots; few fine interstitial and tubular pores; 20 percent pebbles and cobbles; many moderately thick clay films on peds; slightly effervescent; mildly alkaline; diffuse wavy boundary.

B22t—15 to 23 inches, reddish brown (5YR 4/4) gravelly clay, dark reddish brown (5YR 3/4) when moist; strong medium angular blocky structure; very hard when dry, firm when moist, sticky and very plastic when wet; common very fine and few coarse roots; few tubular pores; 25 percent pebbles and cobbles; continuous moderately thick clay films on peds; strongly effervescent; mildly alkaline; gradual wavy boundary.

B3tca—23 to 36 inches, reddish brown (5YR 5/4) gravelly clay loam, reddish brown (2.5YR 4/4) when moist; massive; slightly hard

when dry, firm when moist, sticky and plastic when wet; few very fine and coarse roots; few fine interstitial pores; 30 percent pebbles and cobbles; few thin clay films lining pores; violently effervescent; moderately alkaline; abrupt irregular boundary.

R—36 to 40 inches, fractured extremely hard cherty limestone.

Fractured limestone is at a depth of 20 to 40 inches. The profile is neutral to moderately alkaline in reaction. The A1 and B1t horizons have hue of 5YR to 10YR and value of 4 or 5 when dry and 2 or 3 when moist. The A horizon is gravelly clay loam, loam, clay loam, gravelly loam, and cobbly clay loam. The B2t horizon has hue of 2.5YR or 5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 3 to 6. It is clay loam, gravelly clay loam, cobbly clay loam, clay, gravelly clay, and cobbly clay. The Bt horizon is 2 to 35 percent pebbles and cobbles. In places a Cca horizon is between the B3tca and R horizons.

70B—Roundtop clay loam, 0 to 8 percent slopes. This level to gently rolling soil is in rounded areas. It has a profile similar to the one described as representative for the series, but it lacks pebbles in the surface layer.

Included with this soil in mapping are about 10 percent Tortugas soils and 2 percent limestone outcrop.

Runoff is slow, and the hazard of erosion is slight.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has fair potential for livestock grazing. The main range plants are side-oats grama, shrub liveoak, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VI_s-8.

71B—Roundtop gravelly clay loam, 0 to 8 percent slopes, eroded. This level to gently rolling soil is dissected by common shallow gullies. Included with this soil in mapping is about 5 percent Navajo soils in long, narrow bands along drainageways and bottoms.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has fair potential for livestock grazing. The main range plants are side-oats grama, shrub liveoak, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VI_e-8.

72D—Roundtop gravelly clay loam, 15 to 30 percent slopes. This moderately steep soil is on hills and is underlain by limestone. It has the profile described as representative for the series. Angular chert pebbles cover 15 to 25 percent of the surface. Slopes are smooth and uniform.

Included with this soil in mapping are about 10 percent Tortugas soils along the crests of ridges and 2 percent Rock outcrop of limestone.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has fair potential for livestock grazing. The main range plants are side-oats grama, shrub liveoak, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy

grazing, fire, or other disturbances. Capability unit VI_e-8.

73D—Roundtop-Rock outcrop complex, 8 to 30 percent slopes, eroded. This complex consists of moderately sloping to moderately steep soils on limestone hills. It is about 75 percent Roundtop clay loam and 10 percent Rock outcrop of limestone. The Roundtop soil has a profile similar to the one described as representative for the series, but it is calcareous throughout, has 15 to 20 percent cobbles and stones scattered on the surface, is more eroded, and has a calcareous horizon at a shallow depth. This complex is dissected by a few deep gullies and common shallow gullies. Rock outcrop occurs as escarpments on the sides of the limestone hills.

Included with this complex in mapping is about 15 percent Tortugas cobbly loam along the crests of ridges.

Runoff is rapid, and the hazard of erosion is high.

The soils in this complex are used as range, as wildlife habitat, and as a source of water supply. Potential is fair for livestock grazing on the Roundtop soils, and the main range plants are side-oats grama, shrub liveoak, and Utah juniper. There are no range plants on the areas of Rock outcrop. Range seeding of depleted areas by conventional methods is not feasible because of the areas of Rock outcrop. Capability unit VI_e-8.

74E—Roundtop-Rock outcrop complex, 30 to 50 percent slopes, eroded. This complex consists of steep soils in long, narrow areas on side slopes adjacent to drainageways. It is about 60 percent Roundtop clay loam and 10 percent Rock outcrop of limestone. Common shallow gullies and a few deep gullies dissect the area. The Roundtop soil has a profile similar to the one described as representative of the series, but it is calcareous throughout, has 15 to 20 percent cobbles on the surface, is more eroded, and has a calcareous horizon at a shallow depth. The Rock outcrop of limestone occurs as escarpments and as stair steps on slopes.

Included with this complex in mapping are 15 percent Tortugas soils on the upper slopes and 15 percent Haplustolls-Ustorthents complex on very steep slopes near the drainageways.

Runoff is rapid, and the hazard of erosion is high.

These soils are used as range, as wildlife habitat, and as a source of water supply. The potential for livestock grazing is fair on the Roundtop soil, and the main range plants are side-oats grama, shrub liveoak, and Utah juniper. The Rock outcrop has no potential for livestock grazing. Range seeding of depleted areas by conventional methods is not feasible because of slope and the areas of Rock outcrop. Capability unit VII_e-8.

75D—Roundtop-Jacks-Rock outcrop complex, 15 to 30 percent slopes, eroded. This complex consists of moderately steep soils in rounded areas on hills. It is about 30 percent Roundtop gravelly clay loam, 30 percent Jacks cobbly clay loam, and 10 percent Rock outcrop of limestone and sandstone. The Roundtop soils are on ridgetops and along the crests of ridges. Jacks soils are on the lower slopes adjacent to drainageways. Common shallow gullies and a few deep gullies dissect this complex.

Included with this complex in mapping is about 25 percent Tortugas cobbly loam on ridgetops and along the crests of ridges. Also included are areas that have 15 to 25 percent of the surface covered with scattered pebbles, cobbles, and stones.

Runoff is rapid, and the hazard of erosion is high.

This complex is used as range, as wildlife habitat, and as a source of water supply. Roundtop and Jacks soils have fair potential for livestock grazing, and the main range plants on both are side-oats grama, shrub liveoak, and Utah juniper. Rock outcrop has no potential for livestock grazing. Range seeding of depleted areas by conventional methods is not feasible because of stoniness and the areas of Rock outcrop. Capability unit VIe-8.

76E—Roundtop-Tortugas-Rock outcrop complex, 30 to 50 percent slopes. This complex consists of steep soils in long narrow areas on side slopes adjacent to drainageways and on the crests of ridges. It is 40 percent Roundtop gravelly clay loam, 20 percent Tortugas loam, and 10 percent Rock outcrop. The Roundtop soil is on side slopes adjacent to drainageways. It has a profile similar to the one described as representative for the series, but the surface layer is covered with 25 to 50 percent pebbles, cobbles, and stones. The Tortugas soil is on the crests of ridges. The Tortugas soil has a profile similar to the one described as representative of the series, but it has fewer cobbles on the surface. Rock outcrop of limestone occurs as stairsteps on the side slopes.

Included with this complex in mapping are 15 percent Chevelon and Jacks soils and 15 percent very steep Haplustolls-Ustorthents complex.

Runoff is rapid, and the hazard of erosion is high.

This complex is used as range, as wildlife habitat, and as a source of water supply. The Roundtop and Tortugas soils have poor potential for livestock grazing, and the main range plants on both are side-oats grama, shrub liveoak, and Utah juniper. Rock outcrop has no potential for livestock grazing. Range seeding of depleted areas by conventional methods is not feasible because of slope and the areas of Rock outcrop. Capability unit VIIe-8.

Showlow Series

The Showlow series consists of well drained, nearly level to steep soils on dissected alluvial fans. These soils formed in old alluvium weathered from sandstone, sandy shale, quartzite, limestone, and granite. Slopes are 0 to 50 percent. Elevation ranges from 3,800 to 6,600 feet. Vegetation types include desert-grassland scrub, gramagrass, juniper, pinion woodland, and ponderosa pine forest at elevations of 6,000 feet or more. Annual precipitation is 15 to 20 inches, and mean annual temperature is about 55° F. The frost-free season ranges from 140 to 270 days.

In a representative profile the surface layer is dark reddish brown gravelly clay loam 3 inches thick. The subsoil is dark reddish gray and reddish brown gravelly clay 19 inches thick. The substratum is pink and brown gravelly loam and very gravelly loam to a depth of 60 inches or more.

These soils are slowly permeable. The water supplying capacity is 12 to 15 inches. Available water capacity is low to moderate. Effective rooting depth is 60 inches or more. Reaction is slightly acid to moderately alkaline.

Showlow soils are used as range, as wildlife habitat,

as a source of water supply, and for timber production at an elevation of 6,000 feet or more.

Representative profile of Showlow gravelly clay loam, 8 to 30 percent slopes, eroded, in the center of sec. 26, T. 5 N., R. 20 E.:

A1—0 to 3 inches, dark reddish brown (5YR 3/2) gravelly clay loam, dark reddish brown (5YR 2/2) when moist; moderate fine granular structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; many fine interstitial pores; 20 percent pebbles and cobbles; slightly acid; clear smooth boundary.

B1t—3 to 9 inches, dark reddish gray (5YR 4/2) gravelly light clay, dark reddish brown (5YR 3/2) when moist; weak medium subangular blocky structure; slightly hard when dry, firm when moist, sticky and plastic when wet; common fine and few coarse roots; few fine interstitial and tubular pores; 25 percent pebbles; common thin clay films on peds; slightly acid; gradual wavy boundary.

B21t—9 to 15 inches, reddish brown (5YR 4/4) gravelly clay, dark reddish brown (5YR 3/4) when moist; moderate medium angular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; common very fine and coarse roots; few fine interstitial and tubular pores; 25 percent pebbles and cobbles; many moderately thick clay films on peds; neutral; gradual wavy boundary.

B22t—15 to 22 inches, reddish brown (5YR 4/4) gravelly clay, dark reddish brown (5YR 3/4) when moist; moderate medium angular blocky structure; hard when dry, very firm when moist, very sticky and very plastic; many very fine and few coarse roots; 25 percent pebbles and cobbles; continuous moderately thick clay films on ped faces; noneffervescent; moderately alkaline; clear wavy boundary.

C1ca—22 to 36 inches, pink (7.5YR 8/4) and brown (7.5YR 5/4) very gravelly heavy loam, pink (7.5YR 7/4) and brown (7.5YR 4/4) when moist; massive; slightly hard when dry, firm when moist; slightly sticky and nonplastic when wet; few very fine and coarse roots; few fine tubular pores; 50 percent pebbles; violently effervescent; moderately alkaline; gradual wavy boundary.

C2ca—36 to 60 inches, pink (7.5YR 7/4) very gravelly loam, light brown (7.5YR 6/4) when moist; massive; slightly hard when dry, firm when moist, slightly sticky and nonplastic when wet; few very fine roots; few fine tubular pores; 50 percent pebbles; strongly effervescent; moderately alkaline.

The coarse fragment content of the solum ranges from 15 to 35 percent. The A horizon ranges from

medium acid to neutral. It has hue of 7.5YR or 5YR, value of 3 to 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. The A1 horizon is silt loam, gravelly silt loam, cobbly silt loam, gravelly loam, or gravelly clay loam. The B2t horizon has hue of 2.5YR or 5YR, value of 3 to 5 when dry and moist, and chroma of 3 to 6. It is clay, clay loam, gravelly clay loam, and gravelly clay. The Cca horizon has hue of 7.5YR or 10YR and value of 5 to 7 when moist. The zone of lime accumulation ranges from a weak Cca or Btca horizon to a strong Cca horizon.

77B—Showlow silt loam, 0 to 8 percent slopes. This soil is in long, narrow valleys north of the town of Whiteriver. It has a profile similar to the one described as representative for the series, but the surface layer is brown silt loam and has less than 10 percent pebbles.

Included with this soil in mapping are 15 percent Showlow gravelly clay loam and 2 percent Jacques clay loam in nearly level swales.

Runoff is slow, and the hazard of erosion is slight.

This soil is used for timber production at the higher elevations. It is also used for understory grazing, as wildlife habitat, and as a source of water supply. Capability unit VI_s-8; woodland suitability group 6c2.

78C—Showlow silt loam, 8 to 15 percent slopes. This soil is in long, narrow valleys north of the town of Whiteriver. It has a profile similar to the one described as representative of the series, but the surface layer is silt loam and has less than 10 percent pebbles.

Included with this soil in mapping are 15 percent Showlow gravelly clay loam and 2 percent Jacques clay loam in nearly level swales.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used for timber production at the higher elevations. It is also used for understory grazing, as wildlife habitat, and for watershed. Capability unit VI_e-8; woodland suitability group 6c2.

79D—Showlow cobbly silt loam, 15 to 30 percent slopes. This hilly soil is in a few areas that are southwest of Grasshopper Butte. It has a profile similar to the one described as representative for the series, but the surface layer is silt loam, has 15 to 20 percent cobbles and stones, and is less eroded.

Included with this soil in mapping are 15 percent Showlow gravelly clay loam that has slopes of more or less than 15 to 30 percent and 5 percent Jacks cobbly clay loam.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used for grazing, as wildlife habitat, and as a source of water supply. It has good potential for livestock grazing. The main range plants are side-oats grama, molina, and Utah juniper. Range seeding of depleted areas by conventional methods is not feasible because of stoniness. Capability unit VI_e-6.

80B—Showlow gravelly clay loam, 0 to 8 percent slopes. A few areas of this soil are in the western part of the Reservation. It has a profile similar to the one described as representative for the series, but the substratum has a small accumulation of carbonates. A few shallow gullies are present. About 15 to 20 percent of the surface layer is covered with large rounded pebbles and cobbles.

Included with this soil in mapping are as much as 10 percent long, narrow stringers of Toura silt loam and Cibique loam along the drainageways.

Runoff is slow, and the hazard of erosion is slight.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. It has good potential for livestock grazing. The main range plants are side-oats grama, nolina, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VI_s-8.

81D—Showlow gravelly clay loam, 8 to 30 percent slopes, eroded. This gently rolling to hilly soil formed in a mantle of old gravelly alluvium. It has the profile described as representative for the series. About 15 to 25 percent large rounded pebbles are scattered on the surface and throughout the profile. Shallow gullies are common in areas of this soil.

Included with this soil in mapping are 15 percent Cibique gravelly loam below the crest of the ridges and 2 percent Navajo clay loam, Tours silt loam, and Jacques soils in the nearly level bottoms and swales. Some small areas of Overgaard soils are also included.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used for grazing at elevations of less than 6,000 feet. It has good potential for livestock grazing. The main range plants are side-oats grama, nolina, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. This soil produces some commercial timber at elevations of more than 6,000 feet. There is an understory of grass and browse for livestock and wildlife. Capability unit VI_e-8; woodland suitability group 6c2 for soils above 6,000 feet.

82E—Showlow gravelly clay loam, 30 to 50 percent slopes. This steep soil is dissected by a few shallow gullies. A few large areas are on the steep breaks below the Mogollon Rim. This soil has a profile similar to the one described as representative for the series, but the substratum has less carbonates.

Included with this soil in mapping are a few, long, narrow areas of Lynx fine sandy loam along drainageways.

Runoff is rapid, and the hazard of erosion is high.

This soil is used as a source of water supply, and it produces some commercial timber that has understory grazing. Capability unit VII_e-8; woodland suitability group 6c2.

83E—Showlow-Barkerville complex, 30 to 50 percent slopes, eroded. This complex is in large, irregularly shaped areas along steep breaks below large areas of Showlow soils on undulating to rolling plains. It is 55 percent Showlow cobbly silt loam and 30 percent Barkerville cobbly sandy loam. The Showlow soil is on the upper slopes. It has a profile similar to the one described as representative for the series, but the surface layer is silt loam and is covered with 10 to 25 percent cobbles, stones, and boulders. The Barkerville soil is on the lower slopes adjacent to drainageways. Common shallow gullies dissect this complex.

Included with these soils in mapping are about 10 percent steep Haplustolls-Ustorthents complex and 5 percent Rock outcrop mainly on the lower slopes.

Runoff is rapid, and the hazard of erosion is high.

These soils are used as range, as wildlife habitat, and as a source of water supply. They have poor potential for livestock grazing. The main range plants on the Showlow soil are side-oats grama, nolina, and Utah juniper. The main range plants on the Barkerville soil are bush muhly, side-oats grama, and shrub liveoak. Range seeding of depleted areas by conventional methods is not feasible because of stoniness and slope. Capability unit VIIe-8.

84D—Showlow-Chevelon complex, 15 to 30 percent slopes, eroded. This complex consists of rolling soils on the tops of hills and moderately steep soils on side slopes. It is 45 percent Showlow gravelly clay loam and 25 percent Chevelon cobbly clay loam. The rolling Showlow soil is on the tops of the hills. The moderately steep Chevelon soil is on the side slopes. It has a profile similar to the one described as representative of the series, but the surface layer is cobbly clay loam. Cobbles and stones cover 20 percent of the surface layer of this Chevelon soil. A few deep gullies and common shallow gullies dissect these soils.

Included with these soils in mapping are about 10 percent Cibique gravelly loam along the crests of hills, 10 percent steep Tortugas cobbly loam, and 10 percent Thunderbird cobbly clay loam adjacent to waterways.

Runoff is rapid, and the hazard of erosion is high.

The soils in this complex are used as range, as wildlife habitat, and as a source of water supply. They have fair potential for livestock grazing. The main range plants on the Showlow soil are side-oats grama, nolina, and Utah juniper. The main range plants on the Chevelon soil are side-oats grama, blue grama, and Utah juniper. Range seeding of depleted areas by conventional methods is not feasible because of stoniness and the high hazard of erosion. Capability unit VIe-8.

Sizer Series

The Sizer series consists of well drained soils that are moderately sloping to steep on cinder cones and level to rolling in areas around the cinder cones. These soils formed in cinders. Slopes are 0 to 50 percent. Elevation ranges from 7,200 to 9,400 feet. Vegetation is mixed conifers and grasses. Annual precipitation is 22 to 32 inches, and mean annual temperature is about 45° F. The frost-free season is 85 to 110 days.

In a representative profile the surface layer is dark grayish brown and brown gravelly silt loam 8 inches thick. The subsoil is reddish brown gravelly light clay loam 10 inches thick. The substratum is gray and dark brown cinders to a depth of 60 inches or more.

These soils are moderately permeable. The water supplying capacity is 15 to 22 inches. Available water capacity is low. Effective rooting depth is 60 inches or more.

Representative profile of Sizer gravelly silt loam, 0 to 8 percent slopes, 1 mile southeast of Indian Pine in the NE $\frac{1}{4}$ of sec. 27, T. 8 N., R. 23 E.:

O1-1 inch to 0, pine litter.

A11-0 to 2 inches, dark grayish brown (10YR 4/2) gravelly silt loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; soft when dry, very

friable when moist, nonsticky and nonplastic when wet; common fine roots; many very fine interstitial pores; 20 percent pebbles; neutral; clear smooth boundary.

A12-2 to 8 inches, brown (7.5YR 4/2) gravelly silt loam, dark brown (7.5YR 3/2) when moist; weak fine subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; common fine and a few coarse roots; common fine interstitial pores; 20 percent pebbles; neutral; gradual wavy boundary.

B2t-8 to 18 inches, reddish brown (5YR 4/4) gravelly light clay loam, dark reddish brown (5YR 3/4) when moist; weak medium subangular blocky structure; slightly hard when dry, firm when moist, slightly sticky and slightly plastic when wet; common fine and a few coarse roots; common fine interstitial pores; 20 percent pebbles; few thin clay films on peds and in pores; neutral; abrupt irregular boundary.

IIC-18 to 60 inches, gray (10YR 5/1) and dark brown (7.5YR 4/4) cinders; single grain; loose, nonsticky and nonplastic.

The C horizon is at a depth of 14 to 30 inches. Cinder content ranges from 15 to 35 percent in the solum and is as much as 90 percent or more in the C horizon. The A horizon is medium acid to neutral. It has value of 3 to 5 when dry and chroma of 2 to 4. It is gravelly loam and gravelly silt loam. The B2t horizon has hue of 5YR to 10YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 2 to 4. It is gravelly loam, gravelly silt loam, and gravelly clay loam. The C horizon is gray, dark brown, red, and black loose raw cinders.

85B—Sizer gravelly silt loam, 0 to 8 percent slopes.

This level to gently rolling soil is in areas around cinder cones. It has the profile described as representative of the series. About 15 to 30 percent of the surface is covered with pebbles consisting of red and black cinders.

Included with this soil in mapping are 10 percent undulating Sponseller gravelly silt loam, 5 percent moderately steep Sizer gravelly silt loam on side slopes of cinder cones, and 5 percent Broliar cobbly loam.

Runoff is slow, and the hazard of erosion is slight.

The cinders in the substratum of this soil are used as material for roadbuilding and for building blocks. This soil produces timber, has an understory of forage, mainly grasses, and is used as wildlife habitat and as a source of water supply. Capability unit VI-6; woodland suitability group 4f4.

86D—Sizer gravelly silt loam, 8 to 30 percent slopes.

This moderately sloping to moderately steep soil is on cinder cones. A few shallow gullies commonly dissect this soil. It has a profile similar to the one described as representative for the series, but it is 14 to 15 inches deep to cinders.

Included with this soil in mapping are 10 percent Sizer gravelly silt loam that has slopes of more or

less than 8 to 30 percent and 10 percent Sponseller cobbly loam that has slopes of 8 to 15 percent.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. The woodland has an understory of forage, mainly grasses. Capability unit VIe-6; woodland suitability group 4f4.

87E—Sizer gravelly silt loam, 30 to 50 percent slopes.

This steep soil is on cinder cones in mountainous areas and is in rounded areas dissected by a few shallow gullies. It has a profile similar to the one described as representative for the series, but it is 14 to 15 inches deep to cinders. Included with this soil in mapping is 20 percent Sizer gravelly silt loam that has slopes of less than 30 percent.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used for timber production, as wildlife habitat, and as a source of water supply, and it has an understory of forage, mainly grasses. Capability unit VIIe-6; woodland suitability group 5f3.

Sponseller Series

The Sponseller series consists of well drained soils that are level to rolling on plains, moderately steep on hills, steep on mountains, and steep where adjacent to drainageways. These soils formed from basic igneous rock. Slopes are 0 to 50 percent. Elevation ranges from 7,000 to 8,400 feet. Vegetation is ponderosa pine, Gambel oak, and grasses. Annual precipitation is 20 to 30 inches, and mean annual temperature is about 45° F. The frost-free season ranges from 90 to 125 days.

In a representative profile the surface layer is brown cobbly loam 3 inches thick. The subsoil is 38 inches of brown cobbly loam and reddish brown cobbly clay loam that overlies basalt cobbles, gravel, cinders, and ash.

These soils are moderately slowly permeable. The water supplying capacity is 14 to 20 inches. Available water capacity is moderate. Effective rooting depth is 60 inches or more.

Sponseller soils are used as woodland, as wildlife habitat, as a source of water supply, and for recreation.

Representative profile of Sponseller cobbly loam, 8 to 30 percent slopes, ¼ mile east of Mud Springs, SE¼ of sec. 11, T. 3 N., R. 25 E.:

- O1—1 inch to 0, pine needles and oak leaf litter.
 A1—0 to 3 inches, brown (10YR 5/3) cobbly loam, dark brown (10YR 3/3) when moist; weak medium platy structure parting to moderate fine granular; slightly hard when dry, friable when moist, non-sticky and slightly plastic when wet; many coarse, medium, and fine roots; 35 percent cobbles and pebbles; medium acid; clear wavy boundary.
 B21t—3 to 10 inches, brown (7.5YR 5/2) cobbly loam, dark brown (7.5YR 3/2) when moist; weak fine subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many coarse, medium, and fine roots; 35 percent cobbles and

pebbles; few thin clay films on peds; slightly acid; clear wavy boundary.

B22t—10 to 27 inches, reddish brown (5YR 5/4) cobbly light clay loam, dark reddish brown (5YR 3/4) when moist; weak medium subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; many coarse, medium, and fine roots; common fine interstitial and tubular pores; 35 percent cobbles and pebbles; few thin clay films on peds and lining pores; neutral; clear wavy boundary.

B23t—27 to 41 inches, reddish brown (5YR 5/4) cobbly clay loam, dark reddish brown (5YR 3/4) when moist; weak medium subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; few medium and coarse roots; common fine tubular and few fine interstitial pores; 35 percent cobbles and pebbles; few thin clay films on peds; neutral; clear wavy boundary.

C—41 to 60 inches, basalt cobbles and pebbles, ash and cinders.

The C horizon is at a depth of 24 to 60 inches. The A horizon has hue of 7.5YR and 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. It is gravelly silt loam, gravelly loam, cobbly loam, and cobbly silt loam. The B2t horizon has value of 4 or 5 when dry and 3 or 4 when moist. It is loam, clay loam, gravelly loam, gravelly clay loam, cobbly loam, and cobbly clay loam.

88B—Sponseller cobbly loam, 0 to 8 percent slopes.

This soil is nearly level to gently rolling. Included with this soil in mapping are 10 percent Broliar silt loam in depressions, 10 percent Ess cobbly loam on rolling ridges, 2 percent Sizer gravelly silt loam, and 2 percent Rock outcrop of basalt.

Runoff is slow, and the hazard of erosion is slight.

This soil is used as woodland, as wildlife habitat, for recreation, and as a source of water supply. It produces an understory of forage, mainly grasses. Capability unit VIi-6; woodland suitability group 5o1.

89D—Sponseller cobbly loam, 8 to 30 percent slopes.

This soil has the profile described as representative of the series. It is dissected by V-shaped drainageways. Included with this soil in mapping are 5 percent Rock outcrop and about 10 percent Ess cobbly loam along the crests of hills.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. It produces an understory of forage, mainly grasses. Capability unit VIe-6; woodland suitability group 5o1.

90E—Sponseller cobbly loam, 30 to 50 percent slopes. This steep soil is on mountains and in long, narrow areas adjacent to drainageways. It has a profile similar to the one described as representative of the series except that basalt cobbles are at a depth of 30 inches. Included with this soil in mapping are about 15 percent Ess soils along the crests of ridges, 8 percent Rock outcrop, and 5 percent very steep Cryorthents-Cryoborolls complex.

Runoff is rapid, and the hazard of erosion is high.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. It produces an understory of forage, mainly grasses. Capability unit VIIe-6; woodland suitability group 5r1.

91B—Sponseller gravelly silt loam, 0 to 8 percent slopes. This level to undulating soil has a profile similar to the one described as representative of the series, but it has a surface layer of gravelly silt loam. The surface is covered with 15 to 30 percent cinders and basalt pebbles. Included with this soil in mapping are about 10 percent nearly level Broliar silt loam in depressions and 2 percent basalt outcrop.

Runoff is slow, and the hazard of erosion is slight.

This soil is used for the production of merchantable timber and has an understory of forage for livestock and wildlife. Capability unit VIIs-6; woodland suitability group 5o1.

Springerville Series

The Springerville series consists of well drained soils in a few areas mainly in the vicinity of the Bonita Prairie. These soils are in small depressions surrounded by large areas of level to gently sloping Thunderbird soils on basalt plains. They formed in material weathered from basic igneous rock. Slopes are 0 to 5 percent. Elevation ranges from 6,000 to 7,000 feet. Vegetation is a sparse cover of grasses. Annual precipitation is 18 to 20 inches, and mean annual temperature is about 53° F. The frost-free season is 120 to 160 days.

In a representative profile the surface layer is brown cobbly clay 7 inches thick. The underlying layer is brown and reddish brown clay and cobbly clay 33 inches thick. Fractured basalt is at a depth of 40 inches.

These soils are very slowly permeable. The water supplying capacity is 18 to 20 inches. Available water capacity is low to moderate. Effective rooting depth is 36 to 50 inches. These soils have wide and deep cracks when they are dry.

Springerville soils are used as range, as wildlife habitat, and as a source of water supply.

Representative profile of Springerville cobbly clay, SE $\frac{1}{4}$ of sec. 24, T. 4 $\frac{1}{2}$ N., R. 23 E.:

A11—0 to 1 inch, brown (7.5YR 5/2) cobbly clay, dark brown (7.5YR 3/2) when moist; moderate fine and medium granular structure; hard when dry, friable when moist, sticky and very plastic when wet; common fine roots; many fine interstitial pores; 20 percent cobbles and pebbles; neutral; abrupt smooth boundary.

A12—1 inch to 7 inches, brown (7.5YR 5/2) cobbly clay, dark brown (7.5YR 3/2) when moist; weak medium subangular blocky structure; hard when dry, firm when moist, sticky and very plastic when wet; common fine roots; few very fine tubular pores; 20 percent cobbles and pebbles; common small slickensides; mildly alkaline; clear wavy boundary.

C1—7 to 14 inches, brown (7.5YR 5/2) clay, dark brown (7.5YR 3/3) when moist; massive; very hard when dry, firm when moist, very sticky and very plastic when

wet; common fine roots; few very fine tubular pores; many medium and large slickensides; mildly alkaline; clear wavy boundary.

C2—14 to 24 inches, brown (7.5YR 5/2) clay, dark brown (7.5YR 3/2) when moist; massive; very hard when dry, firm when moist, very sticky and very plastic when wet; common fine roots; few very fine tubular pores; many medium and large slickensides; mildly alkaline; clear wavy boundary.

C3—24 to 32 inches, reddish brown (5YR 5/3) cobbly clay, dark reddish brown (5YR 3/3) when moist; few fine distinct pink (7.5YR 7/4) and reddish yellow (7.5YR 7/6) lime coatings and nodules, brown (7.5YR 5/4) and reddish yellow (7.5YR 6/6) when moist; massive; very hard when dry, firm when moist, sticky and very plastic when wet; very few fine roots; 20 percent cobbles and pebbles; many medium and large slickensides; slightly effervescent; mildly alkaline; clear wavy boundary.

C4ca—32 to 40 inches, brown (7.5YR 5/4) gravelly clay; common fine distinct pink (7.5YR 7/4) lime mottles, brown (7.5YR 5/4) when moist; massive; very hard when dry, firm when moist, sticky and plastic when wet; common fine roots; 20 percent pebbles and cobbles; common medium slickensides; strongly effervescent; moderately alkaline; clear irregular boundary.

R—40 to 44 inches, fractured basalt.

Fractured basalt is at a depth of 36 to 50 inches. Cracks $\frac{1}{2}$ inch to 2 inches wide and 15 to 24 inches deep form when these soils dry. Secondary calcium carbonate is in places above bedrock. The A horizon has hue of 7.5YR and 10YR, value of 4 or 5 when dry, and chroma of 2 or 3. It is cobbly clay or clay. The C horizon has value of 4 or 5 when dry and 3 or 4 when moist and chroma of 2 to 4. It is clay, gravelly clay, or cobbly clay.

92B—Springerville cobbly clay. This nearly level or gently sloping soil is in small depressions surrounded by nearly level to rolling Thunderbird soils on plains. Basalt cobbles are scattered on 15 to 25 percent of the surface.

Included with this soil in mapping are about 10 percent gently sloping Thunderbird cobbly clay loam on toe slopes and about 10 percent Thunderbird soils around the edges of the depressions.

Runoff is slow, and the hazard of erosion is slight.

This soil produces forage for livestock and wildlife. It has good potential for livestock grazing. The main range plants are western wheatgrass, side-oats grama, and vine mesquite. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIIs-8.

Tatiyee Series

The Tatiyee series consists of well drained, level to



Figure 12.—Summer range for cattle on Tatiyee gravelly loam, 0 to 8 percent slopes.

gently rolling soils in mountain meadows north of Mount Baldy (fig. 12). These soils formed in basalt, cinders, and ash. Slopes are 0 to 8 percent. Elevation ranges from 8,000 to 9,200 feet. Vegetation includes subalpine grassland and meadows. Annual precipitation is 30 to 35 inches, and the mean annual temperature is about 41° F. The frost-free season ranges from 85 to 100 days.

In a representative profile the surface layer is very dark grayish brown gravelly loam and gravelly clay loam and gravelly clay loam 12 inches thick. The subsoil is brown very gravelly clay loam and very gravelly clay to a depth of 60 inches or more.

These soils are slowly permeable. They are frequently flooded for brief periods. The water supplying capacity is 30 to 35 inches or more. Available water capacity is moderate. Effective rooting depth is 60 inches or more.

Tatiyee soils are used as range, as wildlife habitat, as a source of water supply, and for recreation.

Representative profile of Tatiyee gravelly loam, 0 to 8 percent slopes, NE $\frac{1}{4}$ of sec. 11, T. 7 N., R. 26 E.:

A11—0 to 3 inches, very dark grayish brown (10YR 3/2) gravelly loam, very dark brown (10YR 2/2) when moist; moderate fine and very fine granular structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; many very fine and fine roots;

common very fine interstitial pores; 30 percent pebbles; medium acid; clear wavy boundary.

A12—3 to 12 inches, very dark grayish brown (10YR 3/2) gravelly clay loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; many very fine and fine roots; common very fine interstitial and tubular pores; 30 percent pebbles; medium acid; abrupt wavy boundary.

B21t—12 to 22 inches, brown (7.5YR 5/4) very gravelly clay, dark brown (7.5YR 4/4) when moist; many large dark brown (7.5YR 3/2) krotovinas, very dark brown (10YR 2/2) when moist; and a few fine faint strong brown (7.5YR 5/6) mottles; weak fine and coarse subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; common fine roots; few very fine interstitial and few fine tubular pores; 70 percent pebbles and cobbles; common moderately thick clay films on peds; slightly acid; abrupt wavy boundary.

B22t—22 to 30 inches, brown (7.5YR 5/4) very gravelly heavy clay loam, dark brown

(7.5YR 4/4) when moist; moderate fine and medium subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; few fine roots; few fine interstitial pores; 70 percent pebbles and cobbles; common moderately thick clay films on peds; neutral; clear wavy boundary.

B3—30 to 60 inches, brown (7.5YR 5/4) very gravelly light clay loam, dark brown (7.5YR 4/4) when moist; massive; hard when dry, friable when moist, slightly sticky and plastic when wet; very few fine roots; few fine interstitial pores; 70 percent pebbles and cobbles; few thin clay films on pebbles; neutral; clear wavy boundary.

Depth to very gravelly soil material ranges from 10 to 18 inches but averages about 12 inches. The A horizon has value of 3 to 5 when dry and 2 or 3 when moist, and chroma of 1 or 2. It is gravelly loam, gravelly silt loam, gravelly clay loam, and cobbly clay loam. The B2t horizon has hue that is dominantly 7.5YR but ranges from 5YR to 10YR. The B3 horizon is more than 50 percent weathered basalt and cinders mixed with loam or clay loam.

93B—Tatiyee gravelly loam, 0 to 8 percent slopes. This nearly level to gently rolling soil is in mountain meadows. Included with this soil in mapping are 10 percent undulating Gordo cobbly silt loam and 3 percent Cryaquolls, nearly level, on bottoms.

Runoff is slow, and the hazard of erosion is slight.

This soil produces forage for livestock and elk in summer. It has good potential for livestock grazing. The main range plants are Arizona fescue, mountain muhly, and pine dropseed. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. The Cryaquolls in this unit are well suited to use as sites for earth-filled dams for recreational lakes. Capability unit Vw-8.

Telephone Series

The Telephone series consists of well drained soils that are south and west of the community of Forestdale along the breaks below the Mogollon Rim. These soils formed in material weathered from sandstone. Slopes are 8 to 50 percent. Elevation ranges from 5,700 to 6,800 feet. Vegetation is ponderosa pine, Gambel oak, shrubs, and grasses. Annual precipitation is 18 to 24 inches, and mean annual temperature is about 52° F. The frost-free season ranges from 120 to 160 days.

In a representative profile the surface layer is light brownish gray very cobbly sandy loam 4 inches thick. The underlying layer is 13 inches of light gray very cobbly sandy loam that overlies fractured, extremely hard sandstone.

These soils have moderately rapid permeability. The water supplying capacity is 12 to 16 inches. Available water capacity is very low. Effective rooting depth is less than 20 inches.

Telephone soils are used as woodland, as wildlife habitat, and as a source of water supply. They produce an understory of grass and browse.

Representative profile of a Telephone very cobbly sandy loam in an area of Telephone-Rock outcrop complex, 30 to 50 percent slopes, NE¼ of sec. 7, T. 9 N., R. 21 E.:

A1-0 to 4 inches, light brownish gray (10YR 6/2) very cobbly sandy loam, dark brown (10YR 4/3) when moist; weak fine granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; common fine and very fine roots; many fine interstitial pores; 50 percent cobbles; slightly acid; clear smooth boundary.

C-4 to 17 inches, light gray (10YR 7/2) very cobbly light sandy loam, brown (10YR 5/3) when moist; massive; soft when dry, very friable when moist, nonsticky and nonplastic when wet; common fine, very fine, and medium roots; common fine interstitial pores; 50 percent cobbles; slightly acid; clear irregular boundary.

R-17 to 20 inches, light gray (10YR 7/2) fractured extremely hard sandstone.

Depth to sandstone ranges from 10 to 20 inches but is dominantly 12 to 17 inches. Coarse fragment content of the profile ranges from 50 to 80 percent. Reaction is medium acid to slightly acid. The A horizon has hue of 7.5YR and 10YR, value of 5 to 7 when dry and 3 to 6 when moist, and chroma of 1 to 3. It is gravelly, cobbly, or stony sandy loam and very cobbly, very gravelly, or very stony sandy loam. The C horizon has hue of 7.5YR and 10YR and value of 6 or 7 when dry and 4 to 6 when moist. It is very gravelly, very cobbly, or very stony sandy loam.

94D—Telephone cobbly sandy loam, 8 to 30 percent slopes. This moderately sloping to moderately steep soil is on hills below the steep breaks of the Mogollon Rim. It has a profile similar to the one described as representative of the series, but it has fewer cobbles.

Included with this soil in mapping are about 10 percent Elledge soils in depressions and on toeslopes and 3 percent rock outcrop.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. It produces an understory forage of grasses and browse. Capability unit VIs-5; woodland suitability group 6x1.

95D—Telephone very cobbly sandy loam, 15 to 30 percent slopes. This moderately steep soil is in long, irregularly shaped areas on breaks below the Mogollon Rim.

Included with this soil in mapping are 15 percent steep Telephone very cobbly sandy loam and 5 percent Elledge cobbly sandy loam.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as woodland, as wildlife habitat, and as a source of water supply. It produces an understory of forage grasses and browse. Capability unit VIs-5; woodland suitability group 7x1.

96E—Telephone-Rock outcrop complex, 30 to 50 percent slopes. This complex is in long, irregularly shaped areas on steep breaks below the Mogollon Rim.

It is about 70 percent Telephone very cobbly sandy loam and 10 percent Rock outcrop. The Telephone soil has the profile described as representative of the series. The surface of this complex is covered with 50 to 75 percent pebbles, cobbles, and stones of sandstone. A few V-shaped drainageways dissect areas of this mapping unit.

Included with this complex in mapping are about 10 percent Elledge cobbly sandy loam in depressions and 10 percent Haplustolls-Ustorthents complex on slopes adjacent to drainageways.

Runoff is medium, and the hazard of erosion is moderate.

This complex produces small amounts of merchantable ponderosa pine and an understory of browse and grass for livestock and wildlife. It is also used as a source of water supply. Capability unit VIIe-5; Telephone soil in woodland suitability group 7x1; Rock outcrop not assigned to woodland suitability group.

Thunderbird Series

The Thunderbird series consists of well drained, nearly level to steep soils on plains, on hills, and in areas adjacent to waterways. These soils formed in basic igneous rock. Slopes are 0 to 50 percent. Elevation ranges from 5,000 to 7,000 feet. Vegetation is mainly grama grasslands and pinon-juniper woodland. Annual precipitation is 16 to 20 inches, and mean annual temperature is about 53 F. The frost-free season ranges from 120 to 160 days.

In a representative profile the surface layer is dark grayish brown cobbly clay loam 2 inches thick. The subsoil is 33 inches of grayish brown, dark brown, and yellowish red cobbly clay loam, clay, and gravelly clay loam that overlies consolidated cinders and basalt rock.

These soils are slowly permeable. The water supplying capacity is 12 to 15 inches. Available water capacity is low to moderate. Effective rooting depth is 30 to 40 inches.

Thunderbird soils are used mainly as range, as wildlife habitat, and as a source of water supply.

Representative profile of Thunderbird cobbly clay loam, 8 to 30 percent slopes, in the center of sec. 7, T. 4 N., R. 23 E.:

A1—0 to 2 inches, dark grayish brown (10YR 4/2) cobbly clay loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; hard when dry, friable when moist, slightly sticky and plastic when wet; many very fine and fine roots; many fine interstitial pores; 20 percent cobbles; neutral; clear wavy boundary.

B1t—2 to 6 inches, grayish brown (10YR 5/2) cobbly clay loam, dark brown (7.5YR 3/2) when moist; weak fine and medium subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; few very fine and fine roots; few fine interstitial pores; 20 percent cobbles; few thin clay films on peds; neutral; clear wavy boundary.

B21t—6 to 21 inches, dark brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) when moist; moderate medium angular blocky structure; very hard when dry, firm when moist, sticky and very plastic when wet; common fine roots; few fine interstitial pores; many moderately thick clay films on peds and lining interstitial pores; few cobbles; moderately alkaline; clear wavy boundary.

B22t—21 to 31 inches, dark brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) when moist; moderate medium angular blocky structure; very hard when dry, firm when moist, sticky and very plastic when wet; common fine roots; few fine interstitial pores; many moderately thick clay films on peds and lining interstitial pores; few small slickensides; moderately alkaline; clear wavy boundary.

B3tca—31 to 35 inches, yellowish red (5YR 5/6) gravelly clay loam, reddish brown (5YR 4/4) when moist; weak medium angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; few tubular pores; 20 percent pebbles; few thin clay films on peds; slightly effervescent; few fine distinct pink (5YR 8/4) lime coatings; moderately alkaline; clear irregular boundary.

R—35 to 40 inches, pinkish gray (5YR 6/2) and reddish yellow (7.5YR 6/6) consolidated cinders and basalt.

Basalt is at a depth of 30 to 40 inches. Pebbles, cobbles, and stones make up 15 to 35 percent of the profile. The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. It is gravelly clay loam, cobbly clay loam, or stony clay loam. The B2t horizon has hue of 5YR or 7.5YR, value of 3 or 4 when dry and moist, and chroma of 2 to 4. It is clay, cobbly or gravelly clay loam, or gravelly, cobbly, or stony clay. The B3t horizon has value of 4 to 6 when dry and 3 to 5 when moist and chroma of 4 to 6. It is gravelly or cobbly clay or gravelly or cobbly clay loam.

The Thunderbird soils in this survey area are darker colored to a greater depth than is defined as within the range for the series. However, this difference does not alter their usefulness or behavior.

97B—Thunderbird gravelly clay loam, 0 to 8 percent slopes. This level to undulating soil is on plains. It has a profile similar to the one described as representative for the series, but it has a lime zone 4 to 8 inches thick over bedrock, and it lacks basalt cobbles and stones on the surface. The surface is covered by 15 to 25 percent basalt pebbles.

Included with this soil in mapping are 10 percent nearly level Springerville cobbly clay in depressions and 2 percent Jacques clay loam on bottoms along drainageways.

Runoff is slow, and the hazard of erosion is slight.

These soils are used as range, as wildlife habitat, and as a source of water supply. It has good potential for livestock grazing. The main range plants are side-oats grama, junegrass, and alligator juniper. Range

seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VI-8.

98B—Thunderbird cobbly clay loam, 0 to 8 percent slopes. This level to gently rolling soil is on plains. It has a profile similar to the one described as representative for the series, but the surface layer is 4 to 6 inches thick.

Included with this soil in mapping are about 5 percent Springerville cobbly clay in depressions and 3 percent nearly level Jacques clay loam in swales.

Runoff is slow, and the hazard of erosion is slight.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has good potential for livestock grazing. The main range plants are side-oats grama, junegrass, and alligator juniper. Range seeding of depleted areas by conventional methods is not feasible because of stoniness. Capability unit VI-6.

99D—Thunderbird cobbly clay loam, 8 to 30 percent slopes. This gently rolling and moderately steep soil is on plains and hills. It has the profile described as representative for the series. Pebbles, cobbles, and stones cover 20 percent of the surface.

Included with this soil in mapping are about 10 percent Springerville cobbly clay in depressions and 2 percent Rock outcrop of basalt.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has good potential for livestock grazing. The main range plants are side-oats grama, junegrass, and alligator juniper. Range seeding of depleted areas by conventional methods is not feasible because of stoniness. Capability unit VI-6.

100E—Thunderbird cobbly clay loam, 30 to 50 percent slopes. This steep soil is on side slopes adjacent to drainageways and is in a few, long, irregularly shaped, narrow areas. It has a profile similar to the one described as representative of the series, but basalt bedrock is at a depth of 30 inches.

Included with this soil in mapping is about 5 percent very steep Haplustolls-Ustorthents complex on side slopes.

Runoff is rapid, and the hazard of erosion is high.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has a fair potential for livestock grazing. The main range plants are side-oats grama, shrub liveoak, and alligator juniper. Range seeding of depleted areas by conventional methods is not feasible because of slope and stoniness. Capability unit VIIe-6.

101B—Thunderbird-Rock outcrop complex, 0 to 8 percent slopes. This complex consists of level to gently rolling areas on plains. It is about 82 percent Thunderbird clay loam and 10 percent Rock outcrop. The Thunderbird soil has a profile similar to the one described as representative for the series, but it has about 25 to 30 inches of fine-textured soil material over bedrock and has fewer cobbles on the surface.

Included with this complex in mapping are about 5 percent Springerville clay in depressions and 3 percent Jacques soils on bottoms along drainageways.

Runoff is slow, and the hazard of erosion is slight.

This complex is used as range, as wildlife habitat, and as a source of water supply. The potential for

livestock grazing is good on the Thunderbird soil, and the main range plants are little bluestem, shrub liveoak, and alligator juniper. Rock outcrop has no potential for livestock grazing. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, and other disturbances. Capability unit VI-8.

102D—Thunderbird-Rock outcrop complex, 15 to 30 percent slopes. This complex consists of hilly areas. It is about 72 percent Thunderbird clay loam and 10 percent Rock outcrop. The Thunderbird soil has a profile similar to the one described as representative for the series, but it has fewer cobbles on the surface.

Included with this complex in mapping are 10 percent undulating Thunderbird cobbly clay loam, 3 percent nearly level Springerville cobbly clay in depressions, and 5 percent steep Cabezon silt loam.

Runoff is medium, and the hazard of erosion is moderate.

This complex is used as range, as wildlife habitat, and as a source of water supply. The potential is fair for livestock grazing on the Thunderbird soil, and the main range plants are side-oats grama, junegrass, and alligator juniper. Range seeding of depleted areas by conventional methods is not feasible because of the areas of Rock outcrop. Capability unit VIe-8.

103E—Thunderbird-Chevelon-Rock outcrop complex, 30 to 50 percent slopes, eroded. This complex consists of steep areas on breaks below large areas of undulating to rolling Thunderbird soils. It is 45 percent Thunderbird cobbly clay loam on the upper parts of side slopes, 25 percent Chevelon cobbly clay loam on the lower slopes of sandstone hills, and 10 percent Rock outcrop. The Thunderbird soil has a profile similar to the one described as representative of the series except that basalt bedrock is at a depth of 30 inches. The Chevelon soil has a profile similar to the one described as representative for the series, but it has a surface layer of cobbly clay loam. Common shallow gullies and a few deep gullies dissect this complex.

Included with this complex in mapping are about 15 percent Cabezon silt loam on upper slopes and 5 percent Haplustolls-Ustorthents complex on side slopes adjacent to drainageways.

Runoff is rapid, and the hazard of erosion is severe.

This complex is used as range, as wildlife habitat, and as a source of water supply. The Thunderbird and Chevelon soils have fair potential for livestock grazing, and Rock outcrop has no potential. The main range plants on the Thunderbird soil are little bluestem, shrub liveoak, and alligator juniper. The main range plants on the Chevelon soil are blue grama, side-oats grama, and Utah juniper. Range seeding of depleted areas is not feasible by conventional methods because of slope, stoniness, and the areas of Rock outcrop. Capability unit VIIe-6.

104E—Thunderbird-Roundtop-Rock outcrop complex, 30 to 50 percent slopes, eroded. This complex is in long narrow areas on steep breaks below basalt plains and above limestone hills. It is 40 percent Thunderbird cobbly clay loam, 30 percent Roundtop clay loam, and 10 percent Rock outcrop of limestone, basalt, and sandstone. The steep Thunderbird soil is on colluvial slopes, and the Rock outcrop of limestone is in areas of this Roundtop soil. The Thunderbird and Roundtop soils have profiles similar to those described as representa-

tive of their respective series, but the Thunderbird soil has basalt bedrock at a depth of 30 inches and the Roundtop soil does not have gravel on the surface. Shallow gullies commonly dissect this complex.

Included with this complex in mapping are 10 percent Tortugas soils on ridge crests, 5 percent Haplustolls-Ustorthents complex on side slopes, and 5 percent nearly level Tours silt loam on bottoms along waterways.

Runoff is rapid, and the hazard of erosion is high.

This complex is used as wildlife habitat, as range, and as a source of water supply. The Thunderbird and Roundtop soils have fair potential for livestock grazing, and the Rock outcrop has no potential. The main range plants on the Thunderbird soil are little blue-stem, shrub liveoak, and alligator juniper. The main range plants on the Roundtop soil are side-oats grama, shrub liveoak, and Utah juniper. Range seeding of depleted areas by conventional methods is not feasible because of slope, stoniness, and the areas of Rock outcrop. Capability unit VIIe-6.

105D—Thunderbird-Showlow complex, 15 to 30 percent slopes. This complex consists of moderately steep soils on hills between large, higher lying areas of undulating to rolling Thunderbird soils on plains and lower lying areas of soils that formed in old gravelly alluvium. It is 50 percent Thunderbird cobbly clay loam and 35 percent Showlow cobbly silt loam. The Thunderbird soil is on the upper parts of slopes, and the Showlow soil is on the lower parts of slopes. The Showlow soil has a profile similar to the one described as representative of the series, but the surface layer is silt loam and cobbles are on the surface.

Included with these soils in mapping are 10 percent Cabezon silt loam on crests of ridges and 5 percent nearly level Lynx loam on bottoms adjacent to drainageways.

Runoff is medium, and the hazard of erosion is moderate.

These soils are used as range, as wildlife habitat, and as a source of water supply. They have fair potential for livestock grazing. The main range plants on the Thunderbird soil are side-oats grama, shrub liveoak, and alligator juniper. The main range plants on the Showlow soil are side-oats grama, nolina, and Utah juniper. Range seeding of depleted areas by conventional methods is not feasible because of stoniness. Capability unit VIe-6.

Tortugas Series

The Tortugas series consists of well drained soils that are moderately steep on hills and steep on sides of drainageways. These soils formed in calcareous sandstone, limestone, or shale. Slopes are 15 to 50 percent. Elevation ranges from 4,000 to 6,000 feet. Vegetation is pinon pine, juniper, shrubs, and grasses. Annual precipitation is 16 to 18 inches, and the mean annual temperature is about 55° F. The frost-free season ranges from 120 to 200 days.

In a representative profile the surface layer is grayish brown and brown cobbly loam 7 inches thick. The underlying layer, to a depth of 20 inches, is pale brown and light gray very cobbly loam and silt loam that overlies extremely hard, fractured limestone.

These soils are moderately permeable. The water supplying capacity is 12 to 15 inches. Available water capacity is very low. Effective rooting depth is 14 to 20 inches. Reaction is moderately alkaline.

Tortugas soils are used as range, as wildlife habitat, and as a source of water supply.

Representative profile of Tortugas cobbly loam in an area of Tortugas-Rock outcrop complex, 30 to 50 percent slopes, SE $\frac{1}{4}$ of sec. 17, T. 5 N., R. 18 E., 3 miles northeast of Salt River Crossing on U.S. Highway 60:

- A11—0 to 2 inches, grayish brown (10YR 5/2) cobbly loam, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; many fine roots; many very fine interstitial pores; 20 percent cobbles and pebbles; violently effervescent; moderately alkaline; clear smooth boundary.
- A12—2 to 7 inches, brown (10YR 5/3) cobbly loam, dark brown (10YR 3/3) when moist; massive structure parting to weak fine granular; soft when dry, friable when moist, slightly sticky and nonplastic when wet; common fine roots; common fine interstitial pores; 35 percent cobbles and pebbles; violently effervescent; moderately alkaline; gradual wavy boundary.
- C1—7 to 12 inches, pale brown (10YR 6/3) very cobbly loam, brown (10YR 5/3) when moist; massive; soft when dry, friable when moist, slightly sticky and nonplastic when wet; common fine and coarse roots; few fine interstitial and tubular pores; 60 percent limestone cobbles and pebbles, $\frac{1}{8}$ to $\frac{1}{4}$ inch of hard lime on bottom of fragments; violently effervescent; moderately alkaline; diffuse irregular boundary.
- C2—12 to 20 inches, light gray (10YR 7/2) very cobbly silt loam, pale brown (10YR 6/3) when moist; massive; hard when dry, firm when moist, nonsticky and nonplastic when wet; few fine and coarse roots; few fine interstitial pores; 70 percent limestone cobbles and pebbles, $\frac{1}{8}$ to $\frac{1}{4}$ inch of hard lime on bottom sides; violently effervescent; moderately alkaline; abrupt wavy boundary.

R—20 to 30 inches, fractured, extremely hard limestone.

Bedrock is at a depth of 14 to 20 inches. The profile averages 45 to 70 percent coarse fragments. The A horizon has hue of 7.5YR or 10YR and value of 4 to 6 when dry. It is gravelly loam, cobbly loam, stony loam, gravelly silt loam, or cobbly or stony silt loam. The C horizon has hue of 7.5YR or 10YR, value of 6 to 8 when dry and 4 to 7 when moist, and chroma of 2 to 4. It is loam, silt loam, or light clay loam and is 35 to 90 percent coarse fragments.

106D—Tortugas cobbly loam, 15 to 30 percent slopes. This moderately steep soil is on hilltops in many

round areas. The areas are dissected by a few shallow gullies.

Included with this soil in mapping are 20 percent Roundtop clay loam, 10 percent Tortugas cobbly loam that has slopes of less than 15 percent or more than 30 percent, and 5 percent Rock outcrop.

Runoff is rapid, and the hazard of erosion is high.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has fair potential for live-stock grazing. The main range plants are side-oats grama, shrub liveoak, and Utah juniper. Range seeding of depleted areas by conventional methods is not feasible because of stoniness. Capability unit VI_s-5.

107E—Tortugas-Rock outcrop complex, 30 to 50 percent slopes. This steep complex is in long areas on slopes above and adjacent to waterways. It is about 70 percent Tortugas cobbly loam and 10 percent Rock outcrop of limestone. The Tortugas soil has the profile described as representative for the series. A few shallow gullies dissect this complex. About 15 to 20 percent of the surface is covered by limestone pebbles, cobbles, and stones.

Included with this complex in mapping are 15 percent Roundtop clay loam in swales and 5 percent Haplustolls-Ustorthents complex on side slopes.

Runoff is rapid, and the hazard of erosion is high.

This complex produces large amounts of browse for wildlife and small amounts of forage for livestock. It is also used as a source of water supply. The Tortugas soil has poor potential for livestock grazing, and the Rock outcrop has no potential. The main range plants on the Tortugas soil are side-oats grama, shrub liveoak, and Utah juniper. Range seeding of depleted areas is not feasible by conventional methods because of slope, stoniness, and the areas of Rock outcrop. Capability unit VII_e-5.

108E—Tortugas-Chevelon-Rock outcrop complex, 30 to 50 percent slopes. This steep complex is in long, narrow, irregularly shaped areas on the slopes above and adjacent to drainageways. It is 30 percent Tortugas cobbly loam, 30 percent Chevelon cobbly clay loam, and 10 percent Rock outcrop of sandstone and limestone. The Tortugas soil is mainly on the lower slopes, and the Chevelon soil is on the upper part of the slopes. The Chevelon soil has a profile similar to the one described as representative for the series, but the surface layer is cobbly clay loam. A few shallow and deep gullies dissect areas of this complex. About 15 to 50 percent of the surface is covered with pebbles, cobbles, and stones.

Included with this complex in mapping are about 20 percent Haplustolls-Ustorthents complex on slopes and 10 percent Cibique gravelly loam on ridgetops.

Runoff is rapid, and the hazard of erosion is high.

This complex is used as range, as wildlife habitat, and as a source of water supply. The Tortugas and Chevelon soils have poor potential for livestock grazing, and the Rock outcrop has no potential. The main range plants on the Tortugas soil are side-oats grama, shrub liveoak, and Utah juniper. The main range plants on the Chevelon soil are blue grama, side-oats grama, and Utah juniper. Range seeding of depleted areas is not feasible by conventional methods because of slope, stoniness, and the areas of Rock outcrop. Capability unit VII_e-6.

109E—Tortugas-Roundtop-Rock outcrop complex, 30 to 50 percent slopes. This complex consists of steep soils in large areas on breaks above drainageways. It is 55 percent Tortugas silt loam, 25 percent Roundtop clay loam, and 10 percent of Rock outcrop of limestone. The Tortugas soil has a profile similar to the one described as representative for the series, but it has a surface layer of reddish brown silt loam and fewer cobbles. The Roundtop soil has a profile similar to the one described as representative for the series, but the surface layer is clay loam. A few shallow gullies dissect this complex. The surface is covered with 15 to 20 percent pebbles, cobbles, and stones.

Included with this complex in mapping is about 10 percent Haplustolls-Ustorthents complex on side slopes along drainageways.

Runoff is rapid, and the hazard of erosion is high.

This complex is used as range, as wildlife habitat, and as a source of water supply. The Tortugas and Roundtop soils have poor potential for livestock grazing. The main range plants on these soils are side-oats grama, shrub liveoak, and Utah juniper. Range seeding of depleted areas by conventional methods is not feasible because of slope and the areas of Rock outcrop. Capability unit VII_e-6.

110E—Tortugas-Showlow-Rock outcrop complex, 30 to 50 percent slopes. This steep complex is in long narrow areas on breaks below areas of gravelly alluvium and above limestone hills. It is 50 percent Tortugas cobbly loam, 25 percent Showlow gravelly clay loam, and 10 percent Rock outcrop of limestone. Showlow soils finger down from the top along the ridges, and the steep Tortugas soils are on the lower slopes of the breaks. The Showlow soil has a profile similar to the one described as representative of the series, but it has less carbonate in the substratum. A few shallow gullies dissect areas of this mapping unit.

Included with this complex in mapping are 10 percent Roundtop soils intermixed with this Tortugas soil and 5 percent Haplustolls-Ustorthents complex.

Runoff is rapid, and the hazard of erosion is high.

This complex is used as range, as wildlife habitat, and as a source of water supply. The Tortugas and Showlow soils have poor potential for livestock grazing, and Rock outcrop has no potential. The main range plants on the Tortugas soil are side-oats grama, shrub liveoak, and Utah juniper. The main range plants on the Showlow soil are side-oats grama, nolina, and Utah juniper. Range seeding of depleted areas by conventional methods is not feasible because of slope, stoniness, and the areas of Rock outcrop. Capability unit VII_e-6.

Tours Series

The Tours series consists of well drained soils in long, narrow areas along the drainageways and on level to moderately sloping recent alluvial fans. These soils formed in recent alluvium derived from shale, sandstone, and limestone. Slopes are 0 to 8 percent. Elevation ranges from 2,900 to 6,000 feet. Vegetation includes desert scrub at the lower elevations and grama grassland and some juniper at the higher elevations. Annual precipitation is 16 to 18 inches, and mean an-

nual temperature is about 57° F. The frost-free season ranges from 120 to 170 days.

In a representative profile the surface layer is reddish brown silt loam 4 inches thick. The underlying layer is reddish brown and red, stratified silty clay loam and silt loam to a depth of 70 inches or more.

These soils are moderately slowly permeable. The water supplying capacity is 15 to 18 inches or more. Available water capacity is high. Effective rooting depth is 60 inches or more. These soils are subject to frequent, brief flooding. Reaction is mildly alkaline to moderately alkaline.

Tours soils are used as range, as wildlife habitat, and as a source of water supply.

Representative profile of Tours silt loam, 0 to 8 percent slopes, eroded, in the center of sec. 17, T. 4 N., R. 21 E.:

A1—0 to 4 inches, reddish brown (5YR 4/4) heavy silt loam, dark reddish brown (5YR 3/4) when moist; weak thick platy structure; soft when dry, friable when moist, slightly sticky and nonplastic when wet; common fine roots; many very fine vesicular pores; slightly effervescent; mildly alkaline; clear smooth boundary.

C1—4 to 9 inches, reddish brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) when moist; weak medium subangular blocky structure; slightly hard when dry, firm when moist, sticky and plastic when wet; common fine roots; common fine interstitial and tubular pores; strongly effervescent; moderately alkaline; gradual wavy boundary.

C2—9 to 21 inches, reddish brown (2.5YR 5/4) silty clay loam, reddish brown (2.5YR 4/4) when moist; weak coarse subangular blocky structure; slightly hard when dry, firm when moist, sticky and plastic when wet; common very fine roots; common fine interstitial and tubular pores; violently effervescent; moderately alkaline; gradual wavy boundary.

C3—21 to 53 inches, reddish brown (2.5YR 5/4) light silty clay loam, reddish brown (2.5YR 4/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine roots; common fine interstitial and tubular pores; violently effervescent; moderately alkaline, gradual wavy boundary.

C4—53 to 70 inches, red (2.5YR 5/6) silt loam, dark red (2.5YR 3/6) when moist; massive; soft when dry, friable when moist, slightly sticky and nonplastic when wet; few very fine roots; common fine tubular and interstitial pores; violently effervescent; moderately alkaline.

The profile extends to a depth of 40 to 70 inches or more. Gravel content is less than 15 percent. The A horizon has value of 4 or 5 when dry and 3 or 4 when moist and chroma of 3 to 6. It is loam, silt loam, fine sandy loam, or light clay loam. The C horizon has

value of 4 to 6 when dry and chroma of 3 to 6. It is clay loam, silty clay loam, loam, or silt loam.

111B—Tours fine sandy loam, 0 to 8 percent slopes, eroded. This level to gently rolling soil is in long narrow areas along drainageways. It has a profile similar to the one described as representative for the series, but the surface layer is fine sandy loam and the subsoil and substratum are loam and clay loam or silty clay loam. A few deep gullies and common shallow gullies dissect this soil.

Included with this soil in mapping are 10 percent Haplustolls-Torrifluvents complex and 5 percent Navajo clay loam in concave areas.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has good potential for livestock grazing. The main range plants are blue grama, western wheatgrass, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIe-1.

112B—Tours silt loam, 0 to 8 percent slopes. This soil is in long narrow areas along drainageways. This soil has a profile similar to the one described as representative of the series, but it is less eroded. It is subject to frequent, brief periods of flooding. A few shallow gullies dissect this soil.

Included with this soil in mapping are 10 percent Cibique gravelly loam on gentle side slopes and 10 percent Navajo and Jacques clay loam in concave areas.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as range, as wildlife habitat, and as a source of water supply. It has good potential for livestock grazing. The main range plants are side-oats grama, western wheatgrass, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIw-1.

113B—Tours silt loam, 0 to 8 percent slopes, eroded. This nearly level to moderately sloping soil is on alluvial fans. It is also in small areas intermingled with rolling to hilly Jacks and Chevelon soils. This soil has the profile described as representative of the series. It is dissected by common shallow gullies and a few deep gullies in a dendritic pattern.

Included with this soil in mapping are about 10 percent Jacks and Chevelon soils in convex areas and 10 percent Navajo clay loam in concave areas.

Runoff is medium, and the hazard of erosion is moderate.

This soil is used as range, as wildlife habitat, and as a source of water supply. It is fairly well suited to use as a site for earthen dams. This soil has good potential for livestock grazing. The main range plants are side-oats grama, western wheatgrass, and Utah juniper. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIe-1.

114B—Tours complex. This complex consists of deep, well drained, stratified, calcareous, nearly level to gently sloping soils on bottoms along Cibique Creek. Slopes are 0 to 8 percent. This complex is 60 percent Tours soils that have a surface layer ranging from

fine sandy loam to clay loam, and it is 30 percent moderately coarse textured and coarse textured Torrifuvents. The Tours soils are in an area between the Torrifuvents and the bordering foothills. The Tours soils have a profile similar to the one described as representative of the series, but the surface layer is fine sandy loam to clay loam. The Torrifuvents are immediately adjacent to drainageways. Areas of this complex are a few hundred feet to one-half mile wide and are several hundred feet to several miles long. These soils are flooded at irregular intervals. They are dissected by a few shallow and deep gullies and by common shallow gullies.

Included with these soils in mapping are areas of soils that are severely gullied and other areas that are cut by streams. Also included are small areas of Rock outcrop.

Runoff is medium to slow, and the hazard of erosion is slight to moderate.

These soils are used as range, as wildlife habitat, and as a source of water supply. The Torrifuvents are used as a source of material for roadfill. These soils have good potential for livestock grazing. The main range plants on the Tours soils are side-oats grama, blue grama, and Utah juniper. The main range plants on the Torrifuvents are western wheatgrass, bottle-brush squirreltail, and sand dropseed. Range seeding speeds revegetation of areas depleted by heavy grazing, fire, or other disturbances. Capability unit VIe-1.

Use and Management of the Soils

In this section the capability grouping used by the Soil Conservation Service is explained, and suggestions for managing soils in each capability group are given. Management of the soils for range, woodland, and wildlife habitat, and the use of soils for engineering purposes are discussed.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or engineering.

In the capability system, the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are desig-

nated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use. (None in the survey area.)

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices. (None in the survey area.)

Class III soils have severe limitations that reduce the choice of plants or require special conservation practices, or both. (None in the survey area.)

Class IV soils have very severe limitations that reduce the choice of plants or require very careful management, or both. (None in the survey area.)

Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, or water supply, or to esthetic purposes. (None in the survey area.)

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

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, Vw-8 or VIc-6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of

limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Fort Apache Indian Reservation are described and suggestions for the use and management of the soils are given.

CAPABILITY UNIT Vw-8

This unit consists of poorly drained and well drained soils that have a surface layer of gravelly loam, silt loam, and clay loam. Slopes are nearly level to gently rolling and range from 0 to 8 percent. These soils are in swales at the higher elevations in the area.

These soils have a high water table or are frequently flooded. Annual precipitation is 30 to 35 inches. The frost-free period is 85 to 110 days. Water supplying capacity is 30 to 35 inches or more. Available water capacity is low to high. Permeability is mainly slow, but in places it is moderately slow. Runoff is very slow or slow. The hazard of erosion is slight. The effective rooting depth is 60 inches or more.

The soils of this unit are used as range, as wildlife habitat, and for recreation.

CAPABILITY UNIT VIe-1

This unit consists of well drained soils that have a surface layer of fine sandy loam, clay loam, cobbly and gravelly loam, loam, and silt loam. Slopes are nearly level to moderately steep. These soils formed in alluvium in swales, on bottoms, and on fans and in deep material on hills and mountains.

Annual precipitation ranges from 16 to 30 inches, and the frost-free period is 85 to 270 days. Permeability ranges from moderate to moderately slow. The water supplying capacity ranges from 12 to 20 inches or more, and available water capacity is moderate or high. Runoff is dominantly medium but ranges to slow. The hazard of erosion is dominantly moderate but ranges to slight. Effective rooting depth is 48 inches or more.

The soils of this unit are used as woodland, as range, as wildlife habitat, and for recreation.

CAPABILITY UNIT VIe-5

This unit consists of well drained soils that have a surface layer of cobbly sandy loam, silt loam, and gravelly and cobbly clay loam. These soils are on upland plains, hills, and mountains. Slopes are dominantly moderately steep but range from nearly level to moderately steep.

Annual precipitation is 14 to 20 inches. The frost-free period is 120 to 240 days. Water supplying capacity is 10 to 15 inches. Available water capacity is very low to moderate. Permeability is moderately rapid to moderately slow. Effective rooting depth is 10 to 40 inches. Runoff is mainly medium but ranges to rapid. The hazard of erosion is mainly moderate but ranges to high. Some areas of these soils are actively eroding.

The soils of this unit are used mainly as range and wildlife habitat. They are also used as woodland and as a source of water supply.

CAPABILITY UNIT VIe-6

This unit consists of well drained soils that have a

surface layer of sandy loam, fine sandy loam, loam, silt loam, and clay loam. These soils are mostly cobbly, but in places they are gravelly or have areas of rock outcrop. They are rolling to hilly on plains and are strongly sloping to moderately steep on hills, on mountains, and on side slopes of drainageways.

Annual precipitation is 15 to 40 inches. The frost-free period is 70 to 270 days. Available water capacity is high to low. Effective rooting depth is 20 to 60 inches or more. Permeability is moderately rapid to slow. Runoff is medium. The hazard of erosion is mostly moderate.

The soils of this unit are used mainly as woodland, as wildlife habitat, and as a source of water supply, but some areas are used as range and for recreation.

CAPABILITY UNIT VIe-8

This unit consists of well drained soils that have a surface layer of very fine sandy loam, sandy loam, fine sandy loam, loam, silt loam, and clay loam. In places these soils are gravelly and cobbly or have areas of rock outcrop. They are level to gently rolling on plains and moderately sloping to moderately steep on mountains, on hills, and on side of slopes of drainageways.

Annual precipitation ranges from 15 to 30 inches. The frost-free period is 85 to 270 days. Water supplying capacity is 12 to 20 inches. Available water capacity is high to low. Effective rooting depth is 20 to 60 inches or more. Permeability is slow and very slow. Runoff is mainly medium but ranges to rapid in some areas. The hazard of erosion is mainly moderate but ranges to high in some areas. Some other areas are actively eroding.

The soils of this unit are used mainly as range, as wildlife habitat, and as a source of water supply. Some of the higher lying areas are used as woodland.

CAPABILITY UNIT VIw-1

This unit consists of well drained soils that have a surface layer of loam, clay loam, and silt loam. Slopes are nearly level to moderately sloping. These soils are in long, narrow drainageways and on the lower ends of alluvial fans.

These soils are frequently flooded. Annual precipitation is 15 to 25 inches. The frost-free period is 115 to 270 days. Water supplying capacity ranges from 12 to 20 inches or more. Available water capacity is high. The effective rooting depth is 60 inches or more. Permeability is mostly moderately slow, but in some areas it is slow or very slow. Runoff is slow to medium. The hazard of erosion generally is slight to moderate, but in places it is high or very high because of runoff from adjacent areas of soils. Some areas of the soils in this unit are actively eroding.

The soils in this unit are used as range, as wildlife habitat, and as a source of water supply.

CAPABILITY UNIT VIe-5

This unit consists of well drained soils that have a surface layer of cobbly or very cobbly sandy loam and loam. Slopes are moderately sloping to moderately steep. These soils are on limestone hills and on breaks below the Mogollon Rim.

Average annual precipitation ranges from 16 to 24

inches, and the frost-free period is 110 to 200 days. Permeability is moderate. The water supplying capacity ranges from 12 to 16 inches, and available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium or rapid. The hazard of erosion is moderate or high.

The soils of this unit are used mainly as range, as wildlife habitat, and as a source of water supply, but they produce some woodland products at higher elevations.

CAPABILITY UNIT VIa-6

This unit consists of well drained soils that have a surface layer of cobbly, stony, or gravelly silt loam and sandy loam and loam. In places along drainageways these soils are loamy sand or sand. Slopes are mainly gently sloping or undulating but are level in places. These soils are on plains and in drainageways.

Average annual precipitation ranges from 15 to 35 inches, and the frost-free period is 85 to 210 days. Permeability is dominantly slow, but it ranges to very rapid in areas along drainageways. The water supplying capacity ranges from 12 to 28 inches, and available water capacity is high to low. Effective rooting depth ranges from 30 to 60 inches or more. Runoff is mainly slow but ranges to medium. The hazard of erosion is dominantly slight but in places is moderate.

The soils in this unit are used mainly as woodland, as range, as wildlife habitat, and as a source of water supply, but they are also used for recreation in some areas.

CAPABILITY UNIT VIa-8

This unit consists of well drained soils that have a surface layer of sandy loam, fine sandy loam, loam, silt loam, clay loam, and clay. In places these soils are gravelly or cobbly. Slopes are mainly undulating but range from nearly level to gently rolling. These soils are on plains of old alluvium or on sandstone, limestone, and basalt.

Average annual precipitation ranges from 15 to 28 inches, and the frost-free period is 90 to 270 days. Permeability is slow to very slow. The water supplying capacity ranges from 12 to 22 inches, and available water capacity is high to low. Effective rooting depth is 20 to 60 inches or more. Runoff is medium to slow, and the hazard of erosion is mostly slight.

The soils of this unit are used mainly as range, wildlife habitat, and watershed. Some areas of soils at the higher elevations are used as woodland.

CAPABILITY UNIT VIc-1

This unit consists of well drained soils that have a surface layer of silt loam. Slopes are nearly level to gently rolling. These soils are on high plains.

Annual precipitation is 24 to 35 inches. The frost-free period is 85 to 110 days. Permeability is moderate. Water supplying capacity is 20 to 30 inches, and available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of erosion is slight.

The soils in this unit are used for timber production, as wildlife habitat, and as a source of water supply. They have an understory of grass and browse for wildlife and livestock.

CAPABILITY UNIT VIIa-1

This unit consists of well drained soils that have a surface layer of gravelly or cobbly loam and clay loam. These steep soils are on mountains and on side slopes of drainageways cut through old alluvium.

Average annual precipitation ranges from 15 to 35 inches, and the frost-free period is 85 to 240 days. Permeability is moderate to moderately slow. The water supplying capacity ranges from 12 to 20 inches, and available water capacity is moderate or high. The effective rooting depth ranges from 20 to 60 inches or more. Runoff is medium or rapid, and the hazard of erosion is moderate or high. Accelerated erosion is active in places.

At the lower elevations the soils of this unit are dominantly used as range, as wildlife habitat, and as a source of water supply. At the higher elevations they are used as woodland, as wildlife habitat, as a source of water supply, and for recreation.

CAPABILITY UNIT VIIa-5

This unit consists of well drained soils that have a surface layer of sandy loam, cobbly sandy loam, gravelly loam, cobbly silt loam, gravelly clay loam, and cobbly clay loam. Rock outcrops are common in some areas. Slopes are dominantly steep but range from gently rolling to very steep. The soils are on the side slopes along drainageways and on mountains.

Average annual precipitation ranges from 14 to 25 inches, and the frost-free period is 100 to 270 days. Permeability ranges from moderately rapid to slow. The water supplying capacity is 12 to 20 inches, and available water capacity is very low to moderate. Effective rooting depth is 4 to 40 inches. Runoff is dominantly rapid but ranges to medium. The hazard of erosion is dominantly high, but it ranges to moderate.

The soils in this unit are dominantly used as range, as wildlife habitat, and as a source of water supply, but they are used as woodland at the higher elevations.

CAPABILITY UNIT VIIa-6

This unit consists of well drained soils that have a surface layer of fine sandy loam, loam, clay loam, and silt loam. Rock outcrops are in some areas. These steep and very steep soils are mostly stony, cobbly, or gravelly. They are on mountains and on side slopes of drainageways.

Average annual precipitation ranges from 16 to 40 inches. The frost-free period is from 70 to 200 days. Permeability is moderately rapid to slow. The water supplying capacity ranges from 12 to 28 inches, and available water capacity is very low to high. Effective rooting depth is 10 to 60 inches or more. Runoff is mainly rapid but ranges to medium. The hazard of erosion is dominantly high, but it ranges to moderate. Some areas are actively eroding.

At the higher elevations these soils are used as woodland, as wildlife habitat, as a source of water supply, and for recreation. At the lower elevations they are used as range, as wildlife habitat, and as a source of water supply.

CAPABILITY UNIT VIIa-8

This unit consists of well drained soils that generally have a surface layer of cobbly or gravelly sandy loam,

loam, silt loam, or clay loam, but it contains gravel and lacks cobbles in places. Rock outcrop occurs in some areas. These steep soils are on the side slopes of drainageways or on mountains.

Average annual precipitation ranges from 15 to 30 inches, and the frost-free period is 85 to 270 days. Permeability is generally slow but ranges to moderately rapid. Water supplying capacity ranges from 12 to 20 inches, and available water capacity is low to high. Effective rooting depth ranges from 20 to 60 inches or more. Runoff is rapid. The hazard of erosion is high. Some areas are actively eroding.

At the higher elevations the soils in this unit are used mainly as woodland, as wildlife habitat, as a source of water supply, and for recreation. At the lower elevations they are used as range, wildlife habitat, and as a source of water supply.

Range

The conservation objective of the Bureau of Indian Affairs on rangeland and grazable woodland on the Reservation is to assist the landowners and operators to appraise the potential of their land for forage and livestock production. Production potential and suitability for forage depend on soils, climate, topography, vegetation, and economic factors. Application of sound conservation measures, based on a scientific inventory of soil, water, and forage resources, reduces soil and water losses and aids in the restoration and improvement of forage. When using the soils for forage, the protection of the soil and maintenance of forage production are important.

Approximately 75 percent of the Fort Apache Indian Reservation is in range or grazable woodland. The elevation, temperature, and precipitation of the area create conditions that permit year-round grazing.

Range management

High production of quality forage conserves and protects soil, moisture, and plant resources. High-quality forage can be produced by maintaining or improving the native vegetation and by preventing overgrazing.

Livestock seek out and graze the more palatable plants. Generally, if about half the grass produced yearly is eaten by livestock, damage to the desirable plants is minimized. The remaining forage—

1. Serves as mulch and enhances intake and storage of water.
2. Allows roots to reach moisture deep in the soil.
3. Protects the surface from soil blowing and water erosion.
4. Allows the better grasses to crowd out weeds and other undesirable plants.
5. Enables plants to store in their roots the food they need for quick, vigorous growth in spring and after periods of drought.
6. Catches and holds precipitation where it falls so that it soaks into the soil.
7. Provides a reserve of food for livestock during dry periods.

Woodland

Forested areas in the survey area commonly are between elevations of 5,700 and 11,402 feet, where the mean annual precipitation exceeds 20 inches. Ponderosa pine is in the 20- to 30-inch precipitation zone, and mixed conifers are on the north-facing slopes at or near the limit of the 30-inch precipitation zone. In the 30- to 35-inch precipitation zone, the spruce-fir type of woodland is on north-facing slopes, and mixed conifers or ponderosa pine is on the south-facing slopes. The spruce-fir type of woodland predominates in the 35- to 40-inch precipitation zone, and pure stands of spruce grow in the more than 40-inch zone.

After logging, regeneration of ponderosa pine is excellent to over-abundant on all soils, particularly on those derived from igneous rock. The main concern in the management of ponderosa pine is the reduction of the density of the reproduction and pole stands.

Fire control is important in managing woodlands. Hot wildfires and burning of slash piles inhibit establishment of ponderosa pine seedlings for 5 years or more. Light fires, however, are used in a controlled burning program to reduce sapling and seedling density in overstocked stands. Exclusion of surface fires inhibits regeneration of ponderosa pine, but controlled use of fire assists regeneration. Light fires in the areas of mixed conifers affect the species composition. Mixed conifer stands that have been destroyed by hot fires are replaced by aspen stands.

In general, Elledge, Overgaard, Amos, and Showlow soils have clay at a depth of 7 to 12 inches, and Telephone soils have a bedrock at a depth of less than 20 inches. These factors inhibit downward root development. These soils can be better managed for pulpwood than for other timber. The areas of these soils are west of Arizona State Highway 73. The remaining areas can be managed for sawtimber.

Aspen, at the higher elevations, is a secondary vegetative type that occupies burned-over stands, but it is necessary for ultimate natural reestablishment of the spruce and spruce-fir climax types.

Woodland suitability groups

Similar soils commonly have the same response to woodland use and management. Because of this, and to simplify interpretations, soils that perform similarly in woodland use are separated into groups. These groups of soils are called woodland suitability groups. Table 2 rates the soils in these groups according to their limitations, potential productivity, and the species of trees suited to the soils. Only those soils suitable for woodland are listed in table 2.

Woodland suitability groups are identified by a three-part symbol; for example, 4f1. The first part is a numeral that indicates productivity by site class. This productivity, or growth rate, is reflected by the site index, which is determined by measuring the total height attained by the dominant and codominant trees in the stand at 100 years of age. The indexes obtained are grouped into site classes as follows: index of 71 to 84, site class 4; 57 to 70, site class 5; 43 to 56, site class 6; and less than 43, site class 7.

Intensive control of stem density increases net annual yields on soils in woodland classes 4 and 5 to an

^a By CHARLES BOMBARDIER, Bureau of Indian Affairs, and CHARLES C. MICHAELS, Soil Conservation Service.

estimated 230 and 130 board feet per acre, respectively. A recent sample of the more dense reproduction and of pole stands on soils in woodland class 4 indicates that stem density averaged 10 or more times the optimum stocking that would produce maximum growth of crop trees.

The second element of the symbol is a letter that denotes the major limitation in woodland use and management. The letter *x* denotes stoniness or rockiness; *d*, restricted rooting depth; *c*, clayey soil; *f*, gravelly or very gravelly soil; *r*, relief or steep slopes; and *o* denotes slight or no limitation.

The third part of the symbol is a numeral that further identifies the woodland suitability group when two groups have the same first and second elements.

In the following paragraphs the terms used in table 2 are briefly explained. Then each woodland suitability group is described.

Seedling mortality ratings are based on soil-caused mortality for naturally occurring or planted seedlings. Where the rating is *slight*, expected mortality is 0 to 25 percent; where *moderate*, between 25 and 50 percent; where *severe*, more than 50 percent.

Erosion hazard is *slight* if problems of erosion control are unimportant; *moderate* if some attention must be given to prevent erosion; *high* if intensive treatments, specialized equipment, and methods of operation must be planned to minimize soil deterioration; and *very high* if extreme erosion hazards require special methods of operation to minimize soil deterioration.

Windthrow hazard is *slight* if normally no trees are blown down by wind; *moderate* if some trees are expected to be blown down during periods of excessive soil wetness and high wind; and *severe* if many trees are expected to be blown down during periods of soil wetness and moderate or high winds.

Plant competition is *slight* if competition does not prevent adequate natural regeneration and early growth and does not interfere with adequate development of planted seedlings. It is *moderate* if plant competition delays natural or artificial regeneration; that is, it affects both establishment and growth rate, but it does not prevent the eventual development of full stocked stands. It is *severe* if competition prevents adequate natural or artificial regeneration without extensive site preparation and weeding.

Equipment limitations are *slight* if equipment use is not restricted in kind of operation or time of year. They are *moderate* if equipment use is moderately restricted in kind of operation by slope, rockiness, seasonal soil wetness, texture, injury to tree roots, soil structure, stability, or other factors. They are *severe* if special equipment is needed and its use is severely restricted by the need to assure safety in operations and by slope, stones or obstructions, seasonal soil wetness, physical soil wetness, physical soil characteristics, injury to tree roots, soil structure, stability, or other factors.

Potential productivity refers to the estimated yield that a given soil can produce under a specified level of management. All productivity ratings are based on yields of ponderosa pine (4). Site index is the most common measurement of woodland productivity. It is the average height attained by the dominant and co-dominant trees in the stand at 100 years of age. Pro-

ductivity is also measured by the average annual yield of board feet per acre.

Suitable trees to plant are those that woodland managers consider productive, either those in existing stands or those preferred for planting.

In the following paragraphs the woodland groups are discussed. Only those soils in the survey area that are suited to woodland have been placed in these groups.

WOODLAND SUITABILITY GROUP 4d1

The soils in this group have clay layers at a depth of 16 to 20 inches, but these layers do not restrict root development of trees before maturity. Ponderosa pine is the dominant species. Growth rates are very good. The soils in this group are well suited to management for saw-timber.

WOODLAND SUITABILITY GROUP 4e1

The soils in this group have slopes of as much as 30 percent. Ponderosa pine is the dominant species, but some Douglas-fir are on the north-facing slopes. The hazard of erosion is high. The operation of equipment is limited when these soils are dusty.

WOODLAND SUITABILITY GROUP 4e2

The soils in this group have slopes of 30 to 50 percent. At higher elevations the dominant species are Douglas-fir, Mexican white pine, white fir, aspen, and ponderosa pine. Prescribed burning can be used to eliminate unwanted seedlings and saplings. The hazard of erosion is moderate during logging operations.

WOODLAND SUITABILITY GROUP 4f1

Generally the soils in this group are at elevations of more than 10,000 feet. Mean annual precipitation is mainly more than 35 inches. The dominant species are Engelmann spruce and some corkbark fir. Windthrow is a hazard that can be controlled in places by thinning the dense spruce stands at an early age. Logging operations require specialized equipment and are limited by climate.

WOODLAND SUITABILITY GROUP 4f2

The soils in this group are at elevations of 9,000 to 10,000 feet. Mean annual precipitation is 30 to 35 inches. The dominant species are Colorado blue spruce, aspen, Engelmann spruce, and corkbark fir. Logging operations require specialized equipment and are limited by climate.

WOODLAND SUITABILITY GROUP 4f3

The soils in this group are in areas where mean annual precipitation is 25 to 30 inches. The main species are Douglas-fir and larger amounts of aspen. At the higher elevations the occurrence of Douglas-fir is governed by aspect. At lower elevations ponderosa pine is in some areas, and Douglas-fir is on aspects *opposite to those* at higher elevations. Logging operations require specialized equipment and are limited by climate.

WOODLAND SUITABILITY GROUP 4f4

The soils in this group have slopes of as much as 30

TABLE 2.—Woodland management
[Only those soils suited to the production of merchantable

Soil name and map symbol	Suitability group	Management concerns		
		Seedling mortality	Erosion hazard	Windthrow hazard
Amos: 1C.	7c1	Slight -----	Moderate -----	Slight -----
^a Baldy: 2D, 3E.	4f1	Severe -----	Slight to moderate --	Moderate -----
	4f2	Severe -----	Slight to moderate --	Moderate -----
	4f3	Moderate -----	Slight to moderate --	Slight -----
Brolliar: 7B, 8B, 9D, 10D.	4c1	Slight -----	Slight to moderate --	Slight -----
11E. For Cryorthents-Cryoborolls part of 11E, see Cryorthents-Cryoborolls complex.	4c2	Slight -----	Moderate -----	Slight -----
Cryorthents-Cryoborolls complex: 22E.	5x1	Slight -----	Severe -----	Slight -----
Elledge: 23B, 25B.	4d1	Slight -----	Slight -----	Slight -----
24E, 26C, 27D, 28C, 29E. For Overgaard part of 29E, see Overgaard series.	6c1	Slight -----	Slight to moderate --	Slight -----
Ess: 30B, 31D.	4f4	Slight -----	Slight -----	Slight -----
32E.	5f1	Slight -----	Moderate -----	Slight -----
Gordo: 34D, 36B, 37C, 38B, 39B.	4o1	Slight -----	Slight where slopes are 0 to 15 percent. Moderate where slopes are more than 15 percent.	Slight -----
35E.	4r1	Slight -----	Severe -----	Slight -----
Haplustolls-Ustorthents complex: 41E.	7x1	Severe -----	Moderate to severe --	Slight -----
Luna: 50D, 52D.	5c1	Slight -----	Moderate -----	Slight -----
51E, 53E.	5c1	Slight -----	Severe -----	Slight -----
Overgaard: 59B, 60D, 61B, 62D, 64D, 65D. For Telephone part of 65D, see Telephone series.	6c1	Slight -----	Slight to moderate --	Slight -----

and productivity

trees are listed in this table. The symbol < means less than]

Management concerns—Continued		Potential productivity			Trees to plant
Plant competition	Equipment limitations	Important trees	Site index ¹	Average annual growth ²	
				<i>Fbm/acre</i>	
Slight -----	Moderate -----	Ponderosa pine ----	<43	12	None.
Slight -----	Moderate -----	Engelmann spruce --	71-84	150	Engelmann spruce.
Moderate -----	Moderate -----	Engelmann spruce --	71-84	150	Engelmann spruce, corkbark fir.
Slight -----	Moderate -----	Engelmann spruce, corkbark fir, Douglas-fir.	71-84	150	Engelmann spruce.
Slight -----	Slight -----	Ponderosa pine ----	71-84	172	Ponderosa pine.
Moderate -----	Slight -----	Ponderosa pine, Douglas-fir, Mexican white pine, white fir, Engel- mann spruce.	71-84	172	Ponderosa pine.
Slight -----	Severe -----	Ponderosa pine ----	57-70	100	None.
Slight -----	Slight -----	Ponderosa pine ----	71-84	172	Ponderosa pine.
Slight -----	Slight -----	Ponderosa pine, chihuahua pine.	43-56	40	None.
Slight -----	Slight -----	Ponderosa pine, aspens in basins ---	71-84	172	Ponderosa pine.
Slight -----	Moderate -----	Ponderosa pine, Mexican white pine, Douglas-fir on north-facing slopes.	57-70	100	None.
Slight -----	Slight -----	Ponderosa pine ----	71-84	172	Ponderosa pine.
Slight -----	Slight -----	Ponderosa pine, Douglas-fir, white fir, Mexican white pine, aspen.	71-84	172	Ponderosa pine.
Moderate -----	Slight to moderate where slopes are 0 to 50 percent. Severe where slopes are more than 50 percent.	Ponderosa pine ----	<43	12	None.
Slight -----	Moderate -----	Douglas-fir -----	57-70	100	None.
Slight -----	Moderate -----	Douglas-fir -----	57-70	100	None.
Slight -----	Slight -----	Ponderosa pine, chihuahua pine.	43-56	40	None.

TABLE 2.—Woodland management

Soil name and map symbol	Suitability group	Management concerns		
		Seedling mortality	Erosion hazard	Windthrow hazard
Overgaard—Continued				
63E.	5c1	Slight -----	Severe -----	Slight -----
Showlow: 77B, 78C, part of 81D, 82E.	6c2	Moderate -----	Severe -----	Slight -----
Sizer: 85B, 86D.	4f4	Slight -----	Slight -----	Slight -----
87E.	5f3	Slight -----	Severe -----	Slight -----
Sponseller: 88B, 91B.	5o1	Slight -----	Slight -----	Slight -----
89D.	5o1	Slight -----	Slight where slopes are less than 15 percent. Moderate where slopes are more than 15 percent.	Slight -----
90E.	5r1	Slight -----	Severe -----	Slight -----
Telephone: 94D.	6x1	Moderate -----	Slight -----	Slight -----
95D, 96E.	7x1	Severe -----	Moderate -----	Slight -----

¹ Site index is based on the average height of the dominant and codominant trees at 100 years of age.

² Timber Management Plan—Fort Apache Indian Reservation, 1967. Hammon, Jensen, and Wallen Inventory, 1957.

percent. The dominant species is ponderosa pine, but some Mexican white pine is on Sizer soils at an elevation of 8,000 feet. Cinders and cobbly basalt are below a depth of 18 inches in these soils.

WOODLAND SUITABILITY GROUP 4r1

The soils in this group have slopes of 30 to 50 percent. Ponderosa pine is the dominant species, but Mexican white pine and Douglas-fir are also on these soils. The hazard of erosion is high if these soils are disturbed during logging operations.

WOODLAND SUITABILITY GROUP 4o1

The soils in this group produce stands of ponderosa pine that have a volume of about 20,000 board feet per acre. Growth rates are generally higher where these soils are in swales and draws. The hazard of erosion is moderate where the soils have slopes of more than 15 percent. Equipment use is limited in places when these soils are wet.

WOODLAND SUITABILITY GROUP 5r1

These soils range from woodland class 4 at the bottoms of slopes to woodland class 6 at the tops of slopes. Most of the soils, however, are in class 5. Ponderosa pine, Douglas-fir, and white fir are in all areas of these soils; Mexican white pine and aspen are only in areas of Gordo, Ess, Sizer, and Broliar soils at higher elevations. The hazard of erosion is high. Logging is difficult, and yields are often marginal at the tops of slopes.

WOODLAND SUITABILITY GROUP 5o1

The soils in this group have clay at a depth of 7 to 14 inches, but because of slope the effective rooting depth is more than 14 inches. Douglas-fir and white fir are in areas of Overgaard soils that have north-facing slopes. Otherwise, the dominant species is ponderosa pine. Stands of mixed conifers are on the Luna soils in this group.

and productivity—Continued

Management concerns—Continued		Potential productivity			Trees to plant
Plant competition	Equipment limitations	Important trees	Site index ¹	Average annual growth ²	
				<i>Fbm/acre</i>	
Slight -----	Moderate -----	Douglas-fir -----	57-70	100	None.
Moderate -----	Moderate -----	Ponderosa pine -----	43-56	40	None.
Slight -----	Slight -----	Ponderosa pine, aspen in basins.	71-84	172	Ponderosa pine.
Slight -----	Moderate -----	Ponderosa pine, Douglas-fir, Mexican white pine, aspen, white fir, Engelmann spruce, corkbark fir.	57-70	100	None.
Slight -----	Moderate -----	Ponderosa pine -----	57-70	100	Ponderosa pine.
Slight -----	Moderate -----	Ponderosa pine -----	57-70	100	Ponderosa pine.
Slight -----	Moderate -----	Ponderosa pine, Douglas-fir on north-facing slopes.	57-70	100	Ponderosa pine.
Slight -----	Slight -----	Ponderosa pine -----	43-56	40	Ponderosa pine.
Moderate -----	Slight to moderate --	Ponderosa pine -----	<43	12	None.

¹ Mapping units 2D and 3E are placed in more than one suitability group because of differences in elevation and precipitation.

WOODLAND SUITABILITY GROUP 5f1

The soils in this group have slopes of 30 to 50 percent. The dominant species is ponderosa pine, but some Douglas-fir is on north-facing slopes at an elevation of less than 8,000 feet. The hazard of erosion is high during logging operations.

WOODLAND SUITABILITY GROUP 5f3

The soils in this group have slopes of 30 to 50 percent, and they are at an elevation of more than 8,000 feet. The dominant species are spruce and aspen and some ponderosa pine. The hazard of erosion is high. Road construction is difficult because of the hard bedrock of basalt rims and dikes.

WOODLAND SUITABILITY GROUP 5r1

The steep soils in this group have slopes of more than 30 percent. Ponderosa pine is the dominant species, but some Douglas-fir are on the north-facing slopes. The hazard of erosion is high. The operation of equipment is limited when these soils are dusty.

WOODLAND SUITABILITY GROUP 5o1

Moderately dense stands of ponderosa pine are on the soils in this group. The hazard of erosion increases in areas of soils that have slopes of more than 15 percent. During the dry season heavy traffic reduces the medium-textured soils to a very fine powder. In places on logging roads, this powder extends to a depth of 8 inches and limits the operation of machinery.

WOODLAND SUITABILITY GROUP 6s1

The soils in this group are at the lower fringes of areas that are mainly made up of Telephone soils. Thickness of the surface layer and available water capacity are about maximum to those in the range defined for the series. Ponderosa pine is the dominant species. Seedling mortality is moderate, and some replanting is needed.

WOODLAND SUITABILITY GROUP 6e1

The soils in this group have clay at a depth of 7 to 12

inches that restricts root development of trees before maturity. The growth rate of young stands is excellent, and establishment of seedlings is no problem. Because of the proximity of a pulp mill, management of the forest for pulpwood is suitable. Pure stands of ponderosa pine predominate. Chihuahua pine is in minor areas on dry sites and is considered a pulpwood species.

WOODLAND SUITABILITY GROUP 6c2

Seedling mortality on these soils is significantly affected by competition from such species as juniper, pinon pine, and manzanita. Root growth is restricted by clay at a depth of 3 to 10 inches. Merchantable pine grows in areas where the surface layer is about 10 inches thick and in areas generally at an elevation of more than 6,000 feet. The hazard of erosion is severe.

WOODLAND SUITABILITY GROUP 7x1

These soils have slopes of more than 50 percent. They are at an elevation of more than 5,500 feet. Ponderosa pine is the main species. The dominant species are mainly less than 50 feet in height. Stem density is very sparse, and volumes per acre are too low to make harvesting worthwhile. The steep slopes severely limit the use of equipment. Seedling mortality is severe.

WOODLAND SUITABILITY GROUP 7c1

These soils receive adequate precipitation, but the thin surface layer and the shallow depth to clay restrict root development. At maturity, trees rarely exceed 50 feet in height. Low growth rate, poor log grade recovery, and low volumes per acre indicate that these soils are not suited to woodland management.

Grazable Woodland

Woodland understory vegetation consists of grasses, forbs, shrubs, and other plants within the reach of livestock or of grazing and browsing wildlife. A well managed wooded area can produce enough understory vegetation to support optimum numbers of livestock or wildlife, or both. The ponderosa pine area of the Fort Apache Indian Reservation generally has understory vegetation suitable for grazing. The mixed conifer woodlands provide less forage than the ponderosa pine, but production may be high in areas that have little canopy cover. Except for areas that have natural openings, the spruce-fir area has a canopy that is too dense to provide sufficient understory for grazing.

The quantity and quality of understory vegetation vary with the kind and age of trees, and density of the canopy, and the depth and condition of the forest litter and the soil, and the past grazing use. The density of the forest canopy is a major influence in that it affects the amount of light that understory plants receive during the growing season. Grazable plant species in the understory decrease as the density of the forest canopy increases.

In table 3 the initial stocking rate for livestock on soils in woodland suitability classes 4, 5, and 6 is given for three canopy classes in the ponderosa pine area. For the purposes of this survey, three tree canopy classes are recognized: an *open* canopy that shades as much as 10 percent of the ground at midday; a *sparse* canopy that shades 11 to 39 percent; and a *medium* canopy that

TABLE 3.—Initial stocking rate for livestock on grazable ponderosa pine woodland

[Only the soils suitable for production of grazable understory vegetation are listed in this table]

Woodland suitability class, soil series, and map symbols	Tree canopy class		
	Open (0 to 10 percent)	Sparse (10 to 39 percent)	Medium (40 to 70 percent)
	<i>Acres per AUM¹</i>	<i>Acres per AUM¹</i>	<i>Acres per AUM¹</i>
<i>Class 4:</i> Brolliar: 7B, 8B, 9D, 10D, 11E Elledge: 23B, 25B, 26C Ess: 30B, 31D Gordo: 34D, 35E, 36B, 37C, 38B Sizer: 85B, 86D	4-5	7-8	14-16
<i>Class 5:</i> Cryorthents-Cryoborolls: 22E Ess: 32E Luna: 50D, 51E, 52D, 53E Overgaard: part of 29E, 63E Sizer: 87E Sponseller: 88B, 89D, 90E, 91B	5-6	8-9	15-17
<i>Class 6:</i> Elledge: 24E, 27D, 28C, part of 29E Overgaard: 59B, 60D, 61B, 62D, 64D, part of 65D Showlow: 77B, 78C, part of 81D, 82E Telephone: 94D	7-8	9-10	20-25

¹ An animal-unit-month, AUM, is a term used to express the carrying capacity of a grazable area. It is the number of animal units, 1,000 pounds of live weight, that can be grazed on 1 acre for a period of 30 days without permanently damaging the grazable vegetation.

shades 40 to 70 percent. No rates are given for canopy classes that shade more than 70 percent because grazing is not feasible in such areas.

Principal understory vegetation in grazable areas of ponderosa pine

The abundance and types of plant species in the understory vegetation determine its value for grazing. Forage quality for the purposes of this survey is defined as follows:

High quality forage. This group of plants includes those species that are the most palatable and are eaten first by a given class of livestock. These species decrease under continuous overuse.

Medium quality forage. This group of plants includes those species that make up the diet of animals grazing a given area after the high quality plants have been overused. These species increase under continuous overuse before they decrease.

Low quality forage. This group of plants includes those species that are rarely eaten except as emergency forage during bad weather or when grazing animals are starved to them.

Species of plants that have a high, medium, or low grazing value are given as follows:

Plants that have a high grazing value. Ponderosa pine woodland at an elevation of less than 7,500 feet.

blue grama	red and yellow peas
side-oats grama	goldenrod
western wheatgrass	muttongrass
beardlip penstemon	phlox

Plants that have a medium grazing value. Ponderosa pine woodland at an elevation of less than 7,500 feet.

junegrass	fleabane
black dropseed	live oaks
squirreltail	mountain-mahogany
screwleaf muhly	Arizona honeysuckle
purple geranium	three-awn
mountain parsley	bluestems
Indian paintbrush	

Plants that have a low grazing value. Ponderosa pine woodland at an elevation of less than 7,500 feet.

three-awns	false pennyroyal
annuals	yarrow
brake	manzanita
opuntia	Oregon grape
groundsel	sumac
mullen	New Mexico locust

Plants that have a high grazing value. Ponderosa pine woodland at an elevation of more than 7,500 feet.

mountain muhly	clovers
Arizona fescue	pine dropseed
American vetch	mountain brome
Arizona peavine	

Plants that have a medium grazing value. Ponderosa pine woodland at an elevation of more than 7,500 feet.

junegrass	meadowrue
squirreltail	Indian paintbrush
slender wheatgrass	deerbrush
Kentucky bluegrass	currants
sedge	serviceberry
Richardsons geranium	shrubby cinquefoil
wild strawberry	bearberry honeysuckle
columbine	

Plants that have a low grazing value. Ponderosa pine woodland at an elevation of more than 7,500 feet.

annual grasses	pine thermopsis (goldenpea)
pussytoes	wild rose
bracken	raspberry
yarrow	mountain ash
New Mexico groundsel	

Wildlife

Suitable wildlife habitat is the most important factor necessary to produce wildlife. Knowing the potential of a soil to produce suitable wildlife habitat can be a valuable tool for the wildlife manager.

Current land use, existing wildlife, predator-prey relationships, and hunting pressure are important factors that require onsite investigation and are discussed in this section. Proper use of soil, water, and plants to produce suitable habitat is one of the most effective ways to improve or maintain wildlife populations. How soils will behave under different types of management can be predicted by knowing the properties of the soils. Sound habitat management plans can be made by using soil surveys and their interpretations.

The rating of a combination of wildlife habitat ele-

ments indicates the potential of the soil to produce a given kind of habitat. This combination of ratings is not so meaningful as are the ratings of each specific habitat element. The general ratings, therefore, are presented only in combination with the suitability ratings of each habitat element. Ratings of the potential of soils to produce wildlife habitat can be used with other factors to provide a comprehensive study of wildlife.

In table 4 the soils are rated for suitability for eight elements of wildlife habitat and for four kinds of wildlife. These ratings are based upon limitations imposed by the characteristics or behavior of the soils. Four levels of suitability are recognized. Numerical ratings of 1 to 4 indicate the degree of soil suitability for a given habitat element. A rating of 1 means the soils are well suited and indicates that habitats generally are easily created, improved, or maintained; that the soil has few or no limitations that affect management; and that satisfactory results can be expected. A rating of 2 means suited and indicates that habitats can be created, improved, or maintained in most places; that the soil has moderate limitations that affect management; and that moderate intensity of management and fairly frequent attention may be required for satisfactory results. A rating of 3 means poorly suited and indicates that habitats can be created, improved, or maintained in most places; that the soil has rather severe limitation; that habitat management is difficult and expensive and requires intensive effort; and that results are not always satisfactory. A rating of 4 means unsuited and indicates that soil limitation is so extreme that it is impractical to attempt to create or improve habitats. Unsatisfactory results are probable.

The eight elements of wildlife habitat rated in table 4 are described in the following paragraphs.

Grain and seed crops are grain- or seed-producing annuals planted to produce food for wildlife. Examples are corn, sorghum, millet, soybeans, wheat, oats, and sunflower.

Grasses and legumes are domestic perennial grasses and legumes that are established by planting and that furnish food and cover for wildlife. Examples of grasses are sudangrass, sorghum, blue panicum, and panicgrasses. Examples of legumes are clover, annual lespedeza, and bush lespedeza.

Wild herbaceous upland plants are perennial grasses and forbs that provide food and cover for wildlife. Examples are western ragweed, common sunflower, switchgrass, plains bristlegrass, and broomweed.

Hardwood trees are nonconiferous trees that produce fruit, nuts, buds, or catkins used extensively as food by wildlife. They commonly become established through natural processes, but they may be planted.

Conifer plants are cone-bearing trees, shrubs, or ground cover that furnishes habitat or supplies food in the form of browse, seeds, or fruitlike cones. Examples are pine, spruce, fir, and juniper. Major soil properties that affect the growth of coniferous plants are depth to the root zone, available water capacity, and wetness.

Shrubs are bushy woody plants that produce fruits, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Examples are mountain-mahogany, bitterbush, and

^a By JOHN C. YORK, biologist, Soil Conservation Service.

TABLE 4.—*Suitability of soils for elements of*
 [A rating of 1 indicates the soil is well suited;

Soil series and map symbols	Elements of wildlife habitat				
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood trees	Conifer plants
Amos: 1C -----	3	2	2	1	1
Baldy:					
2D -----	4	4	3	1	1
3E -----	4	4	3	3	1
Barkerville: 4D, 5E, 6C ----- For Showlow part of 6C, see Showlow series.	4	4	2	2	2
Brolliar:					
7B, 8B, 9D -----	3	3	1	1	1
10D -----	4	3	2	2	1
11E -----	4	4	3	3	1
Cabezon: 12E ----- Rock outcrop part not rated.	4	4	3	2	2
Chevelon:					
13B -----	3	2	1	1	1
14D -----	4	4	3	2	3
15D -----	4	4	3	3	3
16E -----	4	4	3	3	3
17D ----- For Jacks part of 17D, see Jacks series.	4	4	3	3	3
Cibeque:					
18D -----	3	3	2	2	2
19E -----	4	4	3	2	2
20E ----- For Chevelon part of 20E, see Chevelon series.	4	4	3	2	2
Cryaquolls: 21B -----	4	4	4	4	4
Cryorthents-Cryoborolls complex: 22E-----	4	4	4	4	4
Elledge:					
23B, 25B, 26C -----	3	3	2	1	1
27D -----	4	4	3	1	1
28C -----	4	4	2	1	1
24E, 29E ----- For Overgaard part of 29E, see Overgaard series. Rock outcrop part of 29E not rated.	4	4	3	2	2
Ess:					
30B -----	3	3	2	2	2
31D -----	4	3	2	2	2
32E -----	4	4	3	1	1

wildlife habitat and kinds of wildlife

2, suited; 3, poorly suited; and 4, unsuited]

Elements of wildlife habitat—Cont.			Kinds of wildlife			
Shrubs	Wetland plants	Shallow water areas	Open-land	Wood-land	Wetland	Range-land
2	4	4	3	1	4	2
2	4	4	4	1	4	3
3	4	4	4	1	4	3
1	4	4	4	2	4	2
2	4	4	2	1	4	2
2	4	4	3	1	4	2
2	4	4	4	1	4	3
2	4	4	4	3	4	2
2	3	4	2	1	3	2
2	4	4	4	3	4	4
3	4	4	4	4	4	3
3	4	4	4	3	4	3
3	4	4	4	4	4	3
2	4	4	4	4	4	2
2	4	4	4	4	4	3
2	4	4	4	4	4	3
4	1	1	4	4	1	4
4	4	4	4	4	4	4
2	4	4	2	2	4	1
2	4	4	3	2	4	3
2	4	4	4	2	4	2
2	4	4	4	3	4	2
2	4	4	3	2	4	2
2	4	4	3	2	4	2
3	4	4	4	2	4	3

TABLE 4.—*Suitability of soils for elements of*

Soil series and map symbols	Elements of wildlife habitat				
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood trees	Conifer plants
Gordo:					
33D -----	3	3	1	1	1
34D -----	3	3	1	1	1
35E -----	4	4	2	1	1
36B -----	3	2	2	1	1
37C, 38B -----	3	3	2	1	1
39B -----	3	3	2	1	1
Haplustolls-Torrifluvents complex: 40B -----	4	4	2	2	3
Haplustolls-Ustorthents complex: 41E -----	4	4	4	3	3
Jacks:					
42C -----	3	3	1	1	1
43B -----	3	2	1	1	1
44D, 45E -----	4	4	2	2	2
46C -----	3	3	2	2	2
47D -----	4	4	3	2	2
Jacques:					
48B -----	2	2	1	1	1
49B -----	2	2	1	1	1
Luna: 50D, 51E, 52D, 53E -----	4	4	3	1	1
Luna variant: 54B, 55B -----	4	2	1	3	3
Lynx: 56B -----	3	2	1	1	1
Navajo: 57B, 58B -----	3	2	2	1	1
Overgaard:					
59B -----	2	2	1	1	1
60D -----	3	2	1	1	1
61B -----	2	1	1	1	1
62D, 63E -----	4	4	3	1	1
64D ----- For Elledge part of 64D, see Elledge series.	4	4	3	1	1
65D ----- For Telephone part of 65D, see Telephone series.	4	4	3	1	1
Rond:					
66B -----	1	1	1	1	1
67C, 69D -----	3	2	1	1	1
68B -----	2	2	1	1	1

wildlife habitat and kinds of wildlife—Continued

Elements of wildlife habitat—Cont.			Kinds of wildlife			
Shrubs	Wetland plants	Shallow water areas	Open-land	Wood-land	Wetland	Range-land
1	1	1	2	2	1	1
1	4	4	2	2	4	1
1	4	4	4	2	4	3
1	2	2	2	2	2	2
1	4	4	2	2	4	2
1	1	1	2	2	1	1
2	4	4	4	3	4	2
3	4	4	4	3	4	4
1	4	4	2	1	4	1
1	4	4	2	1	4	1
2	4	4	4	2	4	2
2	4	4	3	2	4	2
2	4	4	4	2	4	3
1	1	1	1	1	1	1
1	2	2	1	1	2	1
1	4	4	4	2	4	2
2	1	1	2	3	1	2
1	1	1	3	1	1	1
1	1	1	2	1	1	1
1	4	1	1	1	1	1
1	4	4	2	1	4	1
1	4	4	2	1	4	1
1	4	4	3	1	4	2
1	4	4	3	2	4	2
1	4	4	3	1	4	2
1	1	1	1	1	1	1
1	4	4	2	1	4	1
1	4	4	2	1	4	1

TABLE 4.—*Suitability of soils for elements of*

Soil series and map symbols	Elements of wildlife habitat				
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood trees	Conifer plants
Roundtop:					
70B -----	3	2	1	1	1
71B -----	2	2	1	1	1
72D -----	3	3	1	1	1
73D ----- Rock outcrop part not rated.	3	3	3	2	2
74E, 76E ----- Rock outcrop part of 74E and 76E not rated. For Tortugas part of 76E, see Tortugas series.	4	4	3	2	2
75D ----- For Jacks part of 75D, see Jacks series. Rock outcrop part not rated.	3	3	3	2	2
Showlow:					
77B, 78C -----	3	3	1	1	1
79D -----	4	4	3	2	2
80B, 81D -----	3	3	3	2	2
82E, 83E ----- For Barkerville part of 83E, see Barkerville series.	4	4	3	3	3
84D ----- For Chevelon part of 84D, see Chevelon series.	3	3	3	2	2
Sizer:					
85B -----	2	2	2	2	2
86D -----	3	3	3	3	2
87E -----	4	4	3	3	2
Sponseller:					
88B, 89D -----	3	3	3	2	2
90E -----	4	4	3	2	2
91B -----	3	3	3	1	1
Springerville: 92B -----	3	3	3	3	3
Tatiyee: 93B -----	3	3	1	2	1
Telephone:					
94D -----	3	3	2	2	2
95D -----	4	4	3	3	3
96E ----- Rock outcrop part not rated.	4	4	3	2	2
Thunderbird:					
97B -----	3	3	2	2	2
98B -----	3	3	2	2	2

wildlife habitat and kinds of wildlife—Continued

Elements of wildlife habitat—Cont.			Kinds of wildlife			
Shrubs	Wetland plants	Shallow water areas	Open-land	Wood-land	Wetland	Range-land
1	3	4	2	1	4	1
1	2	2	2	1	2	1
1	4	4	2	1	4	1
2	4	4	3	2	4	3
2	4	4	4	3	4	3
2	4	4	4	3	4	3
1	4	4	2	1	4	1
2	4	4	3	2	4	3
2	4	4	3	2	4	3
2	4	4	4	3	4	3
2	4	4	3	2	4	3
2	4	4	2	2	4	2
2	4	4	3	3	4	3
2	4	4	3	3	4	2
2	4	4	3	2	4	2
2	4	4	4	3	4	3
1	4	4	3	2	4	2
3	2	2	3	3	2	3
2	1	1	2	1	1	2
2	4	4	3	2	4	2
3	4	4	3	3	4	3
3	4	4	3	3	4	3
2	4	4	3	2	4	2
2	3	3	3	2	3	2

TABLE 4.—Suitability of soils for elements of

Soil series and map symbols	Elements of wildlife habitat				
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Hardwood trees	Conifer plants
Thunderbird—Continued					
99D -----	3	3	3	2	2
100E -----	4	4	3	2	2
101B ----- Rock outcrop part not rated.	3	3	2	2	2
102D ----- Rock outcrop part not rated.	3	3	2	2	2
103E ----- For Chevelon part of 103E, see Chevelon series. Rock outcrop part not rated.	4	4	3	2	2
104E ----- For Roundtop part of 104E, see Roundtop series. Rock outcrop part not rated.	4	4	3	2	2
105D ----- For Showlow part of 105D, see Showlow series.	3	3	3	2	2
Tortugas:					
107E ----- Rock outcrop part not rated.	4	4	3	2	2
106D -----	3	3	2	2	2
108E ----- For Chevelon part of 108E, see Chevelon series. Rock outcrop part not rated.	4	4	3	2	2
109E ----- For Roundtop part of 109E, see Roundtop series. Rock outcrop part not rated.	4	4	3	2	2
110E ----- For Showlow part of 110E, see Showlow series. Rock outcrop part not rated.	4	4	3	2	2
Tours:					
111B -----	3	3	2	1	1
112B, 113B, 114B -----	3	3	2	1	1

snowberry. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture.

Wetland plants are annual and perennial wild herbaceous plants in moist to wet sites, exclusive of submerged or floating aquatics, that produce food or cover that is extensively and dominantly used by wetland forms of wildlife. Examples are smartweed, wild millet, bulrush, spikesedge, rushes, sedges, burreeds, and cattails.

Shallow water areas are low dikes and water control

structures established to create habitat principally for waterfowl. They may be designed so that they can be drained, planted, and flooded, or they may be used as permanent impoundments to grow submerged aquatics.

Four kinds of wildlife for which ratings are given in table 4 are briefly described in the following paragraphs:

Open-land wildlife consists of birds and animals that normally frequent fields of irrigated or dryland crops, pastures, lawns, and areas overgrown with grasses,

wildlife habitat and kinds of wildlife—Continued

Elements of wildlife habitat—Cont.			Kinds of wildlife			
Shrubs	Wetland plants	Shallow water areas	Open-land	Wood-land	Wetland	Range-land
2	4	4	3	2	4	3
2	4	4	3	2	4	3
2	3	3	3	2	3	2
2	4	4	3	2	4	2
2	4	4	3	2	4	3
2	4	4	3	2	4	3
2	4	4	3	2	4	3
2	4	4	4	3	4	3
2	4	4	3	2	4	2
2	4	4	4	3	4	2
2	4	4	4	3	4	2
1	2	3	3	2	3	2
1	2	2	3	2	3	2

weeds, herbs, shrubs, and vines. Examples are mourning doves, gambel quail, mountain cottontail rabbits, skunks, and various songbirds.

Woodland wildlife consists of birds and animals that frequent wooded areas containing hardwood trees or a mixture of hardwood and coniferous trees and shrubs. Examples are elk, mule deer, white-tailed deer, bear, mountain lion, porcupine, Alberts squirrel, spruce squirrel, blue grouse, band-tailed pigeon, turkeys, Mearns quail, and bobcats.

Wedland wildlife consists of birds and animals that

inhabit swampy, marshy, or high water table areas. Examples are beaver, muskrat, raccoon, waterfowl, wading birds, and shore birds.

Rangeland wildlife consists of birds and animals that inhabit rangelands. Examples are mule deer, white-tail deer, coyote, jack rabbits, antelope, javelina, fox, and songbirds.

Each species of wildlife in the survey area has evolved in a specific vegetative type, and each has specific requirements for food, water, cover, and resting areas. Man has caused widespread changes in habitat

types, and some wildlife species are in areas other than those in which they evolved. Migrations in summer and winter result in several habitat types being used by wildlife. Assigning an animal to any one habitat is difficult because the animal can probably be found in many habitats, depending on disturbances, seasons, or habitat conditions. Following are some representative species of wildlife and the areas where they are most generally located.

The javalina is a small, pig-like animal that is in areas of oak or cactus, along washes, and in rocky areas. It is most common below the Mogollon Rim. The javalina—a game animal in Arizona—is omnivorous, gregarious, and is well suited to depleted range and desert areas.

The mule deer is common throughout the survey area. It is somewhat migratory in higher ranges. Although the mule deer is mainly a tree and shrub browser, it feeds on nearby herbaceous plants in spring and summer.

The black bear is fairly common in higher mountain areas, and it hibernates where cold temperatures and heavy snows are common. The diet of the omnivorous black bear is mainly insects, rodents, berries, and pine nuts. Color ranges from black to blond.

The elk is a game animal that was once extinct in the survey area. Introductions have re-established the elk, but the present species is not the original one. Elk feed in high mountain areas in summer but move to lower elevations in winter.

The Alberts squirrel is confined to stands of ponderosa pine along the Mogollon Rim. It feeds on leaf buds, flowers, and seeds of ponderosa pine and oak and nests almost exclusively in ponderosa pine.

The spruce squirrel inhabits the spruce-fir forests. It feeds on leaf buds, seeds, berries, mushrooms, herbaceous plants, and spruce seeds and nests in conifers.

The porcupine is located throughout the survey area. It feeds on the bark of trees and shrubs and on mistletoe, pine needles, leaves, and twigs.

The quail in the survey area consists of two main types: Gambels quail, which inhabits lower elevations along valley floors, and Mearns quail, which is mainly in the higher foothills and mountains.

The mourning dove is a common game bird that inhabits the entire survey area during summer.

The blue grouse is a chicken-sized, dark gray bird that is restricted to the spruce-fir forests in the survey area. It is fairly common in the White Mountains and their adjacent areas.

The band-tailed pigeon is commonly located in the survey area during summer. It feeds on fir and spruce buds, oak, and elderberries. The band-tailed pigeon is a flocking bird that is similar to the domestic pigeon (rock dove).

Reptiles and amphibians on the Fort Apache Indian Reservation mainly consist of many species of toads, frogs, lizards, and snakes. Some of the species in the survey area are Sonoran turtle, tiger salamander, Arizona tree frog, horned lizard, striped whip snake, tree lizard, Sonoran gopher snake, Arizona black rattlesnake, black-tailed rattlesnake, western tree frog, and Rocky Mountain toad.

Engineering Uses of the Soils ⁴

This section is useful to planning commissions, town and city managers, land developers, engineers, contractors, farmers, and others who need information about soils used as structural material or as foundation on which structures are built.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the soils on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables. Table 5 shows estimated soil properties significant to engineering. Table 6 gives interpretations for various engineering uses.

This information, along with the soil map and data in other parts of this publication, can be used to make interpretations in addition to those given in tables 5 and 6, and it also can be used to make useful maps.

This information, however, does not eliminate the need for further investigation at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil can include small areas of other kinds of soil that have strongly contrasting properties and different suitability or limitations for soil engineering.

Some of the terms used in this soil survey have different meanings in soil science and in engineering. The Glossary defines many of the terms commonly used in soil science.

⁴ RALPH M. ARRINGTON, conservation engineer for Arizona, Soil Conservation Service, assisted in preparing this section.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system, used by SCS engineers, the Department of Defense (2), and others, and the AASHTO system, adopted by the American Association of State Highway and Transportation Officials (AASHTO) (1).

In the Unified system, soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes, for example, ML-CL.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The estimated AASHTO classification, without group index numbers, is given in table 5 for all soils mapped in the survey areas.

Soil properties significant to engineering

Several estimated soil properties significant in engineering are given in table 5. These estimates are made for representative soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the column headings in table 5.

Depth to bedrock is distance from the surface of the soil to the rock layer.

Depth to seasonal high water table is not given, because a seasonal high water table was not observed in most of the soils. Cryaquolls and Luna, wet variant, are the only wet soils in the area.

Soil texture is described in table 5 in the standard terms used by the United States Department of Agriculture (USDA). These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles

coarser than sand, an appropriate modifier is added, for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used are defined in the Glossary of this soil survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semi-solid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic state; and the liquid limit, from plastic to liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 5 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

Salinity refers to the amount of soluble salts in the soil. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25° C. Salinity affects the suitability of a soil for crop production, its stability when used as construction material, and its corrosiveness to metals and concrete.

Shrink-swell potential is the relative change in volume of soil material to be expected with changes in moisture content; that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to the maintenance of structures built in, on, or with material having this rating.

Corrosivity, as used in table 5, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties, such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity to concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one soil horizon. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that pro-

TABLE 5.— *Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit is made up of two or more kinds of soil. The soils in such for referring to other series that appear in the first column of this table. The symbol > means

Soil series and map symbols	Depth to bedrock	Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches	Percentage less than 3 inches passing sieve—	
				Unified	AASHTO		No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
Amos: 1C -----	4	0-41 41-56	Clay loam and clay - Weathered stratified shale and siltstone.	CH	A-7	0	100	90-100
Baldy: 2D, 3E ----	>5	0-60	Cobbly and gravelly fine sandy loam and sandy loam.	SM	A-2	10-30	75-90	70-85
*Barkerville: 4D, 5E, 6C. For Showlow part of 6C, see Showlow series.	1-1½	0-20 20	Cobbly and gravelly sandy loam. Weathered diabase.	SM	A-2	20-30	70-80	65-75
Broliar: 7B, 8B, 9D, 10D, 11E.	2-4	0-14 14-36 36-48 48	Cobbly silt loam and cobbly clay loam. Cobbly clay ----- Very stony clay loam. Basalt.	CL-ML, CL, GC-GM, GC. CH GC	A-4, A-6 A-7 A-7, A-6	15-25 10-20 55-75	65-85 85-95 50-75	65-75 85-95 45-70
Cabezon: 12E ----- No estimates given for Rock outcrop part.	1-1½	0-4 4-16 16	Cobbly silt loam --- Cobbly clay and clay loam. Basalt.	ML CL	A-4 A-6	15-35 10-30	85-95 90-100	80-90 80-90
*Chevelon: 13B, 14D, 15D, 16E, 17D. For Jacks part of 17D, see Jacks series.	1½-3½	0-5 5-30 30	Silt loam ----- Silty clay loam ---- Shale, siltstone or sandstone.	ML CL	A-4 A-7	0 0	95-100 95-100	90-100 90-100
*Cibeque: 18D, 19E, 20E. For Chevelon part of 20E, see Chevelon series.	>5	0-60	Gravelly loam and gravelly sandy loam.	SC, SC-SM	A-2, A-4	5-20	65-85	55-75
Cryaquolls: 21B ---	>5	0-60	Loam and silt loam.	ML	A-4	0	90-100	85-95
Cryorthents-Cryoborolls: 22E. Properties too variable to rate.								
*Elledge: 23B, 24E, 25B, 26C, 27D, 28C, 29E. For Overgaard part of 29E, see Overgaard series. No estimates given for Rock outcrop part of 29E.	1½-3½	0-7 7-30 30	Cobbly sandy loam and sandy loam. Cobbly clay ----- Sandstone.	SM CL	A-2 A-6	15-25 20-30	85-95 90-100	80-90 85-95

significant to engineering

mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions greater than; the symbol < means less than. Absence of an entry means data were not estimated]

Percentage less than 3 inches passing sieve—Cont.		Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 40 (0.42 mm.)	No. 200 (0.074 mm.)								Uncoated steel	Concrete
80-90	70-80	55-65	35-45	0.06-0.2	<i>In per in of soil</i> 0.19-0.21	pH 6.6-8.4	<i>mmhos per cm</i> <2	High -----	High -----	Low.
50-70	25-35	-----	NP	2.0-6.0	0.08-0.10	5.6-6.5	-----	Low -----	Low -----	Low.
45-55	25-35	-----	NP	2.0-6.0	0.07-0.09	6.1-7.3	-----	Low -----	Low -----	Low.
60-70	45-65	25-35	5-15	0.6-2.0	0.18-0.20	5.6-6.5	-----	Low -----	Moderate --	Moderate.
80-90 40-65	70-90 35-50	55-65 35-45	30-40 15-20	0.06-0.2 0.2-0.6	0.16-0.18 0.06-0.08	6.1-7.3 6.6-7.3	-----	High ----- Moderate --	Moderate -- Moderate --	Low. Low.
70-80 75-85	65-75 70-80	30-40 35-45	5-10 15-25	0.2-0.6 0.06-0.2	0.18-0.20 0.16-0.18	7.4-7.8 6.6-7.3	<2 <2	Low ----- High -----	High ----- High -----	Low. Low.
80-90 90-95	70-85 85-95	35-45 40-50	5-10 20-30	0.6-2.0 0.2-0.6	0.19-0.21 0.19-0.21	6.6-7.3 6.6-7.8	<2	Low ----- Moderate --	Moderate -- High -----	Low. Low.
40-60	25-45	25-30	5-10	0.6-2.0	0.09-0.11	7.4-8.4	2-4	Low -----	High -----	Low.
80-90	70-80	30-40	NP-10	0.6-2.0	0.15-0.17	5.6-7.3	-----	Low -----	Moderate --	Moderate.
60-70 75-85	25-35 65-75	20-30 30-40	NP-5 15-25	2.0-6.0 0.06-0.2	0.08-0.10 0.15-0.17	5.1-7.3 6.1-7.8	<2	Low ----- Moderate --	Moderate -- High -----	Moderate. Low.

TABLE 5.— *Estimated soil properties*

Soil series and map symbols	Depth to bedrock	Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches	Percentage less than 3 inches passing sieve—	
				Unified	AASHTO		No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
Ess: 30B, 31D, 32E	>5	0-11	Cobbly loam and cobbly silt loam.	SM	A-4	15-20	70-80	65-75
		11-60	Very cobbly silt loam and very cobbly clay loam.	GC	A-6	50-60	50-70	50-65
Gordo: 33D, 34D, 35E, 36B, 37C, 38B, 39B.	>5	0-20	Silt loam -----	ML	A-4	0-20	75-95	75-90
		20-40	Gravelly loam -----	CL, GC	A-6	5-15	65-80	65-80
		40-60	Very gravelly clay loam.	GP-GC, GC	A-2	40-50	15-25	10-20
Haplustolls-Torrifluvents: 40B. Properties too variable to rate.								
Haplustolls-Ustorthents: 41E. Properties too variable to rate.								
Jacks: 42C, 43B, 44D, 45E, 46C, 47D.	2-4	0-45 45	Cobbly clay loam and clay. Sandstone.	CH	A-7	10-25	75-95	65-85
Jacques: 48B, 49B	>5	0-10	Clay loam -----	CL	A-6	0	90-100	80-90
		10-60	Clay -----	CH	A-7	0	95-100	85-95
Luna: 50D, 51E, 52D, 53E.	1½-3½	0-30	Clay loam and gravelly clay.	CH	A-7	5-10	90-100	80-90
		30-40 40-44	Loam ----- Tuff.	SM	A-4	5-15	85-95	65-85
Luna variant: 54B, 55B.	>5	0-60	Clay, gravelly clay, and gravelly clay loam.	CH, CL	A-6, A-7	0	85-95	65-75
Lynx: 56B -----	>5	0-60	Clay loam and heavy loam.	CL	A-6	0	85-95	75-90
Navajo: 57B, 58B --	>5	0-60	Silty clay and clay	CL	A-7	0	100	90-100
*Overgaard: 59B, 60D, 61B, 62D, 63E, 64D, 65D. For Elledge part of 64D, see Elledge series. For Telephone part of 65D, see Telephone series.	>5	0-12	Gravelly loam and fine sandy loam.	SM	A-2, A-4	0-5	70-90	55-75
		12-42	Gravelly clay -----	CL, SC	A-7	0-5	75-85	55-75
		42-60	Very gravelly clay loam.	GC, GP-GC	A-2	5-10	20-35	15-35
Rond: 66B, 67C, 68B, 69D.	3½-5	0-54 54	Gravelly clay and gravelly clay loam. Limestone.	CL, GC, CH	A-7	5-10	65-75	55-65

significant to engineering—Continued

Percentage less than 3 inches passing sieve—Cont.		Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 40 (0.42 mm.)	No. 200 (0.074 mm.)								Uncoated steel	Concrete
				<i>In per hr</i>	<i>In per in of soil</i>	<i>pH</i>	<i>mmhos per cm</i>			
55-65	35-50	20-25	NP-5	0.6-2.0	0.11-0.13	5.6-6.5	-----	Low -----	Moderate --	Low.
45-60	35-50	30-40	10-20	0.6-2.0	0.09-0.11	5.6-6.5	-----	Low -----	Moderate --	Moderate.
70-95	60-80	30-40	NP-10	0.6-2.0	0.19-0.21	5.6-6.5	-----	Low -----	Moderate --	Low.
60-75	40-65	30-40	10-20	0.6-2.0	0.12-0.14	5.6-7.3	-----	Moderate --	Moderate --	Low.
10-20	5-15	30-40	15-25	0.6-2.0	0.07-0.09	6.1-6.5	-----	Low -----	Moderate --	Low.
65-80	60-75	55-65	30-40	0.06-0.2	0.16-0.18	6.1-8.4	<2	High -----	High -----	Low.
75-85	70-80	30-40	15-25	0.2-0.6	0.19-0.21	6.6-7.3	-----	Moderate --	High -----	Low.
80-90	75-85	55-65	35-45	0.06-0.2	0.14-0.16	6.6-7.8	<2	High -----	High -----	Low.
70-80	60-70	60-70	35-45	0.06-0.2	0.14-0.16	5.6-6.0	-----	High -----	High -----	Low.
50-60	40-50	30-40	NP-10	0.6-2.0	0.16-0.18	5.6-6.5	-----	Low -----	High -----	Low.
60-70	50-60	35-65	20-35	0.06-0.2	0.15-0.17	5.6-6.5	-----	High -----	High -----	Low.
70-80	65-75	30-40	15-25	0.2-0.6	0.18-0.20	6.6-8.4	<4	Moderate --	High -----	Low.
85-100	80-100	40-50	20-30	<0.06	0.16-0.18	7.4-8.4	<8	High -----	High -----	Low.
50-70	25-50	25-35	NP-5	0.6-6.0	0.07-0.10	5.6-7.3	-----	Low -----	Low -----	Low.
50-60	45-65	40-50	20-30	0.06-0.2	0.12-0.14	6.1-7.3	-----	High -----	High -----	Low.
15-30	10-30	30-40	10-20	0.2-0.6	0.07-0.09	6.6-7.3	-----	Low -----	Moderate --	Low.
50-60	40-55	40-55	20-35	0.06-0.2	0.14-0.16	6.6-8.4	2-4	High -----	High -----	Low.

TABLE 5.—Estimated soil properties

Soil series and map symbols	Depth to bedrock	Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches	Percentage less than 3 inches passing sieve—	
				Unified	AASHTO		No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
	<i>Ft</i>	<i>In</i>						
*Roundtop: 70B, 71B, 72D, 73D, 74E, 75D, 76E. For Jacks part of 75D, see Jacks series. For Tortugas part of 76E, see Tortugas series. No estimates given for Rock outcrop part of 73D, 74E, 75D, and 76E.	1½-3½	0-36 36	Gravelly clay loam and gravelly clay. Cherty limestone.	CL, GC, CH	A-6, A-7	10-15	65-75	50-65
*Showlow: 77B, 78C, 79D, 80B, 81D, 82E, 83E, 84D. For Barkerville part of 83E, see Barkerville series. For Chevelon part of 84D, see Chevelon series.	>5	0-22 22-60	Gravelly clay ----- Very gravelly loam -	CL, SC GM	A-7 A-1	5-20 0-5	75-85 40-50	60-75 25-35
Sizer: 85B, 86D, 87E.	>5	0-8 8-18 18-60	Gravelly silt loam -- Gravelly clay loam - Cinders -----	GM, ML GC, CL GP	A-4 A-6 A-1	0-5 0-5 5-10	65-85 65-85 30-40	50-75 50-75 10-20
Sponseller: 88B, 89D, 90E, 91B.	2-4½	0-41 41-60	Cobbly loam and clay loam. Basalt cobbles and gravel, cinders and ash.	SC GP	A-6 A-1	20-40 25-50	75-85 15-25	50-60 10-20
Springerville: 92B.	3½	0-40 40	Cobbly clay and clay. Basalt.	CH	A-7	10-15	95-100	90-100
Tatiyee: 93B -----	>5	0-12 12-60	Gravelly loam and gravelly clay loam. Very gravelly clay and very gravelly clay loam.	GS, SC GC	A-6, A-2 A-2	0-5 10-15	65-75 50-60	50-60 20-30
Telephone: 94D, 95D, 96E. No estimates given for Rock outcrop part of 96E.	1-1½	0-17 17+	Very cobbly sandy loam. Sandstone.	GP-GM, GM	A-1, A-2	50-75	35-65	35-65

significant to engineering—Continued

Percentage less than 3 inches passing sieve—Cont.		Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 40 (0.42 mm.)	No. 200 (0.074 mm.)								Uncoated steel	Concrete
45-55	40-55	35-45	15-25	<i>In per hr</i> 0.06-0.2	<i>In per in of soil</i> 0.14-0.15	<i>pH</i> 6.6-8.4	<i>mmhos per cm</i> 2-4	High -----	High -----	Low.
55-65 20-30	40-60 15-25	40-50 -----	20-30 NP	0.06-0.2 0.6-2.0	0.13-0.15 0.05-0.07	5.5-7.8 7.9-8.4	2-4 2-4	High ----- Low -----	High ----- High -----	Low. Low.
45-55 45-55 0-5	40-50 35-55 0	25-30 25-35 -----	NP-5 10-15 NP	0.6-2.0 0.2-0.6 6-20	0.14-0.16 0.14-0.16 0.04-0.06	6.6-7.3 6.6-7.3 6.6-7.3	-----	Low ----- Moderate -- Low -----	Low ----- Moderate -- Low -----	Low. Low. Low.
40-50 0-5	35-45 0	30-40 -----	10-20 NP	0.2-0.6 >20	0.14-0.16 0.02-0.04	6.1-7.3 6.1-7.3	-----	Moderate -- Low -----	Moderate -- Low -----	Low. Low.
90-100	85-95	55-65	30-40	<0.06	0.14-0.16	6.6-8.4	<2	High -----	High -----	Low.
40-50	35-45	25-35	10-20	0.6-2.0	0.13-0.15	5.6-6.1	-----	Moderate --	Moderate --	Low.
20-25	15-25	40-55	20-30	0.06-0.2	0.06-0.09	6.6-7.3	-----	Moderate --	Moderate --	Low.
20-45	10-30	-----	NP	2.0-6.0	0.05-0.07	6.1-6.5	-----	Low -----	Low -----	Low.

TABLE 5.—Estimated soil properties

Soil series and map symbols	Depth to bedrock	Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches	Percentage less than 3 inches passing sieve—	
				Unified	AASHTO		No. 4 (4.7 mm.)	No. 10 (2.0 mm.)
*Thunderbird: 97B, 98B, 99D, 100E, 101B, 102D, 103E, 104E, 105D. For Chevelon part of 103E, see Chevelon series. For Roundtop part of 104E, see Roundtop series. For Showlow part of 105D, see Showlow series. No estimates given for Rock outcrop part of 101B, 102D, 103E, and 104E.	<i>Ft</i> 3	<i>In</i> 0-35 35-40	Gravelly and cobbly clay loam and clay. Consolidated basalt cinders.	CH	A-7	10-30	80-95	70-85
*Tortugas: 106D, 107E, 108E, 109E, 110E. For Chevelon part of 108E, see Chevelon series. For Roundtop part of 109E, see Roundtop series. For Showlow part of 110E, see Showlow series. No estimates given for Rock outcrop part of 107E, 108E, 109E, and 110E.	1-1½	0-20 >20	Cobbly and very cobbly loam. Limestone.	GM	A-1	25-60	50-60	40-50
Tours: 111B, 112B, 113B, 114B.	>5	0-70	Silt loam and silty clay loam.	CL	A-6	0	90-100	85-95

¹ NP means nonplastic.

tective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Engineering interpretations of soils

The estimated interpretations in table 6 are based on the engineering properties of soils shown in table 5, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of the Fort Apache Indian Reservation.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means soil properties generally are favorable for the rated use or, in other words, that limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation and special designs. For some uses, the rating of severe is divided to ob-

significant to engineering—Continued

Percentage less than 3 inches passing sieve—Cont.		Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 40 (0.42 mm.)	No. 200 (0.074 mm.)								Uncoated steel	Concrete
65-80	60-75	60-70	40-50	<i>In per hr</i> 0.06-0.2	<i>In per in of soil</i> 0.14-0.16	<i>pH</i> 6.6-8.4	<i>mmhos per cm</i> <2	High -----	High -----	Low.
30-40	15-25	-----	NP	0.6-2.0	0.10-0.12	7.9-8.4	<2	Low -----	High -----	Low.
70-80	60-70	30-40	15-25	0.2-0.6	0.16-0.21	7.4-8.4	<4	Moderate --	High -----	Moderate.

tain ratings of severe and very severe. *Very severe* means one or more soil properties are so unfavorable for a particular use that overcoming the limitations is most difficult and costly and commonly is not practical for the rated use.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 6.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that effect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope affects layout and construction and also the risk of soil erosion, lateral seepage, and

TABLE 6.—*Interpretations of engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The instructions for referring to other series that appear in the first column of this table. Such terms

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary land-fill (trench)
Amos: 1C -----	Severe: percs slowly; depth to rock.	Severe: slope; depth to rock.	Severe: too clayey; depth to rock.	Severe: shrink-swell; low strength.	Moderate: slope; depth to rock.
Baldy: 2D, 3E -----	Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Severe: slope --	Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are 8 to 15 percent; frost action. Severe where slopes are more than 15 percent.	Severe: seepage; slopes of more than 15 percent in places.
*Barkerville: 4D, 5E, 6C ----- For Showlow part of 6C, see Showlow series.	Severe: depth to rock; slopes of more than 15 percent in places.	Severe: depth to rock; slope.	Severe: depth to rock; slopes of more than 15 percent in places.	Moderate where slopes are 8 to 15 percent; depth to rock. Severe where slopes are more than 15 percent.	Severe: depth to rock; slopes are more than 15 percent.
Brolliar: 7B, 8B, 9D, 10D, 11E --	Severe: percs slowly; depth to rock; slopes of more than 15 percent in places.	Severe: depth to rock; slopes of more than 7 percent in places.	Severe: depth to rock; too clayey; slopes of more than 15 percent in places.	Severe: shrink-swell; depth to rock; slopes of more than 15 percent in places.	Severe: depth to rock; too clayey; slopes of more than 25 percent in places.
Cabezon: 12E ----- Rock outcrop not rated.	Severe: depth to rock; percs slowly; slope.	Severe: depth to rock; slope.	Severe: depth to rock; slope.	Severe: depth to rock; slope.	Severe: depth to rock; slope.
*Chevelon: 13B, 14D, 15D, 16E, 17D. For Jacks part of 17D, see Jacks series.	Severe: percs slowly; depth to rock; slopes of more than 15 percent in places.	Severe: depth to rock; slopes of more than 7 percent in places.	Severe: depth to rock; slopes of more than 15 percent in places.	Moderate where slopes are 0 to 15 percent; shrink-swell. Severe where slopes are more than 15 percent.	Severe: depth to rock; slopes of more than 25 percent.
*Cibeque: 18D, 19E, 20E ----- For Chevelon part of 20E, see Chevelon series.	Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Severe: slope --	Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Slight where slopes are 8 to 15 percent. Moderate where slopes are 15 to 25 percent. Severe where slopes are more than 25 percent.
Cryaquolls: 21B -----	Severe: percs slowly; wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

properties of the soils

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the as "percs slowly" and "depth to rock" are defined in the glossary at the back of this survey]

Degree and kind of limitation for—Cont.	Suitability as source of—			Soil features affecting—		
	Local roads and streets	Road fill	Sand	Topsoil	Pond reservoir areas	Dikes, levees, and embankments
Severe: shrink-swell; low strength.	Poor: shrink-swell; low strength.	Unsuited -----	Poor: too clayey.	Slope -----	Shrink-swell; low strength; compressible.	Slopes of 8 to 15 percent; slow permeability; high available water capacity.
Moderate where slopes are 8 to 15 percent; frost action. Severe where slopes are more than 15 percent.	Fair where slopes are 8 to 15 percent; frost action. Poor where slopes are more than 15 percent.	Poor: excess fines.	Poor: slope; small stones.	Slope; seepage -	Piping -----	Slopes are 8 to 50 percent; moderately rapid permeability; moderate available water capacity.
Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Poor: thin layer; area reclaim; slopes of more than 25 percent in places.	Unsuited: thin layer.	Poor: small stones; area reclaim; slope.	Slope; depth to rock.	Thin layer; piping.	Slopes of 8 to 50 percent; moderately rapid permeability; very low available water capacity.
Severe: shrink-swell; low strength; slopes of more than 15 percent in places.	Poor: shrink-swell; low strength; slopes of more than 25 percent in places.	Unsuited -----	Poor: too clayey; small stones; slopes of more than 15 percent in places.	Depth to rock; slope.	Shrink-swell; low strength; compressible.	Slow permeability; moderate to high available water capacity; 0 to 50 percent slopes.
Severe: depth to rock; shrink-swell; slope.	Poor: shrink-swell; thin layer; low strength.	Unsuited -----	Poor: slope; small stones; too clayey.	Depth to rock; slope.	Shrink-swell; thin layer; low strength.	Slopes of 30 to 50 percent; slow permeability; low available water capacity.
Moderate where slopes are 0 to 15 percent; shrink-swell. Severe where slopes are more than 15 percent.	Poor: depth to rock; slopes of more than 25 percent in places.	Unsuited -----	Fair where slopes are 0 to 15 percent; too clayey. Poor where slopes are more than 15 percent.	Depth to rock --	Shrink-swell; low strength; thin layer.	Moderately slow permeability; moderate to low available water capacity; slopes of 0 to 50 percent.
Moderate where slopes are 8 to 15 percent; low strength. Severe where slopes are more than 15 percent.	Fair where slopes are 8 to 25 percent; low strength. Poor where slopes are more than 25 percent.	Unsuited -----	Poor: small stones; slopes of more than 15 percent in places.	Slope -----	Piping -----	Moderate permeability; moderate available water capacity; slopes of 8 to 50 percent.
Severe: frost action; wetness.	Poor: frost action; wetness.	Unsuited -----	Good -----	Favorable -----	Low strength --	Moderately slow permeability; high available water capacity; wetness.

TABLE 6.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary land-fill (trench)
Cryorthents-Cryoborolls complex: 22E. Properties too variable to rate.					
*Elledge: 23B, 24E, 25B, 26C, 27D, 28C, 29E. For Overgaard part of 29E, see Overgaard series. Rock outcrop part of 29E not rated.	Severe: depth to rock; percs slowly; slopes of more than 15 percent in places.	Severe: depth to rock; slopes of more than 7 percent in places.	Severe: depth to rock; slopes of more than 15 percent in places.	Moderate where slopes are 0 to 15 percent; depth to rock; shrink-swell. Severe where slopes are more than 15 percent.	Severe: depth to rock. Severe where slopes are more than 25 percent.
Ess: 30B, 31D, 32E -----	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are 0 to 7 percent; seepage. Severe where slopes are more than 7 percent.	Moderate where slopes are 0 to 15 percent; small stones; too clayey. Severe where slopes are more than 15 percent.	Moderate where slopes are 0 to 15 percent; low strength. Severe where slopes are more than 15 percent.	Slight where slopes are 0 to 15 percent. Moderate where slopes are 15 to 25 percent. Severe where slopes are more than 25 percent.
Gordo: 33D, 34D, 35E, 36B, 37C, 38B, 39B.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are 0 to 7 percent; seepage. Severe where slopes are more than 7 percent.	Moderate where slopes are 0 to 15 percent; small stones. Severe where slopes are more than 15 percent.	Moderate where slopes are 0 to 15 percent; frost action; low strength; shrink-swell. Severe where slopes are more than 15 percent.	Slight where slopes are 0 to 15 percent. Moderate where slopes are 15 to 25 percent. Severe where slopes are more than 25 percent.
Haplustolls-Torrifluents complex: 40B. Properties too variable to rate.					
Haplustolls-Ustorthents complex: 41E. Properties too variable to rate.					
Jacks: 42C, 43B, 44D, 45E, 46C, 47D.	Severe: percs slowly; depth to rock; slopes of more than 15 percent in places.	Severe: depth to rock; slopes of more than 7 percent in places.	Severe: depth to rock; slopes of more than 15 percent in places.	Severe: shrink-swell; low strength; slopes of more than 15 percent in places.	Severe: depth to rock; slopes of more than 25 percent in places.
Jacques: 48B, 49B -----	Severe: percs slowly; floods.	Severe: floods --	Severe: floods; too clayey.	Severe: floods; low strength; shrink-swell.	Severe: floods; too clayey.
Luna: 50D, 51E, 52D, 53E -----	Severe: percs slowly; depth to rock; slope.	Severe: slope; depth to rock.	Severe: slope; depth to rock.	Severe: slope --	Severe: depth to rock; slope.

properties of the soils—Continued

Degree and kind of limitation for—Cont.	Suitability as source of—			Soil features affecting—		
	Local roads and streets	Road fill	Sand	Topsoil	Pond reservoir areas	Dikes, levees, and embankments
Moderate where slopes are 0 to 15 percent; shrink-swell; low strength. Severe where slopes are more than 15 percent.	Poor: depth to rock; low strength; slopes of more than 25 percent in places.	Unsuited -----	Poor: too clayey; small stones; slopes of more than 15 percent in places.	Depth to rock --	Low strength; shrink-swell; thin layer.	Slow permeability; low to moderate available water capacity; slopes of as much as 50 percent.
Moderate where slopes are 0 to 15 percent; low strength; frost action. Severe where slopes are more than 15 percent.	Fair where slopes are 0 to 15 percent; low strength; frost action. Poor where slopes are more than 15 percent.	Unsuited -----	Poor: small stones; slopes of more than 15 percent in places.	Seepage -----	Piping -----	Moderately permeable; moderate available water capacity; slopes of 0 to 50 percent.
Moderate where slopes are 0 to 15 percent; shrink-swell; frost action. Severe where slopes are more than 15 percent.	Fair where slopes are 0 to 25 percent; frost action; shrink-swell. Poor where slopes are more than 25 percent.	Unsuited -----	Poor: small stones; slopes of more than 15 percent in places.	Seepage; slope -	Piping -----	High available water capacity; moderate permeability; slopes of 0 to 50 percent.
Severe: low strength; shrink-swell; slopes of more than 15 percent in places.	Poor: low strength; shrink-swell; slopes of more than 25 percent in places.	Unsuited -----	Poor: too clayey; slopes of more than 15 percent in places.	Depth to rock --	Low strength; shrink-swell; thin layer.	Slow permeability; slopes of 0 to 50 percent; high to moderate available water capacity.
Severe: floods; shrink-swell; low strength.	Poor: shrink-swell; low strength.	Unsuited -----	Fair: too clayey; thin layer.	Slowly permeable; floods.	Low strength; shrink-swell; compressible.	Slow permeability; high available water capacity; flooding.
Severe: slope; shrink-swell; low strength.	Poor: slope; shrink-swell; low strength.	Unsuited -----	Poor: too clayey; slope.	Depth to rock; slope.	Shrink-swell; compressible; low strength.	Slow permeability; low or moderate available water capacity; slopes of 15 to 50 percent.

TABLE 6.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary land-fill (trench)
Luna variant: 54B, 55B -----	Severe: percs slowly; wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness; shrink-swell; low strength.	Severe: wetness.
Lynx: 56B -----	Severe: percs slowly; floods.	Severe: floods --	Severe: floods --	Severe: floods --	Severe: floods --
Navajo: 57B, 58B -----	Severe: percs slowly; floods.	Severe: floods --	Severe: floods; too clayey.	Severe: floods; shrink-swell.	Severe: floods; too clayey.
*Overgaard: 59B, 60D, 61B, 62D, 63E, 64D, 65D. For Elledge part of 64D, see Elledge series. For Telephone part of 65D, see Telephone series.	Severe: percs slowly; slopes of more than 15 percent in places.	Slight where slopes are 0 to 2 percent. Moderate where slopes are 2 to 7 percent. Severe where slopes are more than 7 percent.	Severe: too clayey; slopes of more than 15 percent in places.	Severe: shrink-swell; low strength; slopes of more than 15 percent in places.	Severe: too clayey; slopes of more than 25 percent in places.
Rond: 66B, 67C, 68B, 69D -----	Severe: percs slowly; depth to rock; slopes of more than 15 percent in places.	Moderate where slopes are 0 to 7 percent; depth to rock. Severe where slopes are more than 7 percent.	Severe: too clayey; slopes of more than 15 percent in places.	Severe: shrink-swell; low strength; slopes of more than 15 percent in places.	Severe: too clayey; depth to rock; slopes of more than 25 percent in places.
*Roundtop: 70B, 71B, 72D, 73D, 74E, 75D, 76E. For Jacks part of 75D, see Jacks series. For Tortugas part of 76E, see Tortugas series. Rock outcrop part of 73D, 74E, 75D, and 76E not rated.	Severe: percs slowly; depth to rock; slopes of more than 15 percent in places.	Severe: depth to rock; slopes of more than 7 percent in places.	Severe: depth to rock; too clayey; slopes of more than 15 percent in places.	Severe: shrink-swell; low strength; slopes of more than 15 percent in places.	Severe: depth to rock; too clayey; slopes of more than 25 percent in places.
*Showlow: 77B, 78C, 79D, 80B, 81D, 82E, 83E, 84D. For Barkerville part of 83E, see Barkerville series. For Chevelon part of 84D, see Chevelon series.	Severe: percs slowly; slopes of more than 15 percent in places.	Severe: small stones; too clayey; slopes of more than 7 percent in places.	Severe: too clayey; small stones; slopes of more than 15 percent in places.	Severe: low strength; shrink-swell; slopes of more than 15 percent in places.	Slight where slopes are 0 to 15 percent. Moderate where slopes are 15 to 25 percent. Severe where slopes are more than 25 percent.

properties of the soils—Continued

Degree and kind of limitation for—Cont.	Suitability as source of—			Soil features affecting—		
	Local roads and streets	Road fill	Sand	Topsoil	Pond reservoir areas	Dikes, levees, and embankments
Severe: shrink-swell; low strength; wetness.	Poor: shrink-swell; low strength.	Unsuited -----	Poor: too clayey.	Favorable -----	Low strength; compressible; shrink-swell.	Water table at a depth of 0 to 50 inches; slow permeability; high available water capacity.
Severe: floods; low strength.	Poor: low strength.	Unsuited -----	Fair: too clayey.	Favorable -----	Compressible; low strength; piping.	High available water capacity; moderately slowly permeable; floods.
Severe: floods; shrink-swell; low strength.	Poor: shrink-swell; low strength.	Unsuited -----	Poor: too clayey.	Favorable -----	Compressible; hard to pack; shrink-swell.	High available water capacity; very slowly permeable; floods.
Severe: low strength; shrink-swell; slopes of more than 15 percent in places.	Poor: shrink-swell; low strength; slopes of more than 25 percent in places.	Unsuited -----	Poor: small stones; slopes of more than 15 percent in places.	Slope -----	Compressible; low strength; shrink-swell.	Slow permeability; moderate available water capacity; slopes of 0 to 50 percent.
Severe: shrink-swell; low strength; slopes of more than 15 percent in places.	Poor: shrink-swell; low strength; slopes of more than 25 percent in places.	Unsuited -----	Poor: small stones; too clayey; slopes of more than 15 percent in places.	Depth to rock; slope.	Low strength; compressible; shrink-swell.	Slow permeability; high or moderate available water capacity; slopes of 0 to 30 percent; bedrock at a depth of 40 to 60 inches.
Severe: shrink-swell; low strength; slopes of more than 15 percent in places.	Poor: shrink-swell; low strength; slopes of more than 25 percent in places.	Unsuited -----	Poor: small stones; too clayey; slopes of more than 15 percent in places.	Depth to rock; slope.	Low strength; compressible; shrink-swell.	Slow permeability; low to moderate available water capacity; bedrock at a depth of 20 to 40 inches; 0 to 50 percent slopes.
Severe: shrink-swell; low strength; slopes of more than 15 percent in places.	Poor: low strength; shrink-swell; slopes of more than 25 percent in places.	Unsuited -----	Poor: too clayey; small stones; slopes of more than 15 percent in places.	Slope -----	Low strength; compressible; hard to pack.	Slow permeability; low to moderate available water capacity; slopes of 0 to 50 percent.

TABLE 6.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary land-fill (trench)
Sizer: 85B, 86D, 87E -----	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are 0 to 7 percent; seepage. Severe where slopes are more than 7 percent.	Moderate where slopes are 0 to 15 percent; small stones. Severe where slopes are more than 15 percent.	Moderate where slopes are 0 to 15 percent; shrink-swell. Severe where slopes are more than 15 percent.	Severe: seepage; slopes of more than 25 percent in places.
Sponseller: 88B, 89D, 90E, 91B --	Severe: percs slowly; slopes of more than 15 percent in places.	Moderate where slopes are 0 to 7 percent; small stones. Severe where slopes are more than 7 percent.	Moderate where slopes are 0 to 15 percent; small stones. Severe where slopes are more than 15 percent.	Moderate where slopes are 0 to 15 percent; low strength. Severe where slopes are more than 15 percent.	Severe: seepage; slopes of more than 25 percent in places.
Springerville: 92B -----	Severe: percs slowly; depth to rock.	Severe: depth to rock.	Severe: too clayey; small stones.	Severe: shrink-swell; low strength.	Severe: depth to rock; too clayey.
Tatiyee: 93B -----	Severe: percs slowly; floods.	Severe: floods --	Severe: floods; small stones.	Severe: floods --	Severe: floods --
Telephone: 94D, 95D, 96E ----- Rock outcrop part of 96E not rated.	Severe: depth to rock; slopes of more than 15 percent in places.	Severe: depth to rock; slope; large stones.	Severe: depth to rock; slopes of more than 15 percent in places.	Severe: depth to rock; slopes of more than 15 percent in places.	Severe: depth to rock; slopes of more than 25 percent in places.
*Thunderbird: 97B, 98B, 99D, 100E, 101B, 102D, 103E, 104E, 105D. For Chevelon part of 103E, see Chevelon series. For Roundtop part of 104E, see Roundtop series. For Showlow part of 105D, see Showlow series. Rock outcrop part of 101B, 102D, 103E, and 104E not rated.	Severe: percs slowly; depth to rock; slopes of more than 15 percent in places.	Severe: depth to rock; slopes of more than 7 percent in places.	Severe: depth to rock; too clayey; slopes of more than 15 percent in places.	Severe: shrink-swell; low strength; slopes of more than 15 percent in places.	Severe: depth to rock; too clayey; slopes of more than 25 percent in places.
*Tortugas: 106D, 107E, 108E, 109E, 110E. For Chevelon part of 108E, see Chevelon series. For Roundtop part of 109E, see Roundtop series. For Showlow part of 110E, see Showlow series. Rock outcrop part of 107E, 108E, 109E, and 110E not rated.	Severe: depth to rock; slope.	Severe: depth to rock; slope.	Severe: depth to rock; slope.	Severe: depth to rock; slope.	Severe: depth to rock; slope.

properties of the soils—Continued

Degree and kind of limitation for—Cont.	Suitability as source of—			Soil features affecting—		
	Local roads and streets	Road fill	Sand	Topsoil	Pond reservoir areas	Dikes, levees, and embankments
Moderate where slopes are 0 to 15 percent; shrink-swell. Severe where slopes are more than 15 percent.	Fair where slopes are 0 to 25 percent; shrink-swell; low strength. Poor where slopes are more than 25 percent.	Unsuited -----	Poor: small stones; thin layer; slopes of more than 25 percent in places.	Seepage; slope --	Seepage; piping -----	Rapid permeability below a depth of 18 inches; low available water capacity; slopes of 0 to 50 percent.
Moderate where slopes are 0 to 15 percent; shrink-swell; low strength. Severe where slopes are more than 15 percent.	Fair where slopes are 0 to 25 percent; shrink-swell; low strength. Severe where slopes are more than 25 percent.	Unsuited -----	Poor: small stones; slopes of more than 15 percent in places.	Seepage; piping.	Low strength; shrink-swell; compressible.	Moderately slow permeability; moderate available water capacity; slopes of 0 to 50 percent.
Severe: shrink-swell; low strength.	Poor: shrink-swell; low strength.	Unsuited -----	Poor: too clayey; small stones.	Depth to rock --	Compressible; low strength; hard to pack.	Very slow permeability; low to moderate available water capacity; bed-rock at a depth of 40 inches.
Severe: floods --	Fair: shrink-swell; frost action; low strength.	Unsuited -----	Poor: small stones.	Favorable -----	Compressible; low strength; shrink-swell.	Slow permeability; moderate available water capacity.
Severe: depth to rock; slopes of more than 15 percent in places.	Poor: thin layer; slopes of more than 25 percent in places.	Unsuited -----	Poor: small stones; large stones; slopes of more than 15 percent in places.	Depth to rock; large stones.	Large stones; depth to rock.	Moderately rapid permeability; very low available water capacity; bed-rock at a depth of 10 to 20 inches; slopes of 8 to 50 percent.
Severe: shrink-swell; low strength; slopes of more than 15 percent in places.	Poor: low strength; shrink-swell; depth to rock; slopes of more than 25 percent in places.	Unsuited -----	Poor: too clayey; small stones; slopes of more than 15 percent in places.	Depth to rock; slope.	Compressible; hard to pack; low strength.	Slow permeability; low to moderate available water capacity; bed-rock at a depth of 30 to 40 inches; slopes of 0 to 50 percent.
Severe: depth to rock; slope; low strength.	Poor: depth to rock; low strength; slopes of more than 25 percent in places.	Unsuited -----	Poor: small stones; slope.	Depth to rock; slope.	Thin layer; low strength; compressible.	Very low available water capacity; moderately permeable; bed-rock at a depth of 14 to 20 inches; slopes of 15 to 50 percent.

TABLE 6.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill (trench)
Tours: 111B, 112B, 113B, 114B ---	Severe: percs slowly; floods.	Severe: floods --	Severe: floods --	Severe: floods --	Severe: floods --

downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage, within a depth of 2 to 5 feet, long enough for bacteria to decompose the solids. A lagoon has a nearly level floor; its sides, or embankments, are of soil material compacted to medium density, and the pond is protected from flooding. Properties that affect the pond floor are permeability, organic-matter content, and slope, and if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet; for example, excavations for pipelines, sewerlines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or absence of a high water table.

Dwellings without basements, as rated in table 6, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Sanitary landfill (trench type) is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated the ratings in table 6 apply only to the soil material to a

depth of about 6 feet, so a limitation of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet; nevertheless, every site should be investigated before it is selected.

Local roads and streets, as rated in table 6, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material and the shrink-swell potential indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Sand is used in great quantities in many kinds of construction. The ratings in table 6 provide guidance about where to look for probable sources. A soil rated as a good or fair source generally has a layer of sand at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, and neither do they indicate quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as in preparing a seedbed; natural

properties of the soils—Continued

Degree and kind of limitation for—Cont.	Suitability as source of—			Soil features affecting—		
	Local roads and streets	Road fill	Sand	Topsoil	Pond reservoir areas	Dikes, levees, and embankments
Severe: floods; low strength.	Poor: low strength.	Unsuited -----	Fair; too clayey.	Favorable -----	Low strength; compressible; shrink-swell.	High available water capacity; moderately slowly permeable; slopes of 0 to 8 percent; subject to flooding.

fertility of the material, or plant response when fertilizer is added to the soil; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments affect suitability, and also considered in the ratings is damage that will result at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Dikes, levees, and embankments require soil material that is resistant to seepage and piping and that is of favorable stability, shrink-swell potential, shear strength, and compactibility. Stones or organic material in a soil are among factors that are unfavorable.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulation of salts and alkali; depth of root zone; rate of water intake at the surface; permeability below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage, or depth to water table or bedrock.

Formation and Classification of the Soils⁵

This section discusses the major factors of soil formation as they have existed in the Fort Apache Indian Reservation and provides the classification of the soils of the Reservation according to the system currently used by the National Cooperative Soil Survey.

Factors of Soil Formation

The characteristics of the soils at any given place are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material formed; (3) the relief, or lay

of the land; (4) the plant and animal life on and in the soil; and (5) the length of time the forces of soil development have acted on the soil material (3).

Climate and vegetation are the active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and bring about the development of genetically related horizons. The effects of climate and vegetation are conditioned by relief, which is marked by extreme differences in the Fort Apache Indian Reservation. The parent material also affects the kind of profile that can be formed, and in extreme instances, it determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. Generally, a long time is required for the development of distinct horizons.

Climate and vegetation

Climate is directly responsible for variations in vegetation and for some of the major differences in soils. Climate and vegetation influence the weathering of underlying material and are partly responsible for the soil-forming processes that promote horizon differentiation. As elevation increases, precipitation increases and temperature decreases.

Two distinct climatic zones occur in the area. The lower climatic zone is semiarid. It ranges in elevation from about 2,650 to 6,500 feet. The upper boundary of this zone begins about 10 miles east of the confluence of Big Bonita Creek and the Black River and runs northwest to just west of Pinetop, then west along the Mogollon Rim to the boundary of the Reservation. Winters are mild and summers are hot in this zone. Precipitation is 15 to 20 inches, mean annual temperature is 46° to 58° F., and the frost-free season ranges from 120 to 270 days. The vegetation in this zone includes desert scrub, chaparral, piñon pine, juniper, and grama grasses.

The upper climatic zone is subhumid. It has an elevation that ranges from about 6,500 to 11,404 feet. This zone mainly includes the eastern one-third of the Reservation and extends west along the Mogollon Rim to the western boundary of the Reservation. Winters are cold and summers are cool in this area. This zone

⁵ By D. M. HENDRICKS, University of Arizona, Agricultural Experiment Station.

has a mean annual precipitation of 20 to 40 inches, a mean annual temperature of 35° to 46°, and a frost-free period ranging from 80 to 130 days. The dominant vegetation of the subhumid zone is ponderosa pine, mixed conifer, spruce-fir, aspen, and mountain meadows and grassland.

Most of the soils in these climatic zones have properties that are similar and that can be attributed to the dominating influence of climate and vegetation, but relief, parent material, and time have had a modifying influence. Other soil-forming factors must be relatively constant to evaluate the influence of climate and vegetation in each climatic zone. The Thunderbird and Gordo soils, for example, occur in different climatic zones, but they formed in similar parent material of about the same age and have similar relief.

Thunderbird soils formed under alligator juniper, and grasses in a semiarid climate. This vegetation has produced sufficient organic matter to form a thin, dark-colored surface layer (A horizon), but very little litter has accumulated on the soil surface. Weathering of the parent material and the translocation of silicate clays have resulted in a moderately developed clay subsoil (B2t horizon). Carbonates have been leached from the surface layer and the upper part of the subsoil and have accumulated in the lower part of the subsoil. Reaction ranges from neutral near the surface to moderately alkaline in the subsoil. Thunderbird soils have a dark brown to yellowish red subsoil, which indicates the oxidation of iron compounds released by weathering. These soils are classified as Argiustolls.

Gordo soils formed under mixed conifers and aspen and an understory of grasses and sedges in a subhumid climate. A layer of conifer and aspen litter (O1 horizon) has accumulated on the soil surface, and there is a thick, dark colored surface layer (A horizon). A medium textured to moderately fine textured subsoil (B2t horizon) has formed, which indicates translocation of silicate clay. There are no secondary carbonates in the soil. The reddish brown color indicates the presence of ferric oxides. Reaction is medium acid to slightly acid in the surface layer and slightly acid to neutral in the subsoil. These soils are classified as Cryoborolls.

The properties of the Thunderbird and Gordo soils are strongly influenced by the prevailing climatic regime in each zone. The semiarid zone has, in addition to the lowest precipitation, the highest temperature and thus the highest potential evapotranspiration. These soils dry out to a greater extent during the dry seasons than do the soils in the zone that is cooler and has higher rainfall. Translocation of clay and the formation of ferric oxides are two properties that are strongly influenced by marked alternate seasonal wetting and drying. The translocation of clay has caused the Thunderbird soils in the semiarid zone to have a more pronounced clay subsoil (B2t horizon) than the Gordo soils. The soils of the subhumid zone have more litter (O1 horizon) and a thicker A horizon than do the soils of the semiarid zone. These differences are probably caused by differences in plant production, which are the result of higher precipitation and a lower rate of decomposition of organic matter because of lower temperatures. Leaching and acidity increase as elevation and precipitation increase.

Parent material

The soils of the Fort Apache Indian Reservation formed in many different kinds of parent material. Most of the soils in the eastern part of the area formed in basaltic material that was extruded as lava and basaltic ejecta, mainly from volcanoes in the Baldy Mountain area during the late Tertiary and early Quaternary stages. A more recent extrusion of lava and basaltic ejecta came from many small volcanoes in the northeastern part of the survey area. The main soils of this area are of the Gordo, Sponseller, Sizer, Ess, Broliar, Thunderbird, and Cabezon series. These soils are dark colored, are medium textured to fine textured, and have a weakly developed to moderately developed Bt horizon. The dark color of these soils is caused, in part, by the dark colored minerals derived from the parent rock. However, the Baldy soils in the same general area formed in moderately coarse textured material derived from andesite and rhyolite on the slopes of Mount Baldy. The Baldy soils are light colored and lack a B horizon. The light color of the Baldy soils has been inherited from the light colored minerals of the parent rock.

The soils in the extreme southwestern part of the Reservation formed in weathered Pre-Cambrian and Tertiary diabase and Pre-Cambrian granite. This area has been exposed by the erosion of the overlying Triassic, Jurassic, and Cretaceous sedimentary rock. Barkerville soils, which formed in diabase or granite, are dark colored, are moderately coarse textured, and have an A1 horizon as the only expression of soil development.

Most of the soils in the western two-thirds of the Reservation formed in material weathered from Pre-Cambrian to Cretaceous sedimentary rock. Gravelly outwash, which was deposited during the late Tertiary and Quaternary stages, mantles the sedimentary rock along the Mogollon Rim and other sedimentary rocks in other parts of the area. Elledge soils formed in material derived from sandstone, and Overgaard soils formed in gravelly alluvium. These are apparently old soils, as evaluated by profile development, and they appear to be on the oldest land surfaces in the area.

Jacks and Chevelon soils formed in material derived from sandstone and siltstone. The absence of a Cca horizon in the Jacks and Chevelon soils is probably caused by the small amount of carbonate initially in the parent material.

Showlow soils formed from Tertiary and Quaternary gravelly alluvium. Showlow soils are similar to the Jacks and Chevelon soils, but they typically have a Cca horizon at a depth of 22 inches. Tortugas and Roundtop soils formed on Carboniferous and Devonian limestone and siltstone. These soils are mainly in the southwestern part of the Reservation along the Salt River and its tributaries. They contain carbonates in the profile, mainly because of the carbonates inherited from the parent rock.

Relief and topography

The elevation of the Fort Apache Indian Reservation ranges from about 3,000 feet at the Salt River to 11,404 feet on Baldy Peak. Excluding the very small areas along the Salt River and Mount Baldy, most of

the area ranges from 4,000 to 10,000 feet in elevation. Going from high to low elevations, the northeastern part of the area is nearly level to rolling plains, moderately steep hills, and steep mountains. Small steep and very steep cinder cones are scattered within this area, and Mount Baldy is on the eastern boundary. From the northwest corner of the Reservation to the town of Lakeside, the Mogollon Rim forms the northern boundary. Below the breaks of the Mogollon Rim and extending to the southwest, a series of steep and very steep canyons dissects large areas of undulating to rolling plains and hills. These canyons are tributaries of the Salt River that drain toward the south and west, and their headwaters originate near the Mogollon Rim on the north and Mount Baldy to the northeast.

The effect of topography on the soils is considered when the climate, vegetation, and age and kinds of parent material are similar.

Thunderbird and Springerville soils formed in material derived from basalt of the same age under similar vegetation in a semiarid climate. Thunderbird soils are in convex areas and have a moderately developed clay subsoil and clay films indicating clay translocation. Springerville soils are in concave areas and have gilgai microrelief and no subsoil. The Springerville soils shrink when they are dry and swell when they are wet; thus, deep wide cracks form during the dry periods and close when the soil is saturated.

Cibeque and Showlow soils formed in gravelly alluvium of apparently the same age under similar vegetation and climate. Cibeque soils are mainly on ridges and side slopes and probably have been subjected to more geological erosion than Showlow soils. These soils have some carbonates in the surface layer and have pronounced accumulation of carbonates in the subsoil. Showlow soils are undulating to rolling and apparently have been subjected to less erosion than have Cibeque soils. These factors have caused the soil formation to be more active in Showlow soils. Carbonates are leached from the surface layer and the upper part of the subsoil and accumulate in the lower part of the subsoil. Clay is translocated from the surface to form a clay subsoil.

Time

The kinds of horizons in soils and the degree of expression of these horizons depend, in part, on the length of time the soils have developed. The soils of the Fort Apache Indian Reservation range from young to relatively old, as evidenced by soil development.

The youngest soils are those that formed in recent alluvium, such as the Tours, Navajo, Lynx, and Jacques soils. These soils periodically receive sediment from flooding of the bottoms and flood plains. Therefore, the horizons in these soils have developed for a short time. The A horizon mainly formed from accumulations of organic matter from the surface, but some of the apparent organic matter was inherited from the alluvial parent material. Stratification caused by perial deposition of sediment is commonly evident.

The oldest soils, as indicated by horizon development, are Overgaard and Elledge soils on what apparently are the oldest land surfaces on the Reserva-

tion. Both soils are along the Mogollon Rim, have a light-colored A2 horizon, and have a moderately developed to strongly developed clay Bt horizon.

Soils that have moderate horizon development are the Roundtop, Jacks, Chevelon, and Thunderbird soils. These soils seem to be on a younger landscape and formed under less precipitation than Elledge and Overgaard soils. The lower amount of precipitation and the younger landscape would account for their intermediate horizon development. Roundtop, Jacks, Chevelon, and Thunderbird soils have moderate accumulations of organic matter in the surface layer. Silicate clay minerals have been translocated from the A horizon to form a moderately developed clay Bt horizon.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison of large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965 (6). Because this system is under continual study, readers interested in developments of the current system should search the latest literature available.⁶

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 7, the soils of the survey area are classified according to the system. Categories of the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized as classes in the system. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Moll-i-sol).

SUBORDER: Each order is subdivided into suborders that are based primarily on those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic

⁶ See U.S. Department of Agriculture, 1975. "Soil taxonomy: a basic system of soil classification for making and interpreting soil surveys." U.S. Dep Agric. Handb. 436. 754 pp.

TABLE 7.—*Classification of the soils*

Soil Name	Family or higher taxonomic class
Amos -----	Fine, mixed, mesic Typic Hapludalfs.
Baldy -----	Coarse-loamy, mixed, nonacid Typic Cryorthents.
Barkerville ----	Sandy-skeletal, mixed, mesic Typic Ustorthents.
Brolliar -----	Fine, montmorillonitic Argic Cryoborolls.
Cabezon -----	Clayey, montmorillonitic, mesic Lithic Argiustolls.
Chevelon -----	Fine-silty, mixed, mesic Udic Haplustalfs.
Cibeque -----	Fine-loamy, mixed, mesic Ustollic Calciorthids.
Cryaquolls ----	Cryaquolls.
Cryoborolls ----	Cryoborolls.
Cryorthents ----	Cryorthents.
Elledge -----	Fine, mixed, mesic Udic Haplustalfs.
Ess -----	Loamy-skeletal, mixed Argic Cryoborolls.
Gordo -----	Fine-loamy, mixed Argic Pachic Cryoborolls.
Haplustolls ----	Haplustolls.
Jacks -----	Fine, mixed, mesic Udic Haplustalfs.
Jacques -----	Fine, mixed, mesic Cumulic Haplustolls.
Luna -----	Fine, montmorillonitic Argic Pachic Cryoborolls.
Luna variant --	Fine, montmorillonitic Argic Cryaquolls.
Lynx -----	Fine-loamy, mixed, mesic Cumulic Haplustolls.
Navajo -----	Fine, mixed (calcareous), mesic Typic Torrifuvents.
Overgaard ----	Fine, mixed Typic Cryoboralfs.
Rond -----	Fine, mixed, mesic Typic Argiustolls.
Roundtop ----	Fine, mixed, mesic Typic Argiustolls.
Showlow -----	Fine, montmorillonitic, mesic Typic Argiustolls.
Sizer -----	Fine-loamy over fragmental, mixed Argic Cryoborolls.
Sponseller ----	Fine-loamy, mixed Argic Cryoborolls.
Springerville --	Fine, montmorillonitic, mesic Typic Chromusterts.
Tatiyee -----	Clayey-skeletal, montmorillonitic Argic Cryoborolls.
Telephone ----	Loamy-skeletal, mixed, nonacid, mesic Lithic Ustorthents.
Thunderbird ¹ --	Fine, montmorillonitic, mesic Aridic Argiustolls.
Torrifuvents --	Torrifuvents.
Tortugas -----	Loamy-skeletal, carbonatic, mesic Lithic Haplustolls.
Tours -----	Fine-silty, mixed (calcareous), mesic Typic Torrifuvents.
Ustorthents ----	Ustorthents.

¹In this survey area, this soil is a taxadjunct to the Thunderbird series.

range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is *Boroll* (*Bor*, meaning cool, and *oll*, from Mollisol).

GREAT GROUP: Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots, movement of water, or both; and thick, dark colored surface horizons. The features used are the self-mulching

properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Argiborolls (*Argi*, meaning clay or argillic horizon, *bor* for cool, and *oll*, from Mollisols).

SUBGROUP: Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Argiborolls (a typical Argiboroll).

FAMILY: Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reactions, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentiae (see table 7). An example is the fine-loamy, mixed family of Typic Argiborolls, which is the classification of the Sponseller series.

Five soil orders are represented in the survey area—Alfisols, Aridisols, Entisols, Mollisols, and Vertisols.

Entisols.—Entisols essentially are soils that lack developed horizons. The Entisols in the survey area are of the Torrifuvents, Ustorthents, and Cryorthents great groups.

The Torrifuvents are Entisols that have been subjected to stream deposition and are mainly dry in most years. The soils of the Tours and Navajo series are classed as Typic Torrifuvents and are on nearly level to moderately sloping alluvial fans, swales, and bottoms.

Ustorthents are Entisols that lack any evidence of diagnostic horizons within the control section. They are dry for 90 cumulative days or more in most years in places between depths of 12 and 35 inches or above bedrock. Telephone soils are shallow to noncalcareous sandstone and are classified as Lithic Ustorthents. They are strongly sloping to steep.

Cryorthents are Entisols that have a low mean annual soil temperature. The soils of the Baldy series are strongly sloping to steep and are between elevations of 9,000 and 11,404 feet on mountains.

Vertisols.—Vertisols are mineral soils without a lithic or paralithic contact within 20 inches of the surface. They have more than 30 percent clay in all horizons down to bedrock or a paralithic contact, to a calcic horizon, or to a depth of 40 inches. They crack widely and deeply during dry periods; however, these cracks close when the soil is wet. The soils of the Springerville series are the only vertisols in the sur-

vey area. They are classified as Typic Chromusterts, indicating that they are in a dry region. These soils are in small depressions and nearly level areas.

Aridisols.—The Aridisols are mainly dry in most years in all parts of the soil between depths of 7 and 20 inches. They have a light colored surface layer that maintains its patterns when the soil is dry. The soils of the Cibique series are classified as Ustollic Calciorthids and are the only Aridisols in the survey area. These soils formed in old gravelly alluvium and have an accumulation of carbonates in the subsoil.

Mollisols.—The Mollisols are soils in which there has been accumulation and decomposition of relatively large amounts of organic matter in the presence of calcium, producing calcium-rich forms of humus. The base saturation is more than 50 percent by the ammonia acetate method. These soils have a dark colored surface layer that is at least 1 percent organic matter. Soil structure is strong enough so that the horizon pattern is maintained when the soils are dry. Many soils in the Fort Apache Indian Reservation are Mollisols. They represent three great groups—Cryoborolls, Argiustolls, and Haplustolls.

The Cryoborolls are cold Mollisols, which are at the higher elevations. The Ess, Broliar, Sponseller, Sizer, and Tatiyee soils have argillic horizons and, therefore, are classified as Argic Cryoborolls. The Gordo and Luna soils are classified as Argic Pachic Cryoborolls, indicating that they have argillic horizons and a thicker, darker colored surface layer than is typical for Mollisols.

The Argiustolls are at lower elevations under a warmer and drier climate than the Cryoborolls. These soils have argillic horizons, and leaching generally has not removed all of the carbonates from the solum. Cabezon soils are classified as Lithic Argiustolls and have bedrock at a depth of 20 inches or less. The Rond, Roundtop, and Showlow soils are classified as Typic Argiustolls.

The Haplustolls mainly differ from the Argiustolls because they lack an argillic horizon. Tortugas soils are classified as Lithic Haplustolls. They have bedrock at a depth of 20 inches or less. The Jacques and Lynx soils are classified as Cumulic Haplustolls, indicating that they have thick, dark colored surface layers because of the deposition of fresh sediments on flood plains or in swales.

Alfisols.—The Alfisols are mainly moist in some part of the soil between depths of 10 and 20 inches, but they generally have a period when evapotranspiration exceeds precipitation and one or more horizons have a moisture content that drops well below field capacity or reaches the wilting point. The Alfisols have argillic horizons and have a surface layer that is lower in content of organic matter or is lighter in color than that of Mollisols. Cryoboralfs, Hapludalfs, and Haplustalfs are great groups of the Alfisols recognized in this area.

Cryoboralfs are Alfisols that have cold temperatures. These soils are characterized by an A2 horizon and a moderately developed to strongly developed argillic horizon. Overgaard soils are classified as Typic Cryoboralfs. The parent material of these soils is old gravelly alluvium derived from sandstone, quartzite, and granite.

The Hapludalfs are Alfisols that have warmer temperatures than the Cryoboralfs, and they are mainly moist in most years. Amos and Elledge soils are classified as Typic Hapludalfs.

The Haplustalfs are Alfisols in a climate that has pronounced warm and dry seasons. They are commonly drier than the Hapludalfs. Jacks and Chevelon soils are classified as Udic Haplustalfs.

General Nature of the Area ⁷

This section is for those not familiar with the Fort Apache Indian Reservation. It discusses the history and population, transportation facilities, community facilities, natural resources, recreation, ranching and farming, and climate of the Reservation.

History and Population

The principal town on the Fort Apache Indian Reservation, Whiteriver, was established as a U.S. Army camp after the discovery of gold in California in 1849. On November 9, 1871, the White Mountain Indian Reservation was established by Executive Order. On June 7, 1897, an Act of Congress established the area north of the Salt and Black Rivers as the Fort Apache Indian Reservation for the White Mountain Apache Indians. The San Carlos division was added to the Reservation in 1972.

In 1897 the Indian population of the Reservation was 1,811, but by 1967 it had grown to more than 7,000. The population of the Reservation, including Indians and non-Indians, is about 9,000. The communities on the Reservation and their populations are Whiteriver, 2,160; Fort Apache, East Fork, and Seven Mile, 1,420; Cibecue, 1,300; Canyon Day, 850; North Fork, 520; McNary, 370; Cedar Creek, 350; and Carrizo, 190. The main towns near the Reservation and their populations are Pinetop-Lakeside, 2,600; Show Low, 2,500; Springerville-Eager, 2,430; Pinetop, 800; and Lakeside, 600.

Transportation Facilities

U.S. Highway No. 60 traverses the central part of the reservation from the north to the south. This hard-surfaced road provides all-weather transportation to Phoenix, Arizona, and Albuquerque, New Mexico. Paved Federal, State, or county roads and roads maintained by the Bureau of Indian Affairs connect all major communities on the Reservation. Most of the unimproved roads are passable during dry weather.

One railway provides freight service from McNary to Holbrook, where it connects with another line. A part of the old logging railway from McNary to Apache Springs is used for scenic and recreational purposes.

Charter air service from Show Low and Whiteriver provides access to major transcontinental airlines at Phoenix.

⁷ By CARL-ERIC GRANFELT, Bureau of Indian Affairs, Department of the Interior.

Community Facilities

Three Bureau schools, two mission schools, and five public schools on the Reservation are attended by more than 2,800 students. Three of these provide a four-year high school curriculum. Ten churches are in various communities. A hospital operated by the U.S. Public Health Service is at Whiteriver.

General merchandise is available at 15 trading posts. The main shopping center, however, is off the reservation in the Lakeside-Pinetop area. Electric power and liquid petroleum gas service are available to the Reservation communities. Mail is delivered daily. Telephone service is available at all major communities. Domestic water supply is piped from wells and springs to areas throughout the Reservation.

Natural Resources ⁸

The reservation contains 720,000 acres of merchantable timber, mainly ponderosa pine. Other commercial

⁸ Data from Branch of Forestry, Fort Apache Agency, 1974.

trees are Englemann and Colorado blue spruce, Douglas-fir, white fir, corkbark fir, white pine, and aspen. Noncommercial species are piñon pine and juniper. The harvest and production of this timber provides one of the main sources of employment on the Reservation. About 75 million board feet of timber is cut annually under a forest management plan.

Mineral deposits of asbestos, manganese, iron, gypsum, and coal and indications of uranium have been located on the Reservation. Most of the mineral deposits have not been developed to any extent.

The reservation has a favorable climate, water resources, and soil conditions necessary for livestock production and recreational developments. Ranches and recreational areas are also important sources of employment for the inhabitants of the Reservation.

Recreation

The Reservation provides many recreational activities and is open to visitors. More than 300 miles of

TABLE 8.—Temperature

Whiteriver

Month	Temperature						
	Average daily maximum	Average daily minimum	Average monthly	Highest	Year	Lowest	Year
	°F	°F	°F	°F		°F	
January -----	53.5	20.4	37.0	75	1950	-13	1949
February -----	56.9	24.1	40.6	78	1957	-6	1948
March -----	62.2	28.6	45.5	86	1900	5	1953
April -----	69.9	34.1	52.0	98	1914	14	1921
May -----	78.6	41.4	60.1	100	1914	22	1953
June -----	88.7	49.1	69.0	104	1902	30	1918
July -----	90.4	56.9	73.7	106	1958	42	1915
August -----	87.9	55.9	72.0	102	1911	40	1902
September -----	84.8	49.5	67.2	101	1948	25	1915
October -----	75.4	38.4	56.9	93	1950	18	1915
November -----	63.5	27.2	45.4	91	1909	-7	1931
December -----	54.6	21.4	38.1	79	1942	-12	1905
Year -----	72.2	37.2	54.8				

Mc Nary

January -----	44.0	16.4	30.2	66	1950	-23	1949
February -----	45.5	18.4	32.0	69	1957	-18	1939
March -----	50.9	22.4	36.7	70	1956	-13	1951
April -----	60.2	27.9	44.0	80	1962	0	1949
May -----	69.5	33.0	51.3	89	1952	8	1950
June -----	78.3	39.6	58.9	92	1954	20	1950
July -----	80.5	48.1	64.3	94	1958	30	1935
August -----	77.8	48.3	62.9	91	1962	32	1956
September -----	74.9	41.8	58.3	89	1948	21	1945
October -----	65.7	32.6	49.1	81	1950	7	1949
November -----	53.6	22.0	37.7	72	1934	-3	1952
December -----	46.8	18.5	32.6	70	1950	-18	1945
Year -----	62.3	30.8	46.5				

¹ Trace.

clear, cold streams and numerous lakes and ponds make the area suitable for camping and fishing. Both cold and warm water fish are taken. Two national fish hatcheries ensure a plentiful supply of trout year-around. The Reservation has many kinds of wildlife. Visitors may hunt elk, bear, javelina, mountain lion, bobcat, waterfowl, and dove under permit. The taking of game and fish on the Reservation complies with Arizona State laws.

Many ancient Pueblo ruins are on the Reservation. One of these is Kinishba (Apache for "brown house"), located about 8 miles southwest of Whiteriver. Another interesting site is "old Fort Apache." Established in 1870, it was manned continuously until 1923. In 1924 it was turned over to the Secretary of the Interior for use as a school. Many of the old buildings are still standing. There are plans to make the area a national historical site.

More than 1,000 campsites, complete with tables, fireplaces, and sanitary facilities, have been constructed for vacationers. In addition to these, there are other tourist facilities, including motels, a resort hotel, ski

runs, cabins, boat docks, and stores for the visitor's convenience.

Ranching and Farming

The Apache Tribe has been raising cattle since 1900, when a few head were brought in from Mexico. In 1917, 800 head of Hereford cattle were driven onto the Reservation to provide a foundation stock. The Tribe now owns approximately 17,000 head of Hereford cattle and about 1,000 horses. About 90 percent of the area is used for grazing. This area is divided into nine grazing districts for management purposes. Cattle auctions are held on the Reservation each year in October for buyers from throughout the Southwest. These auctions have established an excellent market for Reservation livestock.

In conjunction with the livestock industry, the Indian people are engaged in subsistence farming on small irrigated and dryland tracts. The products from the irrigated tracts include fruit, alfalfa, and vege-

and precipitation data

[Period of record 1900-1962]

Precipitation						Estimated average relative humidity at—	
Average monthly	Average daily maximum	Year	Snow, sleet, and hail			6:00 A.M.	6:00 P.M.
			Average monthly	Monthly maximum	Year		
In	In		In	In		Pct	Pct
1.61	3.00	1905	5.7	27.9	1960	66	54
1.37	1.85	1917	4.2	16.0	1928	68	57
1.60	2.15	1912	3.4	35.5	1952	66	46
.99	2.10	1905	.8	10.0	1927	61	40
.47	1.05	1930	.1	3.0	1915	57	35
.46	1.67	1954	.0	.0		59	38
2.81	4.02	1932	∞	∞	1954	77	55
3.05	2.25	1961	∞	∞	1955	81	60
1.77	2.25	1958	.0	.0		74	53
1.17	2.25	1911	.1	4.2	1959	68	54
1.18	2.20	1918	1.4	14.2	1931	63	52
1.41	1.92	1908	3.8	16.8	1960	69	61
1.49			1.63			67	50

[Period of record 1934-1962]

2.59	2.95	1952	24.0	70.5	1937	70	63
2.18	2.00	1937	20.7	52.0	1948	73	68
2.47	4.41	1954	18.0	54.0	1952	72	55
1.30	1.18	1935	7.3	27.6	1941	67	51
.69	1.45	1937	.9	6.0	1960	64	43
.57	1.41	1955	∞	1.0	1945	66	50
3.15	1.55	1961	∞	∞	1954	85	74
3.99	2.40	1951	∞	∞	1954	84	72
2.28	2.60	1946	∞	∞	1961	79	63
1.80	2.78	1959	1.1	22.0	1961	74	61
1.29	1.50	1962	7.9	38.5	1952	67	58
2.39	2.94	1945	14.4	52.0	1961	72	66
2.06			7.86			73	60

tables. The dryfarmed areas produce mostly corn and beans.

Climate ⁹

The climate of the Fort Apache Indian Reservation ranges from semiarid to subhumid. The variations in climate are the result of differences in elevation, terrain, and prevailing airflow.

May and June are the driest months of the year. Thundershowers that begin in July and extend into September make summer the rainy season. These thundershowers are caused by moisture-laden winds that sweep across the desert from the Gulf of Mexico and rise along the Mogollon Rim and the White Mountains. These winds cause heavy rainfall in the mountainous areas, but precipitation decreases at the lower elevations.

Precipitation in winter comes from storms that move into the area from the Pacific Ocean. Although these storms are not so violent as storms in summer, they usually last longer and sometimes provide heavy snows, particularly in the higher mountains. At Whiteriver, approximately 30 percent of the precipitation in winter is in the form of snow, but at McNary about 80 percent is snow. Climatological data for Whiteriver and McNary are given in table 8.

Summer is mild to cool. During the day, temperatures at Cibecue and Whiteriver reach the high eighties and low nineties, and at night they drop to the high forties and middle fifties. In the higher mountains during July and August, the daytime temperatures average in the high seventies and low eighties, dropping to the high forties early in the morning. Freezing temperatures have occurred in all summer months.

At the lower elevations, winter is characterized by mild days and cold nights. Temperatures in the afternoon are in the middle to upper fifties, and early morning temperatures are in the twenties. At Whiteriver, temperatures below zero can be expected in two winters out of five. At higher elevations, winters are characterized by cool days and cold nights. Afternoon temperatures are in the middle forties, and early morning temperatures are below freezing. The lowest temperature officially observed for the Reservation, and also for the State, was -40° F at Hawley Lake on January 7, 1971.

Winds are mostly light to moderate, but strong, gusty winds commonly accompany local thunderstorms. Winds of 35 to 50 miles per hour along the high plateau areas are common in spring. Velocities higher than these have occurred.

Because subfreezing temperatures have been recorded in all months of the year, except at the lower elevations in July and August, the growing season is unpredictable. Normally the mean frost-free periods for five stations are Whiteriver, May 3 to October 23; Cibecue, May 20 to October 14; Forestdale, June 7 to September 26; McNary, June 3 to August 19; and Maverick, June 25 to August 19.

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Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low -----	0 to 3
Low -----	3 to 6
Moderate -----	6 to 9
High -----	More than 9

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

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.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Compressible. Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

⁹ By PAUL C. KANGIESER, climatologist for Arizona, National Weather Service, U.S. Department of Commerce.

- 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.
- Depth to rock.** Bedrock at a depth that adversely affects the specified use.
- Drainage class (natural).** Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
- Excessively drained.**—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
- Somewhat excessively drained.**—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
- Well drained.**—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
- Moderately well drained.**—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
- Somewhat poorly drained.**—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
- Poorly drained.**—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
- Very poorly drained.**—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."
- Favorable.** Favorable soil features for the specified use.
- Flooding.** The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. None means that flooding is not probable; rare that it is unlikely but possible under unusual weather 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. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.
- Frost action.** Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.
- Hardpan.** A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.
- Horizon, soil.** A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. 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, formed or forming 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.
- A₂ horizon.**—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.
- B horizon.**—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.
- C horizon.**—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that 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.
- Igneous rock.** Rock produced by the cooling of melted mineral material; examples are granite, andesite, diorite, and basalt.
- 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.** Rock fragments 10 inches (25 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.
- Low strength.** Inadequate strength for supporting loads.
- Mottling, soil.** Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—few, common, and many; size—fine, medium, and coarse; and contrast—faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).
- Ped.** An individual natural soil aggregate, such as a granule, a prism, or a block.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

pH value. (See *Reaction, soil*). A numerical designation of acidity and alkalinity in soil.

Piping. Moving water forms subsurface tunnels or pipeline cavities in the soil.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

pH		pH	
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

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.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature 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 other plant and animal life characteristics of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining 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).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soils, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer" or the "Ap horizon."

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. Otherwise suitable soil material too thin for the specified use.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

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

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Wilting point (or permanent wilting point). The moisture content of soil, on an oven-dry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

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