Issued July 1967

SOIL SURVEY

Zuni Mountain Area New Mexico

UNITED STATES DEPARTMENT OF AGRICULTURE
Forest Service and Soil Conservation Service
In cooperation with
NEW MEXICO AGRICULTURAL EXPERIMENT STATION

HOW TO USE THIS SOIL SURVEY REPORT

Major fieldwork for this soil survey was done in the period 1957–59. Soil names and descriptions were approved in 1964. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1957–59. This survey of the Zuni Mountain Area was made to gather information needed to manage lands of the Cibola National Forest, and as a part of the technical assistance furnished by the Forest Service and the Soil Conservation Service to the Bluewater, Lava, and McKinley Soil Conservation Districts.

THIS SOIL SURVEY of the Zuni Mountain Area contains information that can be applied in managing range, forests, and watersheds; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for recreation purposes and as a habitat for wildlife.

Locating Soils

All the soils of the Zuni Mountain Area are shown on the detailed map at the back of this report. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. 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

The "Guide to Mapping Units" can be used to find information in the report. This guide lists all of the soils of the Area in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for each management group.

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. Interpretations not included in the text can be developed by grouping soils according to suitability or degree of limitation for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. 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.

Foresters and others can refer to the section "Forest Management," in which the soils of the Area are grouped according to their suitability for trees.

Watershed specialists and hydrologists can read about hydrologic characteristics of the soils in the section "Watershed Management."

Game managers, sportsmen, and others concerned with wildlife will find information about soils and wildlife in the section "Wildlife Management."

Ranchers and others interested in range can find, under "Range Management," groupings of the soils according to their suitability for range and their capacity for herbage production.

Recreation planners and others concerned with recreation development can read about the soil properties that affect the choice of recreation areas in the section "Development of Recreation Sites."

Engineers and builders will find, under "Soils in Engineering," tables that give descriptions of the engineering properties of the soils in the Area and that name soil features that affect engineering practices and structures.

Scientists and others can read about how the soils formed and how they are classified in the section "Genesis, Morphology, and Classification of the Soils."

Students, teachers, and others will find information about soils and their management in various parts of the text.

Newcomers in the Zuni Mountain Area may be especially interested in the section "Soil Management Areas," where broad patterns of soils are described. They may also be interested in "Part I: The Landscape," which gives additional information about the Area.

Cover: Forest road in ponderosa pine forest near Mt. Sedgwick. The soil is a Mirabal stony loam.

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NOTICE TO LIBRARIANS

Series year and series number are no longer shown on soil surveys. See explanation on the next page.

Issued July 1967

EXPLANATION

Series Year and Series Number

Series year and number were dropped from all soil surveys sent to the printer after December 31, 1965. Many surveys, however, were then at such advanced stage of printing that it was not feasible to remove series year and number. Consequently, the last issues bearing series year and number will be as follows:

Series 1957, No. 23, Las Vegas-Eldorado Area, Nev.
Series 1958, No. 34, Grand Traverse County, Mich.
Series 1959, No. 42, Judith Basin Area, Mont.
Series 1960, No. 31, Elbert County, Colo. (eastern part)
Series 1961, No. 42, Camden County, N.J.
Series 1962, No. 13, Chicot County, Ark.
Series 1963, No. 1, Tippah County, Miss.

Series numbers will be consecutive in each series year, up to and including the numbers shown in the foregoing list. The soil survey for Tippah County, Miss., will be the last to have a series year and series number.

SOIL SURVEY OF ZUNI MOUNTAIN AREA, NEW MEXICO

BY JOHN A. WILLIAMS, FOREST SERVICE

SOILS SURVEYED BY JOHN A. WILLIAMS, TRUMAN C. ANDERSON, JR., AND DARWIN B. CREZEE, FOREST SERVICE, AND BASIL ABASKIN, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, FOREST SERVICE AND SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE NEW MEXICO AGRICULTURAL EXPERIMENT STATION.

Part I: The Landscape

The Zuni Mountain Area, in the northwestern part of New Mexico (fig. 1), is part of the Cibola National Forest. It is 415,630 acres, or about 649 square miles, in size. The Federal government owns 261,850 acres, and the rest is privately owned. About one-third of the Area is in McKinley County, and the rest is in Valencia County. Gallup, the county seat of McKinley County, is approximately 10 miles north of the northwestern corner of the Area.

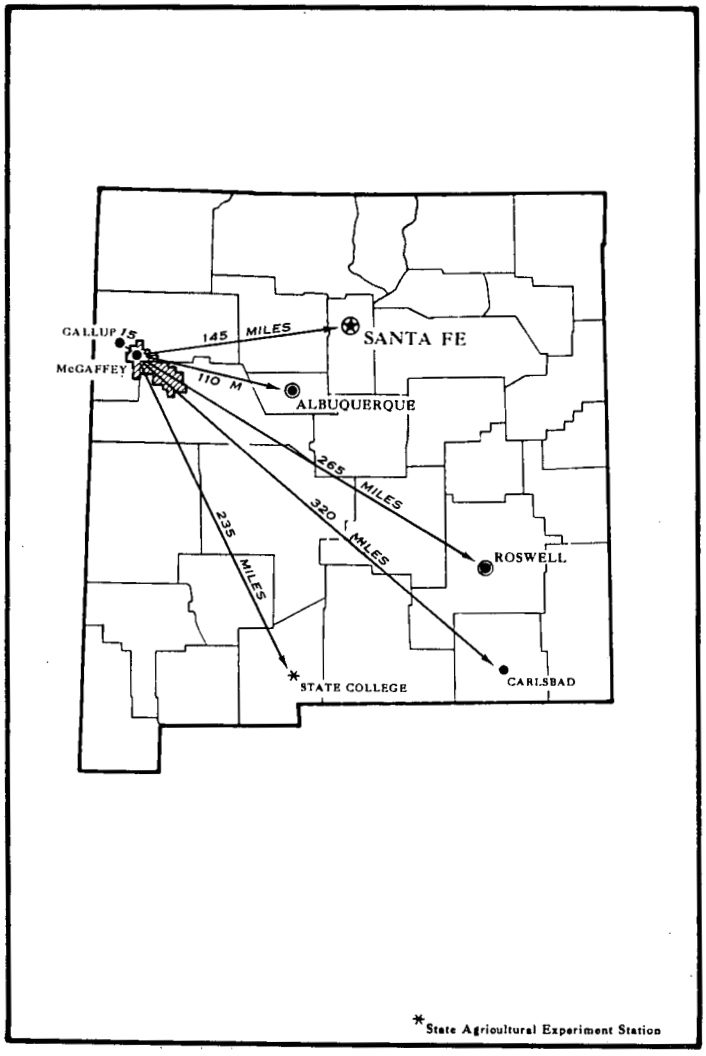

Figure 1.—Location of Zuni Mountain Area in New Mexico.

Interstate Route 40 (U.S. 66) is a few miles outside the Area to the east and north (fig. 2). State Highways 53 and 56 cross the southeastern part of the Area. State Highway 400 is a paved road that serves the northwestern part of the Area but terminates at McGaffey. Forest Road 350 is the main thoroughfare. It runs from McGaffey southeastward through the central part of the Area and terminates at State Highway 56 near the southeastern corner of the Area. Many minor roads and trails give access to the northern and southern flanks of the mountains.

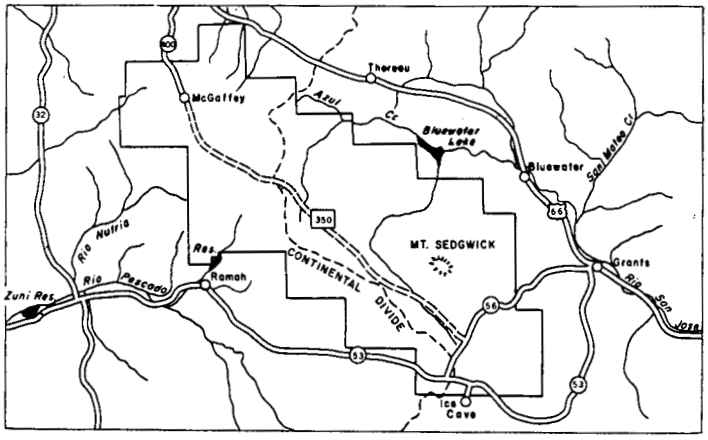

Figure 2.—Regional setting of the Zuni Mountain Area.

Topography and Drainage

The Zuni Mountains are in the southeastern part of the Colorado Plateau physiographic province. They are crossed by the Continental Divide in a general northwest-southeast direction. The altitude ranges from about 6,500 to more than 9,200 feet but is most commonly between 7,500 and 8,000 feet. Prominent features of the landscape are Mt. Sedgwick in the east, Oso Ridge in the south,

Lookout Mountain in the central part of the Area, and the Nutria Monocline (Hogback) along the western boundary.

The topographic features of the Area can be best described as four groups.

1.—A large area underlain by granite is located in the eastern part. The terrain is rough, very steep, rocky, and mountainous. Outcrops of weatherworn granite are common, and the very steep slopes are cut by numerous little drainageways created by erosion.

2.—A series of relatively broad interior valleys extends from McGaffey, in the northeastern part of the Area, to the southeastern corner. These valleys are divided by escarpments, rims, and low hills. Deep and extensive active gullies are common.

3.—Abrupt, steep rims and escarpments, rising several hundred feet above adjacent valley floors, stud the northern and southern parts of the survey Area. The northern rim is broken by a series of deep canyons that have nearly vertical walls. Oso Ridge, the southern rim, is a very high escarpment that extends nearly unbroken for many miles.

4.—Moderately steep, rocky, ridged topography extends from McGaffey westward to the boundary of the survey Area. The conspicuous Nutria Hogback is in this part, and there are many narrow, V-shaped draws and canyons.

Because the Area is crossed by the Continental Divide, natural drainage is divided between two major river basins. West of the Divide, the drainage is tributary to the Colorado River; drainage east of the Divide is tributary to the Rio Grande. In the northwestern part of the Area, streams flow through a series of large canyons, notably Sixmile, Fourmile, Foster, and Smith Canyons. Drainage in the southwest is through canyons and draws running into Rio Nutria and Rio Pescado. These two rivers join west of the boundary of the Cibola National Forest to form the Zuni River, which is a tributary of the Little Colorado River. East of the Divide are Cottonwood, Sawyer, and Bluewater Creeks, which drain to the north, and Prop Canyon and its tributaries and Zuni Canyon, which provide channels to the east. Bonita Canyon and Agua Fria Creek flow southeastward.

Rock Formations

The central core of the Zuni Mountains contains some of the oldest exposed rocks in northwestern New Mexico (*2*).[1] These rocks, largely granite, are believed to have formed between 500 million and 2,000 million years ago, during the Precambrian period. About 500 million years ago, the Area was composed of low, gently rolling granitic hills. Some 270 million years later, during the Permian period, a sea advanced slowly from the south to a line just north of the present Zuni Mountains, where it left deposits of shale, sandstone, and limestone about 1,000 feet thick. Later, another sea advanced and receded several times, leaving thick deposits of gray and black shale and thin layers of lighter colored sandstone. This sea retreated for the last time about 70 million years ago, near the end of the Cretaceous period. Then the uplift that formed the mountains began. The granite mass rose gradually, and as it rose the sedimentary rocks that had formed over it were fractured and tilted upward. The Zuni Mountains are now a broad, elongated dome almost completely ringed with high, inward-facing cliffs of sandstone and shale.

Figure 3 shows, in cross section, the position of some of the major rock formations in the Area.

Precambrian granite gneiss, biotite schist, granite, and quartzite are the rocks in the central upland of the Area. Except in the vicinity of Mt. Sedgwick, the Precambrian rocks are less rugged than the surrounding sedimentary rocks.

Within the upland valleys, around the Precambrian core, are Pennsylvanian rocks of the Magdalena group. These rocks range from calcareous, reddish-brown to medium-gray quartzite and feldspar conglomerate to gray, dense, massive limestone. The younger sedimentary rocks dip away in all directions from the central upland valleys, forming a chain of cuestas toward the lower valleys.

Permian rocks overlie the Pennsylvanian rocks. They consist of Abo sandstone, Glorieta sandstone, San Andres limestone, and the Yeso member of the Chupadera formation. The Abo formation consists of layers of red to reddish-brown sandstone, siltstone, and shale. The Yeso formation is made up of interbedded, fine-grained or medium-grained sandstone, siltstone, and shale. The color ranges from reddish yellow to red to yellowish gray.

Glorieta sandstone is yellowish gray to light gray or white, medium grained, and noncalcareous. It forms the inner ledge and rim of high mesas around the central valleys above the Yeso formation. It is resistant to weathering. Steep cliffs and long, gentle dip slopes are common.

The San Andres formation consists of gray limestone, of medium-grained, grayish-yellow to light-gray sandstone, and of silty and cherty, light-red limestone. It is massive, dense, and nonfossiliferous. It overlies Glorieta sandstone. Limestone makes up most of the formation.

The Chinle formation and Wingate sandstone are Triassic rocks. The Chinle formation is composed of shale, coarse-grained sandstone, and lenses of conglomerate. Petrified wood is abundant. Wingate sandstone, which forms the lower part of the escarpment in the southwestern corner of the Area, is composed of massive, conglomeratic, medium-grained to coarse-grained, yellowish-gray sandstone.

Jurassic and Cretaceous rocks outcrop in the western part of the Area and form the Nutria Monocline and that portion of the eastern flank of the Gallup Sag lying within the boundaries of the Cibola National Forest. Entrada sandstone of the Jurassic system is massive, medium grained or coarse grained, friable, and reddish yellow to medium red. Dakota sandstone, Mancos shale, and the Mesaverde rocks are part of the Cretaceous system.

Dakota sandstone is massive, resistant, yellowish-gray to light-brown, conglomeratic sandstone separated by gray shale. Mancos shale is dark gray and fossiliferous and contains lenses of siltstone and sandstone. It has some thin beds of bentonite. The Mesaverde group is composed of Gallup sandstone and the Crevasse Canyon member. The pink to yellowish-gray Gallup sandstone is massive and medium grained or coarse grained. The Crevasse Canyon member is gray to dark-gray shale that contains carbonaceous material, thin beds of coal, and lenses of gray to light-gray sand.

[1] Italic numbers in parentheses refer to Literature Cited, p. 85.

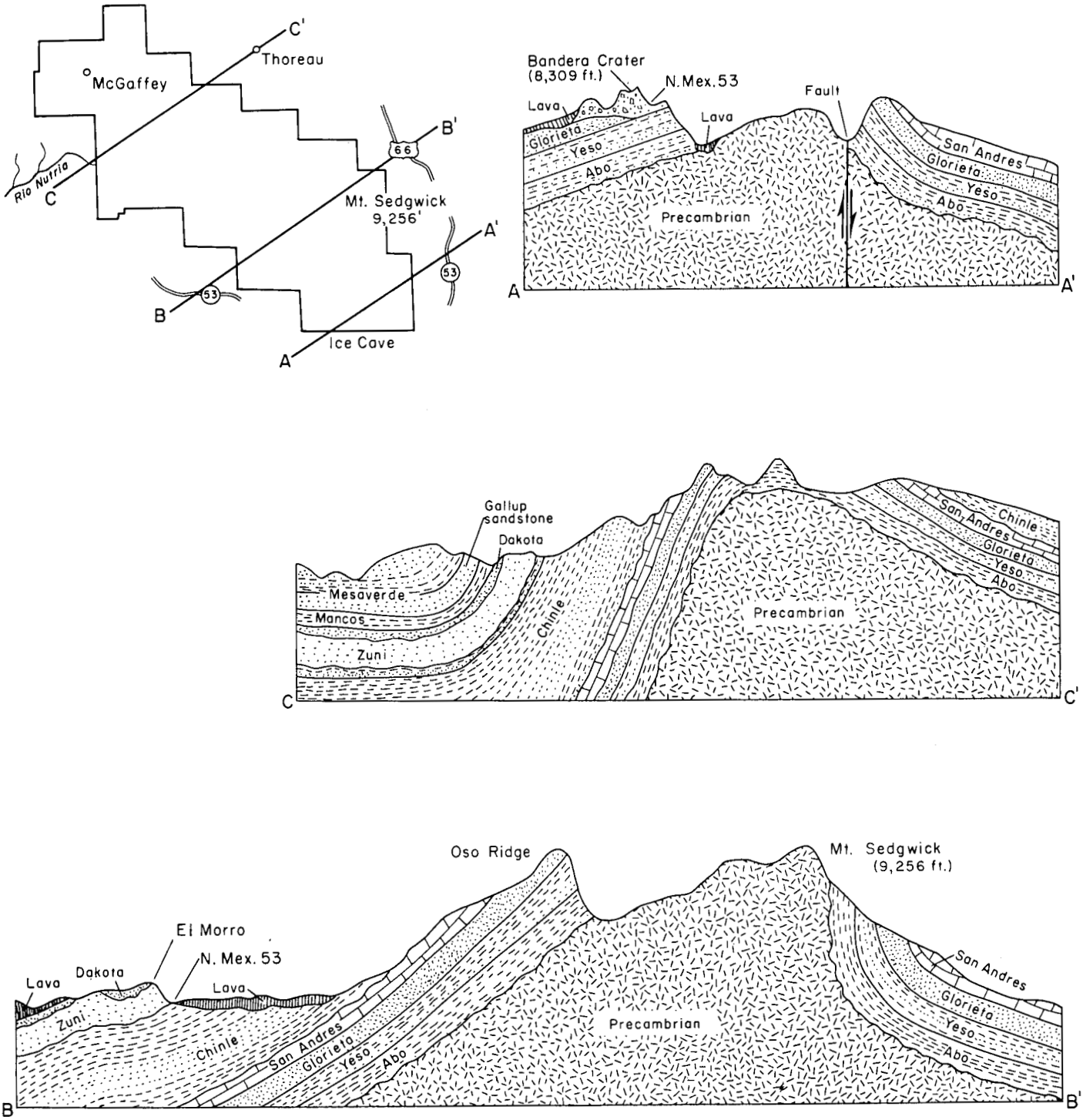

***Figure 3.*—Cross sections of important geologic formations.**

The Tertiary and Recent systems are represented by basalt flows and unconsolidated or very poorly consolidated alluvial deposits. The alluvium has not been mapped as a geologic unit. The basalt flows appear to be of two distinct periods. There are two small remnants on Lookout Mountain in Township 11 North, Range 14 West. Because of their limited extent, thickness, higher topographic position, and isolation from other flows, these remnants appear to be older than those farther east. The main flows occur in the eastern part of the Cibola National Forest and are associated with volcanic cones. The younger flows follow present-day drainageways, and there has been little alteration of these drainageways since the lava was laid down. The basalt is black and dark gray to dark red. It is dense to very vesicular.

Climate [2]

Most of the Zuni Mountain Area has a semiarid continental climate, but the valleys on the eastern border of the Area have an arid continental climate and the higher parts of the national forest have a subhumid continental climate. Figure 4 shows the pattern of average annual rainfall in the Area.

[2] Prepared by GEORGE F. VON ESCHEN, state climatologist (retired), New Mexico.

The distribution of rainfall varies seasonally and geographically. Table 1 shows the monthly and annual averages at several weather stations in and near the survey Area. The figures for the various stations are not exactly comparable, because they are based on records of different lengths. Nevertheless, they show how the amount of rainfall differs from season to season on opposite slopes of the Continental Divide.

Most of the moisture-bearing weather systems that reach this Area in winter (December through March) move in from the Pacific coast, and at this time of the

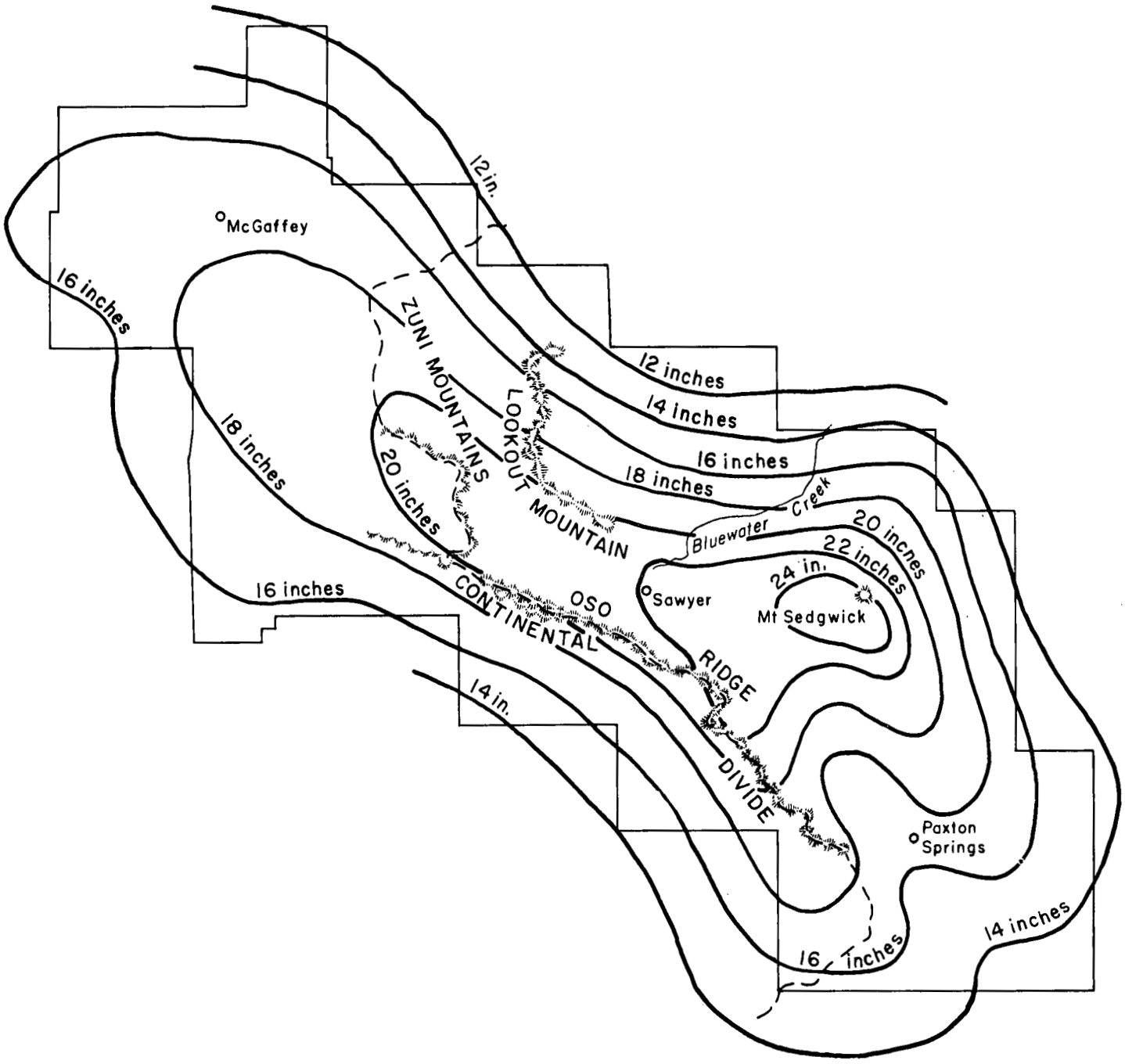

Figure 4.—Pattern of average annual rainfall in the Zuni Mountain Area.

TABLE 1.—*Average monthly and annual precipitation*

[Period of record differs from station to station. The shortest is 13 years, the longest 57 years]

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
On western slope of Continental Divide:													
El Morro National Monument (Elevation 7,218 ft.)	0. 89	0. 71	1. 12	0. 65	0. 45	0. 53	1. 95	2. 77	1. 30	0. 80	0. 55	0. 99	12. 71
Fort Wingate (Elevation 7,000 ft.)	. 91	1. 24	1. 04	. 87	. 59	. 59	2. 15	2. 30	1. 35	1. 02	. 74	. 96	13. 76
Gower (Elevation 7,300 ft.)	1. 06	1. 58	1. 13	. 80	. 49	. 46	1. 69	1. 89	1. 29	. 93	. 74	1. 10	13. 16
McGaffey (Elevation 7,800 ft.)	1. 39	1. 49	1. 63	1. 05	. 76	. 62	2. 50	2. 75	1. 71	1. 19	. 93	1. 85	17. 87
Zuni (Elevation 6,440 ft.)	. 87	. 86	. 82	. 64	. 46	. 48	1. 60	1. 87	1. 16	. 85	. 65	. 81	11. 07
On eastern slope of Continental Divide:													
Bluewater (Elevation 6,800 ft.)	. 42	. 35	. 42	. 46	. 50	. 63	1. 75	2. 53	1. 19	. 47	. 46	. 46	9. 64
Diener (Elevation 9,000 ft.)	1. 08	1. 16	1. 76	1. 98	1. 19	1. 91	5. 00	3. 88	2. 61	1. 09	2. 14	2. 14	25. 04
Grants (Elevation 6,520 ft.)	. 50	. 21	. 31	. 38	. 48	. 41	1. 55	2. 72	. 70	. 36	. 31	. 31	8. 31
IX–XI Ranch (Elevation 7,220 ft.)	1. 14	. 81	1. 10	. 57	. 70	. 98	1. 96	3. 88	1. 64	1. 02	1. 33	1. 33	15. 74
San Rafael (Elevation 6,509 ft.)	. 36	. 72	. 84	1. 19	. 67	. 82	2. 73	3. 26	1. 25	1. 12	. 80	. 80	14. 31

year more rain falls on the western slope of the Continental Divide than on the eastern slope. Weather Bureau records show that the part of the Area that is on the western slope receives 33 percent of its total annual precipitation during this period, and the part that is on the eastern slope only 22 percent.

The moist air masses that reach the Area in summer (July through September) originate over the Gulf of Mexico, and during these months the eastern slope receives more rainfall. According to Weather Bureau records, the part of the Area that is on the eastern slope receives 50 percent of its total annual precipitation during this period, and the part that is on the western slope only 41 percent.

Summer thundershowers are more intense and more frequent on the eastern slope than on the western. Such showers ordinarily occur in the afternoon or early in the evening. Although brief and localized, they may result in flash floods and in severe erosion of steep slopes, particularly of slopes on which there is little vegetation. Many thundershowers are accompanied by hail.

Data on snowfall are limited. On the western slope, the annual total ranges from about 30 inches at the lower elevations to 80 inches or more in the mountains. On the lower parts of the eastern slope, the total is about 18 inches. No records have been kept at the higher elevations on the eastern slope, but the total for a year is probably 60 inches or more.

Temperatures in the survey Area vary almost directly with elevation. Figure 5 shows the relation of annual mean temperature to elevation within the Area. (The mean temperature is computed by averaging the daily maximum and daily minimum temperatures.) Differences in air drainage, caused by local topographic features, may modify the relation between temperature and elevation. The annual mean temperature at a station located on a valley floor is likely to be slightly lower than that at a station that is at the same elevation but on a slope, where air drainage is better.

Wide ranges in temperature, both yearly and daily, are characteristic of the climate of this Area. Even at the higher elevations, the maximum temperature is above 60° F. on some winter days. On a cold night in midwinter, the minimum temperature in the high mountain valleys is likely to be −30° or below. On many winter days the temperature varies by as much as 50°, and a variation of as much as 75° in 24 hours is not uncommon. In summer, the daytime temperature may exceed 90° at the higher elevations, and at the lower elevations it occasionally rises above 100°. In any part of the Area, the mini-

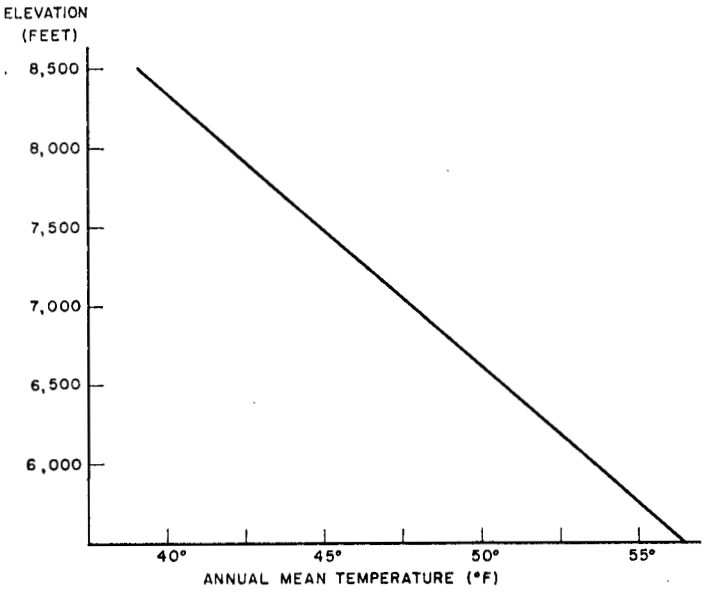

***Figure 5.*—Relation of annual mean temperature to elevation.**

mum temperature on a summer night may be below freezing. The daily variation is usually somewhat less in summer than in winter.

At Zuni, which is on the western slope of the Continental Divide, to the northwest of the survey Area, the prevailing winds are from the northeast, but the winds of highest velocity are commonly from the west or southwest. At Grants, on the eastern slope, the prevailing winds are from the west, and the winds of highest velocity are generally from the west-southwest.

There is no record of a tornado having occurred in this Area. Some winter snowstorms are accompanied by moderately strong winds, but blizzards are not usual.

Sunny weather predominates in the survey Area throughout the year. The sun shines at least 75 percent of the daylight hours. Relative humidity probably averages near 50 percent. It is lowest late in winter and early in spring, when it often falls to 20 percent and sometimes to 5 percent.

Vegetation

The character of the vegetation in the Zuni Mountain Area varies, depending on the nature of the soil, the climate, the aspect, the elevation, and other factors. Many kinds of trees, shrubs, grasses, and other plants are included. The following are the principal native and introduced plants in the Area.

TREES

Scientific name	*Common name*
Abies concolor	White fir.
Juniperus communis	Common juniper.
J. deppeana	Alligator juniper.
J. monosperma	One-seeded juniper.
J. osteosperma	Utah juniper.
J. scopulorum	Rocky Mountain juniper.
Pinus edulis	Pinyon pine.
P. flexilis	Limber pine.
P. ponderosa	Ponderosa pine.
Populus spp	Cottonwood.
P. tremuloides	Quaking aspen.
Pseudotsuga menziesii	Douglas-fir.
Quercus emoryi	Emory oak.
Q. gambelii	Gambel oak.

SHRUBS

Scientific name	*Common name*
Amelanchier spp	Serviceberry.
Artemisia frigida	Fringed sagebrush.
A. tridentata	Big sagebrush.
Atriplex canescens	Fourwing saltbush; chamiso.
Berberis repens	Creeping mahonia.
Cercocarpus montanus	True mountain-mahogany.
Cowania mexicana	Cliffrose.
Chrysothamnus spp	Rabbitbrush.
Eurotia lanata	Winterfat.
Gutierrezia sarothrae	Broom snakeweed.
Purshia tridentata	Bitterbrush; antelope-brush.
Quercus turbinella	Shrub live oak.
Rhus trilobata	Skunkbush; squawbush; sumac.
Rosa spp	Wild rose.
Symphoricarpos spp	Snowberry.
Tetradymia spp	Horsebrush.
Yucca spp	Yucca; Spanish bayonet; Soapweed.

FORBS AND GRASSLIKE PLANTS

Scientific name	*Common name*
Achillea lanulosa	Western yarrow.
Allium spp	Wild onion.
Antennaria spp	Pussytoes.
Artemisia biennis	Herbaceous sagebrush.
Aster spp	Aster.
Astragalus spp	Locoweed.
Brassica spp	Mustard.
Carex spp	Sedge.
Cirsium spp	Thistle.
Convolvulus spp	Field bindweed.
Equisetum spp	Horsetail; scouringbrush.
Erigeron spp	Wild daisy; fleabane.
Eriogonum spp	Wild buckwheat.
Helianthus annuus	Common sunflower.
Hymenoxys richardsoni	Pingue.
Iris missouriensis	Iris; flag.
Melilotus alba	White sweetclover.
M. officinalis	Yellow sweetclover.
Penstemon spp	Beardtongue.
Phlox spp	Phlox.
Plantago spp	Plantain; Indianwheat.
Salsola kali (pestifer)	Russian-thistle; tumbleweed.
Senecio spp	Groundsel.
Taraxacum spp	Dandelion.
Verbascum thapsus	Mullein.
Xanthium spp	Cocklebur.

GRASSES

Scientific name	*Common name*
Agropyron spp	Wheatgrass.
Andropogon hallii	Sand bluestem; turkeyfoot.
A. scoparius	Little bluestem.
Aristida fendleriana	Fendler three-awn.
A. longiseta	Red three-awn.
Bouteloua curtipendula	Sideoats grama.
B. eriopoda	Black grama.
B. gracilis	Blue grama.
Blepharoneuron tricholepis	Pine dropseed.
Bromus anomalus	Nodding brome.
B. tectorum	Cheatgrass brome; downy chess.
Calamovilfa gigantea	Big sandreed.
Danthonia intermedia	Timber oatgrass.
Deschampsia caespitosa	Tufted hairgrass.
Elymus glaucus	Blue wildrye.
Festuca arizonica	Arizona fescue.
Hordeum jubatum	Foxtail barley.
Koeleria cristata	Prairie junegrass; mountain junegrass.
Lycurus phleoides	Wolftail; Texas timothy.
Muhlenbergia arizonica	Arizona muhly.
M. montana	Mountain muhly.
M. torreyi	Ring muhly.
Poa spp	Bluegrass.
P. fendleriana	Mutton bluegrass; muttongrass.
Sitanion hystrix	Bottlebrush squirreltail.
Sporobolus airoides	Alkali sacaton.
S. cryptandrus	Sand dropseed.
Stipa comata	Needle-and-thread.
S. robusta	Sleepygrass.
S. scribneri	Scribner needlegrass.

Originally, the vegetation of the Area consisted mainly of a thick forest of ponderosa pine, which was surrounded by a belt of pinyon pine and juniper woodland and open grassland. Clearing, logging, grazing, and burning have changed the original vegetation, but ponderosa pine forest still covers about 75 percent of the acreage. Four types of vegetative cover are recognized: Ponderosa pine, pinyon-juniper, grass, and mixed conifer.

Ponderosa pine.—The ponderosa pine forest is in the highest parts of the Area. The overstory is 90 percent ponderosa pine. The remaining 10 percent consists of Douglas-fir, white fir, and limber pine, all of which occur on north-facing slopes and in favorable spots in the deeper canyons. Except in a few small isolated spots, the pine is second growth (fig. 6).

Figure 6.—**Young second-growth ponderosa pine on Zuni-Mirabal stony loams.**

Pine forests in the southwestern part of the United States generally include large open areas of grass, called parks. A lack of a significant acreage of parkland is a striking feature of the pine forest in the Zuni Mountain Area. There are large areas of grass, but most are clearings, not natural openings.

The understory in the pine forest is composed of grasses, forbs, and shrubs. The principal grasses are Arizona fescue, mountain muhly, junegrass, blue grama, and squirreltail. Arizona fescue, mountain muhly, junegrass, and muttongrass are the most desirable grasses, ecologically, in this type of forest. Lupines, asters, daisies, yarrow, and iris are the common forbs. Oak brush, cliffrose, Apache-plume, mountain-mahogany, and rabbitbrush are the principal shrubs and browse plants. Oak brush is the most plentiful of these. It grows up along with the young pine in areas that have been heavily cutover.

Pinyon-juniper.—Pinyon-juniper woodland (fig. 7) occurs along the lower border of the Area, but in places it extends up into the ponderosa pine zone. At its upper edge, it includes scattered pines and a little oak brush. Juniper predominates in the overstory. In places the stand of pinyon pine and juniper trees is so thick that little else grows. Many south-facing slopes are severely eroded. North-facing slopes are covered with a thin layer of litter.

Figure 7.—**Stand of pinyon pine and juniper on Thurloni soils. Prewitt soils in foreground.**

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Blue grama, ring muhly, sand dropseed, and three-awn are the main grasses. A desirable forage cover would consist of sideoats grama, wolftail, little bluestem, and blue grama. Snakeweed, rabbitbrush, cliffrose, and fourwing saltbush are the principal shrubs. Cliffrose and saltbush are the most desirable of these.

Grass.—The grassland is chiefly along the southwestern and southern border of the Area. Stipa, sand dropseed, sacaton, and blue grama are the principal grasses. Horsebrush, rabbitbrush, snakeweed, Russian-thistle, and annual weeds are common. A desirable cover would consist of sideoats grama, plains lovegrass, black grama, and tall species of three-awn.

Mixed conifer.—This type of forest is of limited extent. It occurs chiefly at the higher elevations near Mt. Sedgwick and Ojo Redondo. Douglas-fir, white fir, and limber pine are dominant on the north-facing slopes, in the narrow valleys, and on canyon floors. In many places on the canyon floors, aspen is mixed with the conifers. Small mountain meadows are scattered in the forest. Mountain muhly and Arizona fescue are the principal grasses. Kentucky bluegrass and much Rocky Mountain iris grow in the small meadows.

Wildlife

The combination of pine forest, pinyon-juniper woodland, and grassland in the Zuni Mountain Area provides favorable environments for a variety of wildlife. The principal game animals in the area are mule deer (*Odocoileus hemionus*), elk (*Cervus canadensis nelsoni*), bear (*Euarctos americanus*), squirrel (*Sciurus* spp), and cottontail rabbit (*Sylvilagus* spp). Game birds are wild turkey (*Meleagris gallopavo*) and mourning dove (*Zenaidura macroura*). Rainbow trout (*Salmo gairdneri*) inhabit the streams.

Mule deer (fig. 8) are the most common big game animals and constitute the most important wildlife resource. Wild turkeys are increasing in numbers and provide some hunting. Bear are hunted, but only a few are taken each season. Elk, a reintroduced species, are so few in number that hunting is not permitted. Gophers and other rodents and porcupines have established habitats

Figure 8.—**Rocky Mountain mule deer.**

Figure 9.—**McGaffey Lake is a prime fishing spot in a scenic area of natural beauty.**

throughout the Area. Predators include mountain lions, bobcats, and coyotes.

Bluewater Creek is the only stream in the Area that has any potential for development as a stream fishery. Fishing is generally limited to an artificial lake (fig. 9) near McGaffey. The New Mexico Game and Fish Department manages this lake for trout fishing, under a "special use" permit from the Forest Service. Bluewater Lake, outside the boundary of the survey Area, is the principal trout-fishing spot in this part of New Mexico. Most of the runoff feeding the lake comes from the watershed within the national forest.

People and Their Use of the Land

Before the 17th century the region around the Zuni Moutains was inhabited by Pueblo Indians. Villages of the Zuni Indians still exist just southwest of the mountains. After Coronado's exploration and conquest, the bottom lands just outside the Area were settled by Spaniards in the early 1600's. Just south of the boundary of the national forest is El Morro National Monument, with its "Inscription Rock," a sheer sandstone cliff on which the early explorers and settlers carved inscriptions. The oldest is that of Don Juan de Onate, New Mexico's first Spanish governor. It is dated April 1605.

Settlers entered the Area soon after subjugation of the Navajos by Kit Carson in the 1800's. Fort Wingate was established in the 1870's.

Exploitation of the forest resources began on a small scale with the clearing of the land. The coming of the railroad created a ready market for timber products, and the scale of logging operations increased rapidly.

Between 1890 and 1940 three large companies harvested timber. Many railroad ties and mine props were cut. One of the companies operated a large mill at McGaffey. The other two shipped uncut logs to a sawmill in Albuquerque. The virgin forests were heavily logged, and little, if any, care was taken during this period to retain a residual stand for reforestation.

The lands within the survey Area have been used to graze domestic livestock for at least 300 years. In the 50 years between 1890 and 1940, landowners brought in large herds of livestock, and the grasslands were severely overgrazed.

A farm community existed for a number of years near McGaffey, but only four or five families still live on farms. With the exception of one township and several scattered parcels, practically all of the odd-numbered sections of land were granted to a railroad company and later acquired by lumber companies. Some of the even-numbered sections were designated by the State as institutional lands. In 1909, an area comprising a little more than two townships was withdrawn from the public domain and placed under the administration of the Forest Service. In 1924, the boundaries of the national forest were set and have remained virtually unchanged since that time. Ownership of the land did not change, however, and for a long time the Federal Government owned only between 5 and 10 percent of the total acreage. By 1944, as a result of acquisition and exchange, most of the acreage was under Forest Service administration. At the present time 67 percent of the survey Area is owned by the Federal Government.

Lumbering operations are now limited and are carried on chiefly by small mills. The grasslands are now in a condition to provide spring and summer grazing for sizable numbers of cattle and sheep. The Area is also an important source of water for the irrigation developments in the surrounding country. Most of the water stored in Bluewater, Ramah, and Nutria Lakes comes from watersheds within the boundaries of the Cibola National Forest.

The Forest Service maintains three camp and picnic grounds, with tables, fireplaces, and sanitary facilities. The main sites are the McGaffey and Quaking Aspen areas, which are in the western part of the mountains. A smaller site is in Ojo Redondo, near Mt. Sedgwick. Increasing numbers of people come to the Area for camping, picnicking, hunting, fishing, and hiking.

Part II: The Soils

The soils of the Zuni Mountain Area vary in color, texture, fertility, reaction, and stone content. The parent rock from which the soils developed includes sandstone, limestone, granite, gneiss, schist, shale, and basalt and other volcanic rock.

Soil colors range from gray through brown to red. Grayish browns, browns, and reddish browns predominate in the surface soil, and reddish browns and dark browns predominate in the subsoil. The texture and consistence of the soils range from soft loamy sand to heavy firm clay. Generally, the surface layer is sandy loam or loam, but in some soils the surface layer is clay loam or silt loam. The subsurface layers range from loamy sand to clay.

Some of the soils are fertile and productive; others are not. The reaction ranges from medium acid to moderately alkaline. Some of the soils are calcareous to the surface; others are noncalcareous throughout. In some soils a definite zone of lime accumulation is present.

Many of the soils are stony and shallow; some are so stony and rocky that travel on foot or horseback is difficult. Rock outcrops and exposures of bedrock are common, but several of the soils contain only a few stones.

The soils differ in degree of development. Some have distinct horizons discernible by color, structure, and evidence of leaching and translocation of clay. Others have only weakly expressed horizons.

granular structure. They have a brown or reddish-brown subsoil that is granular and has a high content of limestone gravel. The substratum is light reddish brown, slightly hard, and very gravelly. It has weak, granular structure.

Soils of the Andrews series border the granite uplifts of the central and eastern parts of the mountains. They are associated with Wilcoxson and Zuni soils.

TABLE 2.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent	Soil	Acres	Percent
Andrews gravelly loam, 5 to 20 percent slopes	1, 330	0. 3	Osoridge rocky complex, 5 to 20 percent slopes	44, 090	10. 6
Badland	8, 970	2. 2	Osoridge rocky complex, 20 to 40 percent slopes	7, 930	1. 9
Bandera gravelly loam, 5 to 15 percent slopes	5, 440	1. 3	Polich loam	5, 160	1. 2
Bandera gravelly loam, 15 to 35 percent slopes	960	. 2	Prewitt clay loam	7, 080	1. 7
Bond sandy loam, 5 to 15 percent slopes	3, 120	. 8	Rock land	42, 730	10. 3
Cabezon rocky complex, 2 to 10 percent slopes	6, 440	1. 5	Rock outcrop, gently sloping	920	. 2
Clayey alluvial land	580	. 1	Rock outcrop, cliffs	5, 600	1. 3
Concho clay loam, 1 to 3 percent slopes	2, 790	. 7	Sanchez stony complex, 10 to 20 percent slopes	16, 700	4. 0
Concho clay loam, 3 to 10 percent slopes	2, 630	. 6	Savoia fine sandy loam, 2 to 5 percent slopes	9, 770	2. 4
Fortwingate loam, 2 to 8 percent slopes	14, 420	3. 5	Savoia fine sandy loam, 5 to 20 percent slopes	2, 740	. 7
Friana silt loam	800	. 2	Showlow clay loam, 5 to 15 percent slopes	1, 790	. 4
Gem stony loam, 2 to 7 percent slopes	2, 910	. 7	Showlow loam, 0 to 5 percent slopes	580	. 1
Jekley silt loam, 3 to 7 percent slopes	26, 220	6. 3	Supervisor stony loam, 20 to 45 percent slopes	6, 520	1. 6
Jekley stony loam, 10 to 30 percent slopes	20, 610	5. 0	Tabiona fine sandy loam, 10 to 15 percent slopes	250	. 1
Jekley rocky complex, 30 to 40 percent slopes	5, 320	1. 3	Tampico loam	6, 300	1. 6
Kettner loam, 3 to 10 percent slopes	1, 580	. 4	Tampico loam, dark variant	170	(1)
Kettner stony loam, 10 to 20 percent slopes	1, 580	. 4	Thurloni clay, 5 to 20 percent slopes	7, 770	1. 9
Kiln rocky complex, 3 to 20 percent slopes	35, 400	8. 5	Thurloni clay, black variant, 3 to 10 percent slopes	290	. 1
Kiln rocky complex, 20 to 40 percent slopes	3, 040	. 7	Trail loamy fine sand	3, 360	. 8
Laporte stony loam, 3 to 10 percent slopes	9, 520	2. 3	Trail loamy fine sand, hummocky	1, 030	. 2
Laporte stony loam, 20 to 40 percent slopes	1, 250	. 3	Turkeysprings clay loam, 2 to 10 percent slopes	3, 580	. 9
Larry silty clay loam	340	. 1	Valentine loamy fine sand, 5 to 15 percent slopes	960	. 2
Lava flows	3, 370	. 8	Wilcoxson loam, 3 to 5 percent slopes	2, 070	. 5
Lava rock land	1, 370	. 3	Wilcoxson clay loam, 3 to 15 percent slopes	2, 540	. 6
McGaffey loam	12, 780	3. 1	Zuni sandy loam, 2 to 10 percent slopes	13, 590	3. 3
Mirabal stony loam, 5 to 15 percent slopes	4, 980	1. 2	Zuni-Mirabal stony loams, 10 to 30 percent slopes	23, 560	5. 7
Mirabal stony loam, 15 to 45 percent slopes	10, 510	2. 5			
Mirabal stony loam, low rainfall, 5 to 20 percent slopes	6, 770	1. 6			
Montoya clay	830	. 2			
Nathrop loam, 0 to 5 percent slopes	610	. 1			
Ordnance loam	2, 080	. 5	Total	415, 630	100. 0

[1] Less than 0.05 percent.

Descriptions of the Soils

In this section each series and mapping unit is described in detail. The present use of each soil and its suitability for different uses are briefly discussed. Table 2 shows the approximate acreage and proportionate extent of the soils. Figures 10, 11, 12, and 13 show the position of the soils on the landscape.

Andrews series

Shallow, dark-colored, highly calcareous, well-drained soils of the uplands make up the Andrews series. These soils formed in material weathered from limestone of the Madera formation. They are at elevations of 8,000 feet, where the annual precipitation is 18 to 20 inches. Fragments of limestone are common on the surface, and there are some outcrops. The vegetation consists of native grasses, such as Arizona fescue and blue grama, a little ponderosa pine, pinyon pine, and juniper, and some bitterbrush, Oregon grape, and mullein.

Andrews soils have a dark reddish-brown surface layer that is soft when dry and friable when moist and has

Andrews gravelly loam, 5 to 20 percent slopes (Ag).—This soil is on the side slopes and tops of round-topped hills. Angular, gravel-sized fragments of limestone cover 50 to 70 percent of the surface. Included in the areas mapped are scattered breaks that have a slope of more than 20 percent.

The surface layer is brown to dark reddish-brown, calcareous gravelly loam about 7 inches thick. Beneath this is dark-colored, calcareous, friable clay loam that contains large amounts of limestone gravel, cobblestones, and stones. The depth to bedrock generally does not exceed 14 to 18 inches. In places there are outcrops of limestone.

Infiltration and permeability are moderate. The capacity to store water underground is low, and there is little chance of sustained yield. Runoff is medium after heavy rainfall or rapid snowmelt, and the erosion hazard is moderate. Fertility is medium.

This soil is used for grazing in summer and early in fall. It is moderately well suited to herbage and has a good cover of blue grama. It is poorly suited to timber,

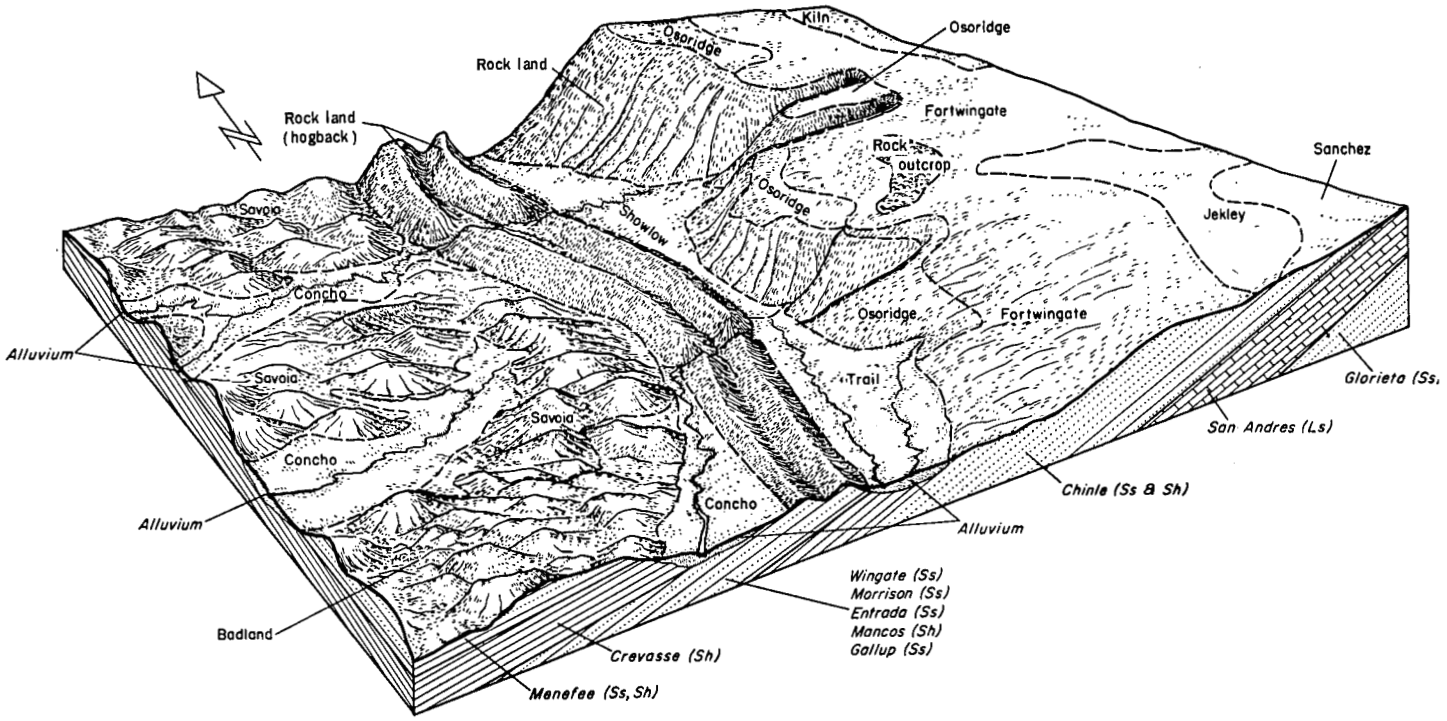

Figure 10.—**Typical section of soils in the northwestern part of the Zuni Mountains.**

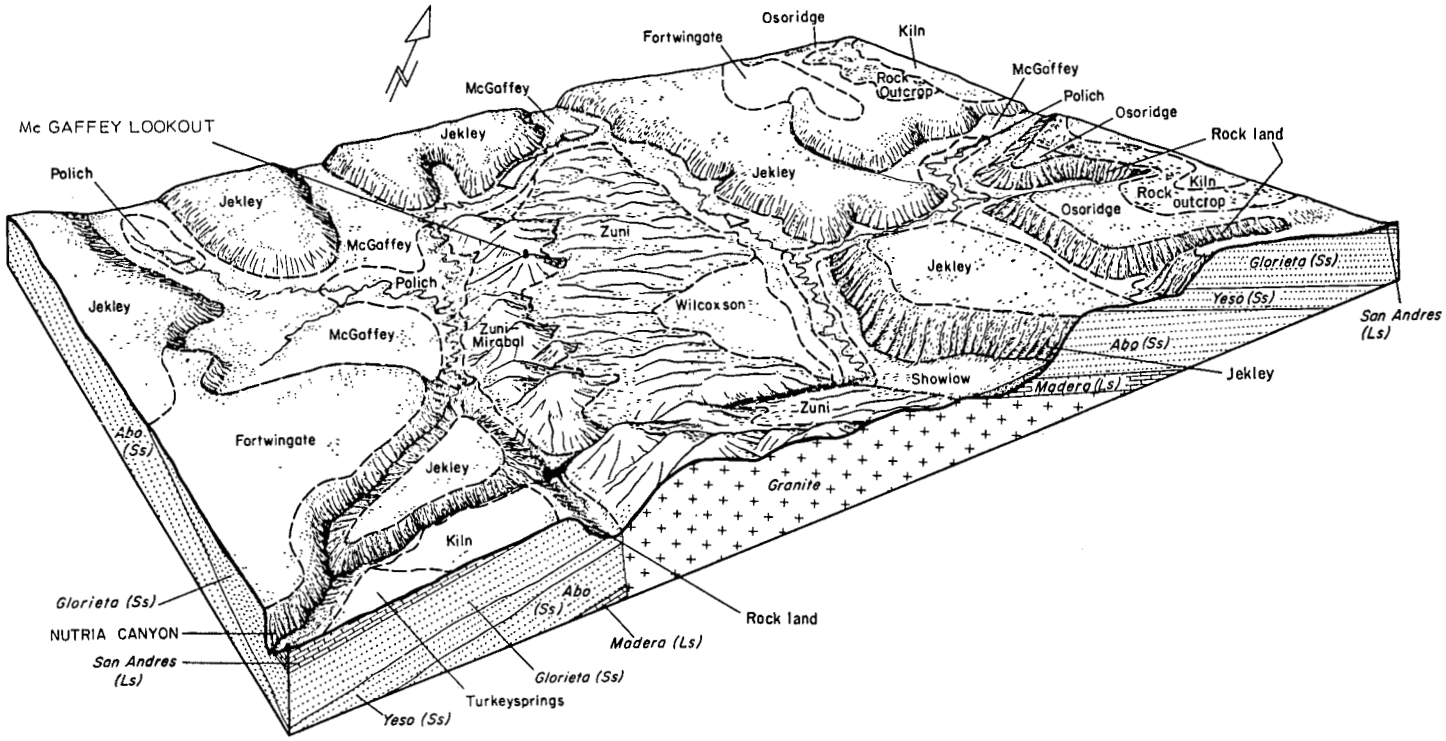

Figure 11.—**Typical section of soils in the northern part of the Zuni Mountains, near McGaffey.**

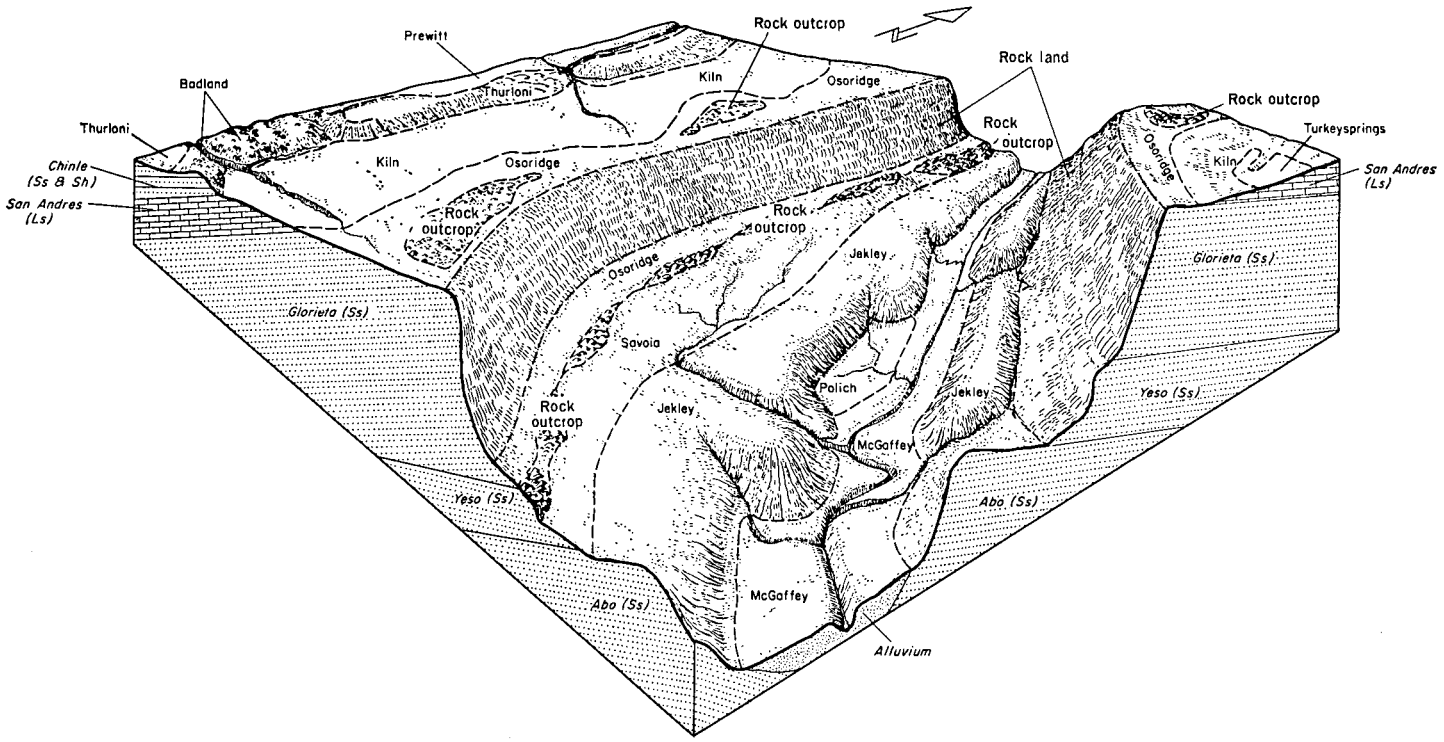

Figure 12.—Typical section of soils in the central part of the Zuni Mountains, west of Lookout Mountain.

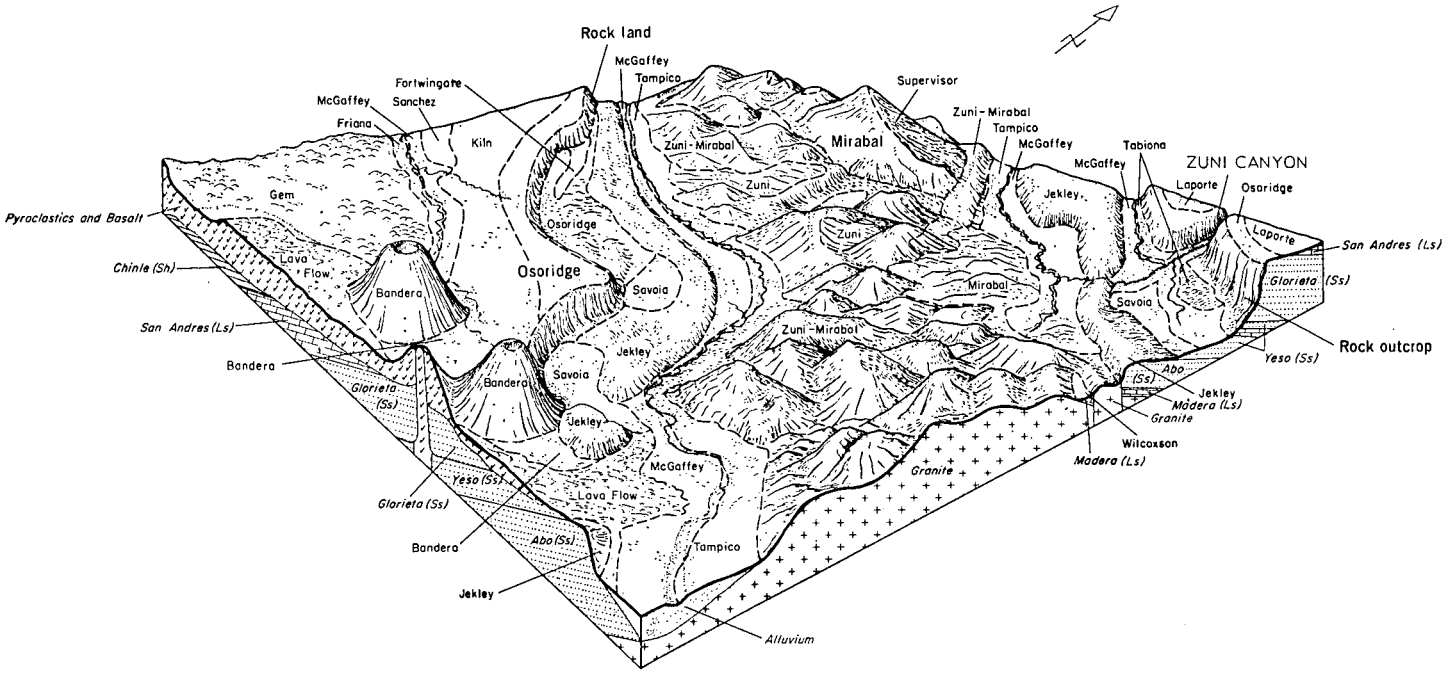

Figure 13.—Typical section of soils in the southern part of the Zuni Mountains, between Zuni Canyon and the Ice Cave area.

and the ponderosa pine trees are scrubby and of low quality. It provides a desirable habitat for deer because of the presence of bitterbrush, a browse plant. The best uses for this soil are the production of herbage and of food and cover for wildlife. (Management group 7)

Badland

Badland (Ba) makes up about 2 percent of the Area. It is rough and steep, the slopes ranging from 20 percent to more than 50 percent. There are many outcrops of Chinle and Mesaverde shale and sandstone. Some areas of Badland consist wholly of exposed and weathered Chinle shale. The colors of the exposed rock are brilliant, ranging from red to blue to tan to purple to black. These areas have scenic appeal.

Intermixed with the rock outcrops are shallow pockets and remnants of unstable silty clay and clay, some highly calcareous and some weakly calcareous. The vegetation consists predominantly of pinyon and juniper, but in places there are stunted and poorly formed ponderosa pine trees. Between the trees there is a sparse ground cover of blue grama and annual weeds, but much of the surface is bare. Vegetation is scanty or entirely lacking on the eroded areas of Chinle shale.

Runoff is rapid, and in many places erosion is severe. If erosion continues, the pockets and remnants of soil will disappear, and restablishment of natural vegetation will be most difficult. Management should be planned to minimize disturbance of the vegetative cover. It would be desirable to exclude grazing animals and to leave this land type completely unused for a number of years. (Management group 6)

Bandera series

Dark-colored, well-drained, moderately sloping or rolling and steep soils of the uplands make up the Bandera series. These soils formed from fine, dark-colored cinders that were ejected from cinder cones and volcanic vents. They are at elevations of 7,800 to 8,000 feet, where the annual precipitation is 16 to 18 inches. The vegetation consists of ponderosa pine, an understory of Gambel oak and juniper, and a ground cover of mountain muhly, blue grama, squirreltail, and mullein.

Bandera soils have a dark-colored surface layer that is soft when dry and friable when moist and has weak, granular structure. They have a yellowish-brown subsoil that is soft or friable and has granular structure. The substratum is made up of dark-gray or black, irregularly shaped cinders about a quarter of an inch in diameter.

Soils of the Bandera series occur in the southeastern part of this survey Area. They are associated with Gem and Friana soils.

Bandera gravelly loam, 5 to 15 percent slopes (Bd).—This soil is on rolling uplands and toe slopes adjacent to the cinder cones near the Ice Caves.

The surface layer is brown to grayish-brown, noncalcareous gravelly loam about 9 inches thick. Beneath this is a yellowish-brown, noncalcareous gravelly loam, about 7 inches thick, which abruptly overlies dark-gray or black, hard, porous cinders (fig. 14). Nearly all of the cinders are lime coated on the underside. The gravel in the soil consists of cinders and pieces of cinders. In most places the surface is covered with a quarter-inch layer of pine-needle litter in various stages of decay. The depth to cinders ordinarily is 16 to 18 inches.

Infiltration and permeability are rapid. The capacity to store water is limited because most of the water that infiltrates is lost in the cinders. Runoff is slow, and the erosion hazard is low. The organic-matter content is low.

This soil is poorly suited to timber and is used primarily for summer and early fall grazing (fig. 15). Gambel oak provides some forage for deer. (Management group 7)

Bandera gravelly loam, 15 to 35 percent slopes (Bg).—This soil is shallower than Bandera gravelly loam, 5 to 15 percent slopes. It occurs on the side slopes of cinder cones. Near the top of the cones, the soil is very shallow

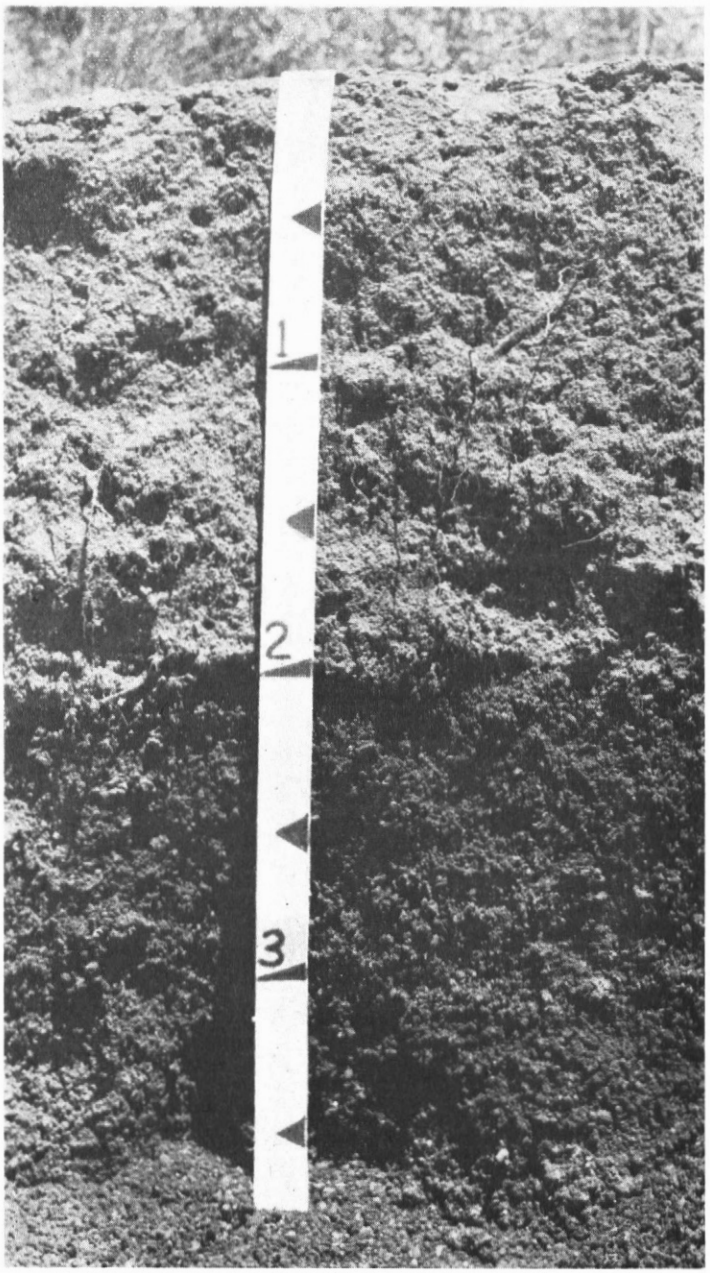

Figure 14.—**Profile of Bandera gravelly loam, 5 to 15 percent slopes. A layer of unweathered cinders lies at a depth of about 2 feet.**

Figure 15.—An area of Bandera gravelly loam, 5 to 15 percent slopes. This soil is used mainly for grazing.

and clinkers and cinders are exposed. The erosion hazard is high on account of the slope.

This soil is poorly suited to timber, and its usefulness for grazing is limited because of the slope. The erosion hazard is a serious limitation. (Management group 8)

Bond series

Shallow, well-drained, noncalcareous soils on gently undulating ridgetops and long dip slopes make up the Bond series. These soils formed in material weathered from the red, coarse-textured Gallup sandstone of the Mesaverde formation. They are at elevations of 7,000 to 7,500 feet, where the annual precipitation is 15 to 17 inches. The vegetation consists of a mixed cover of ponderosa pine, pinyon pine, juniper, Gambel oak, and such shrubby plants as mountain-mahogany, bitterbrush, rabbitbrush, and Oregon grape. The grass cover is blue grama. In places about 20 to 30 percent of the surface is barren.

Bond soils have a reddish-brown, single-grain surface layer that is soft when dry and friable when moist. They have a yellowish-red or reddish-yellow, hard, blocky subsoil that rests on hard, slightly weathered sandstone.

Soils of the Bond series occur mainly on the western flank of the mountains west of the Nutria Hogback. They are associated with Concho and Savoia soils and with Rock land and Badland.

Bond sandy loam, 5 to 15 percent slopes (Bo).—As mapped, this soil includes sandstone outcrops that make up 5 to 10 percent of the area and small, thin stringers of very sandy alluvium that make up about 5 percent. In some localities there are short breaks that have a slope of as much as 20 percent.

The surface layer is reddish-brown, noncalcareous sandy loam about 6 to 8 inches thick. Beneath this is yellowish-red clay, 8 inches thick, which overlies pebbly, noncalcareous, sandy and clayey material. This layer is underlain by massive sandstone bedrock. The depth to bedrock is commonly 18 to 20 inches, but it ranges from 12 to 20 inches. Fragments of sandstone make up 5 to 30 percent of the profile. The stonier areas are near the outcrops of sandstone.

Infiltration is rapid, but permeability is moderately slow because the subsoil is clayey. The surface layer becomes saturated during prolonged, heavy rainfall. The capacity to store water is low, and there is little chance of sustained yield. Runoff is medium, and the erosion hazard is high. Loss of soil is evident, even under the trees. Without the surface stones and rock outcrops, more soil would be lost.

This soil produces low-grade timber. It is poorly suited to ponderosa pine because of inadequate rainfall, shallowness, and the predominantly western exposure. It is used for summer grazing but is only moderately well suited to herbage. Desirable browse makes this soil a good winter habitat for deer. (Management group 7)

Cabezon series

Shallow, dark-colored, undulating soils of the uplands make up the Cabezon series. These soils formed in material weathered from basalt. They are at elevations of 7,500 to 8,000 feet, where the annual precipitation is 15 to 18 inches. Surface stones and outcrops of basalt are common. The vegetation consists of blue grama, forbs, and some ponderosa pine, pinyon pine, and juniper. In many places these soils are barren because of the basalt outcrops and the many stones on the surface.

Cabezon soils have a dark grayish-brown surface layer that is slightly hard when dry but friable when moist and has platy or granular structure. They have a stony, brown or reddish-brown subsoil that is hard or firm and has blocky structure.

Soils of the Cabezon series occur in the southeastern part of the Area. They are associated with Bandera and Gem soils.

Cabezon rocky complex, 2 to 10 percent slopes (Ca).—This complex consists of shallow stony loam and clay loam and outcrops of basalt. It is on uplands in the ponderosa pine forest. It has gentle or undulating slopes. Stones and rock outcrops make up 30 to 60 percent of the acreage. Small areas of Gem stony loam, 2 to 7 percent slopes, are mapped with this complex. Minor areas of alluvial soil material in narrow strips or in small depressions are also included.

Cabezon stony loam is the principal soil in this complex. Its surface layer is dark grayish-brown, friable stony loam. It is about 4 inches thick and has platy to granular structure. In places this layer is stony clay loam, but stony loam is predominant. Beneath this is brown or reddish-brown, firm stony clay loam or stony clay, 9 to 11 inches thick, that has blocky structure. This layer overlies basalt bedrock. In places where the underlying basalt is fissured, clayey material from the subsoil has filled the cracks.

Infiltration is moderate, and permeability is moderately slow to slow. The stones and outcrops restrict the capacity of the soil to store water. Runoff is slow, and the erosion hazard is low. Roots are plentiful in the upper part of the profile and follow along structure breaks into the lower part of the profile.

This soil is poorly suited to ponderosa pine but is moderately well suited to range herbage. The rock outcrops and the coarse fragments interfere with the use of machinery for reseeding. (Management group 7)

Clayey alluvial land

Clayey alluvial land (0 to 2 percent slopes) (Cb) is composed of stratified alluvium. It occupies basins and low

terraces at the northern end of Ramah Reservoir. The area was formerly a lacustrine plain.

This land type is moderately deep or deep and is calcareous to the surface. The color of the surface layer is grayish brown, brown, or reddish brown. The subsoil is brown or reddish brown. In most places the texture is clayey, but sandy sediments are prominent in some places. In the basins the water table is commonly at a depth of 40 inches, and on the terraces it is at a depth of 50 inches. The depth to water is related to the distance from the lake. In all places these deposits are moderately alkaline; in many places they show evidence of salt accumulation.

This land type is used mostly for oats and grass. In years when precipitation is adequate, it is very productive. It is not suited to ponderosa pine or other trees. Most of the acreage is privately owned. (Management group 3)

Concho series

Deep, dark-colored, well-drained, permeable soils on valley floors and alluvial fans make up the Concho series. These soils formed from mixed alluvium washed from the Mesaverde formation. They are at elevations of 6,500 to 7,000 feet, where the annual precipitation is 12 to 15 inches. The vegetation consists of a few ponderosa pines, many annual weeds, sunflowers, Russian-thistle, sleepygrass, blue grama, and introduced wheatgrass. Many areas are nearly barren.

Concho soils have a brown or dark-brown surface layer that is soft when dry and friable when moist and has platy to granular structure. They have a brown subsoil that is slightly hard or hard when dry and friable or firm when moist. The subsoil has blocky structure. Typically, it is calcareous or strongly calcareous. The substratum is brown. It is hard when dry and firm when moist. It has weak structure or is massive.

Seams of visible lime in the lower horizons are characteristic of these soils. The content of soluble salts varies; some areas contain an injurious amount of salts, but other areas do not. In many places these soils receive deposits of reddish outwash. Buried soils are common, and more than one may occur within a distance of 20 feet. Deep gullies with vertical walls are common.

Soils of the Concho series occur in the western part of the Area. They are associated with Savoia and Bond soils and with Badland.

Concho clay loam, 1 to 3 percent slopes (Cc).—This soil occupies broad flood plains and flats in the area between the Nutria Hogback and the western boundary of the Cibola National Forest. It has no rock outcrops, no surface stones, and no stones within the profile. The slopes are gentle and smooth. Nearly level areas are common. Small areas of Concho clay loam, 3 to 10 percent slopes, are included in the areas mapped, as well as small areas that have a surface layer of loam. These inclusions are generally along the boundaries of the areas.

A layer of sandy overwash, 1 to 2 inches thick, covers the surface layer, which consists of dark-brown clay loam and is 4 to 8 inches thick. Beneath the surface layer is a dark-brown, noncalcareous, clayey layer about 7 to 11 inches thick, which overlies a calcareous layer 15 to 17 inches thick. This, in turn, overlies calcareous, sandy material, which is underlain by a buried soil. The buried soil is dark colored and moderately fine textured and has distinct and well-developed horizons. The soils are stratified, and the depth to the buried soil is variable. The texture of the surface layer of the buried soil ranges from sandy loam to loam, and the texture of its subsoil ranges from clay loam to clay.

Infiltration and permeability are moderate. The capacity to store water is high, but much of the subsurface moisture drains into deep gullies. Runoff is slow, and the erosion hazard is moderate. Fertility is high. Roots penetrate deeply.

This soil is well suited to herbage and, under more intensive management, could be more productive. It is used primarily for summer range. Ponderosa pine does not grow well, and it is doubtful that this soil ever supported much pine. Lack of suitable browse limits the usefulness of this soil as a habitat for big game. (Management group 3)

Concho clay loam, 3 to 10 percent slopes (Co).—The depth to a calcareous layer is greater in this soil than in Concho clay loam, 1 to 3 percent slopes, the color of both the surface layer and the subsoil is redder, and buried soils are less common. Because of the stronger slopes, this soil has more rapid surface runoff than Concho clay loam, 1 to 3 percent slopes, and consequently is more likely to erode.

This soil is well suited to herbage and responds well to reseeding. It is used mostly for summer range. It is better suited to ponderosa pine than is Concho clay loam, 1 to 3 percent slopes. (Management group 3)

Fortwingate series

Moderately deep to deep, well-drained, moderately permeable soils of the uplands make up the Fortwingate series. These soils formed in material weathered from Glorieta sandstone. They are at elevations of 7,800 to 8,000 feet, where the annual precipitation is about 18 to 20 inches. The vegetation consists of ponderosa pine, scattered patches of Gambel oak, and an understory of Arizona fescue, mountain muhly, squirreltail, pine dropseed, and Oregon grape.

Fortwingate soils have a brown or grayish-brown surface layer that is soft to slightly hard when dry but friable when moist and has platy to granular structure. The subsoil and the substratum are reddish brown, extremely hard, firm, and blocky. Generally, these soils have a 1-inch organic layer composed of pine needles, oak leaves, and grass stems. These soils are generally noncalcareous, but the lower part of the substratum is weakly calcareous in some places.

Soils of the Fortwingate series occur on long, gently sloping and undulating dip slopes. They are associated with Osoridge and Kiln soils.

Fortwingate loam, 2 to 8 percent slopes (Fo).—In most areas of this soil (fig. 16), the slope gradient is between 3 and 5 percent. Small areas of Osoridge rocky complex, 5 to 20 percent slopes, and Kiln rocky complex, 3 to 20 percent slopes, are included in the areas mapped.

The surface layer is brown or grayish-brown, friable, noncalcareous loam or very fine sandy loam about 12 inches thick. Beneath this is reddish-brown, friable, noncalcareous, blocky sandy clay or clay, 24 to 30 inches thick, which overlies sandy soil material or sandstone bedrock. When dry, the surface layer is slightly hard in places, and the subsoil is extremely hard. The subsoil is well developed, and the color change from brown or grayish brown

Figure 16.—Stand of ponderosa pine on Fortwingate loam, 2 to 8 percent slopes.

in the surface layer to reddish brown in the subsoil is distinct and abrupt. In most places the surface is covered by a 1- to 2-inch layer of litter. The depth to bedrock ranges from 32 to more than 48 inches. This range in depth is attributed to dipping and undulation of the underlying sandstone.

Infiltration is rapid, but permeability is impeded by the subsoil and is moderate or moderately slow. The capacity for water storage and sustained yield is high. Runoff is moderately slow, and the erosion hazard is moderate. Root penetration is moderately deep or deep. Fertility is high.

This soil is well suited to timber and herbage. It has good stands of young pine. Even though most of the area has been extensively logged, the stands restock through natural regeneration. Overgrazing has depleted much of the grass cover. Desirable browse, avenues of escape, and concealment areas make this soil an excellent habitat for deer. (Management group 5)

Friana series

Deep, dark-colored, well-drained soils make up the Friana series. These soils formed in alluvium washed from basalt. They are at an elevation of 7,600 feet, where the annual precipitation is 15 inches. The vegetation consists mainly of blue grama, but there is some rabbitbrush, Russian-thistle, and snakeweed, and a little juniper and pinyon pine.

Friana soils have a dark grayish-brown surface layer that is soft when dry and very friable when moist and has platy structure. They have a reddish-brown subsoil that is hard and firm and has blocky structure. The substratum is reddish brown or yellowish red. It is slightly hard or hard when dry and friable when moist and has weak, blocky structure.

Soils of the Friana series occupy flat valley floors and gently sloping old alluvial fans in the southeastern part of the survey Area. They are associated with Gem and Bandera soils.

Friana silt loam (1 to 3 percent slopes) (Fr).—This soil occurs in the vicinity of the Ice Caves. The slope is 0 to 1 percent on the valley floors and 2 to 3 percent on alluvial fans.

The surface layer is dark grayish-brown, noncalcareous, friable silt loam and is about 6 inches thick. It has platy to granular structure. Beneath this layer is reddish-brown, friable to firm, noncalcareous, blocky silty clay or clay about 38 inches thick. Under this layer is variegated, yellowish-red and reddish-brown, noncalcareous, very friable, blocky sandy clay loam. The subsoil ranges from heavy clay loam to clay in texture and from dark brown to reddish brown in color. Locally, the lower part of the profile may be weakly calcareous.

Infiltration and permeability are moderate. The capacity to store water is high, but the capacity for sustained yield is low. Runoff is slow to medium, and the erosion hazard is low to moderate. Roots penetrate deeply. Fertility is high.

This soil is used for late spring, summer, and early fall grazing. It is well suited to range. Small areas have been cropped to small grain, but yields vary because rainfall is erratic. Ponderosa pine does not grow well on this soil, mainly because the climate is too dry. Lack of concealment limits suitability for wildlife. (Management group 3)

Gem series

Dark-colored, moderately deep soils on smooth to undulating uplands make up this series. These soils formed in material weathered from basalt. They are at elevations of 7,500 to 8,000 feet, where the annual precipitation is about 16 to 18 inches. The vegetation consists of ponderosa pine, pinyon pine, juniper, rabbitbrush, mullein, and blue grama. Basalt stones are common on the surface, and there are many outcrops of basalt. Because of these stones and outcrops, many areas are barren.

The surface layer is brown and has platy or granular structure. It is soft to slightly hard when dry but friable when moist. The subsoil is reddish brown or brown and has blocky structure. It is hard when dry and firm when moist. The substratum is reddish brown and has blocky structure. It is hard when dry and friable when moist.

Soils of the Gem series occur mainly in the southeastern part of the survey Area. They are associated with Bandera and Friana soils.

Gem stony loam, 2 to 7 percent slopes (Gm).—This moderately deep soil is mainly on gently sloping uplands. There are many basalt stones on the surface, and basalt outcrops make up about 15 percent of most areas. Included in the areas mapped are some localized breaks that have a slope of as much as 15 percent. Also included are small areas of Cabezon rocky complex, 2 to 10 percent slopes, and minor areas of alluvial material in narrow strips or small depressions.

The surface layer is brown, friable, noncalcareous stony loam about 9 inches thick. The texture of the surface layer ranges from stony loam to stony silt loam, but

stony loam is predominant. The subsoil is reddish-brown or brown, hard clay or clay loam, 15 to 21 inches thick. This layer has visible lime in places. It overlies reddish-brown clay that rests on basalt. The depth to the basalt bedrock ranges from 20 to 38 inches but is most commonly 30 inches. Cracks in the basalt are filled with clayey material.

Infiltration is moderate, and permeability is moderately slow to slow. Permeability is slow in the subsoil. The capacity for water storage is medium, and sustained yield is low. Runoff is slow, and the erosion hazard is low. Roots are plentiful in the upper part of the profile and are prominent along structure breaks in the lower part of the profile.

This soil is only moderately well suited to timber. Most of it receives barely enough moisture for ponderosa pine. It is better suited to herbage than to timber, and most of it has a good cover of grass. It provides avenues of escape and areas of concealment for wildlife. (Management group 5)

Jekley series

Dark-colored, well-drained, shallow to moderately deep soils of the uplands make up the Jekley series. These soils are undulating and gently sloping to steep. They formed in material derived chiefly from red siltstone or fine-grained sandstone of the Abo and Yeso formations. Some formed in material weathered from the redder, silty members of the Chinle formation. These soils are at elevations of 7,800 to 8,200 feet, where the annual precipitation is 19 to 21 inches. The vegetation consists of a vigorous stand of young ponderosa pine, some Gambel oak, Oregon grape, and a grass cover of Arizona fescue, pine dropseed, mountain muhly, and squirreltail.

Jekley soils have a reddish-brown surface layer that is soft to slightly hard when dry and friable when moist and has platy to granular structure. They have a reddish-brown subsoil that is very hard or firm and has blocky structure. The substratum contains many fragments of slightly weathered sandstone. The content of sandstone fragments in the profile ranges from 0 to 20 percent.

Soils of the Jekley series occur throughout the Area. They are associated with Kiln, Fortwingate, and Zuni soils.

Jekley silt loam, 3 to 7 percent slopes (Je).—This soil (fig. 17) is on broad, rolling or undulating uplands. It makes up more than 6 percent of the Area. Small swales and narrow strips of alluvium are included in the areas mapped. Also included are minor areas of Jekley stony loam and areas of soils that have a weakly developed subsoil or that lack a distinct subsoil.

The surface layer is reddish-brown, noncalcareous silt loam about 8 inches thick. It is friable when moist. Below this is reddish-brown, noncalcareous, friable silty clay loam or silty clay about 9 to 12 inches thick. This layer overlies silty clay loam that contains fragments of laminated sandstone. This, in turn, rests on very hard, fine-grained, platy sandstone. The thickness of the soil ranges from 14 to 26 inches. In some places the texture of the surface layer is fine sandy loam or very fine sandy loam. In most places a 1- to 2-inch layer of decaying needles and leaves covers the surface. Many small fragments of sandstone or siltstone are also on the surface. Typically, this soil is noncalcareous, but there are spots in which the substratum is weakly calcareous. These calcareous spots probably result from the presence of lime within the sandstone.

Infiltration is rapid, and permeability is moderate. The capacity to store water is limited by lack of depth, and much of the water passes through the soil into the underlying laminated sandstone. Runoff is slow during most storms because water is trapped by the mat of surface litter and infiltrates rapidly. The erosion hazard is low. Fertility is high.

This soil is one of the best in the Area for the production of ponderosa pine. Although much of the acreage has been severely cut over, the stands are maintained by natural regeneration. There is an excellent stand of second-growth pine (fig. 18). This soil is moderately well suited

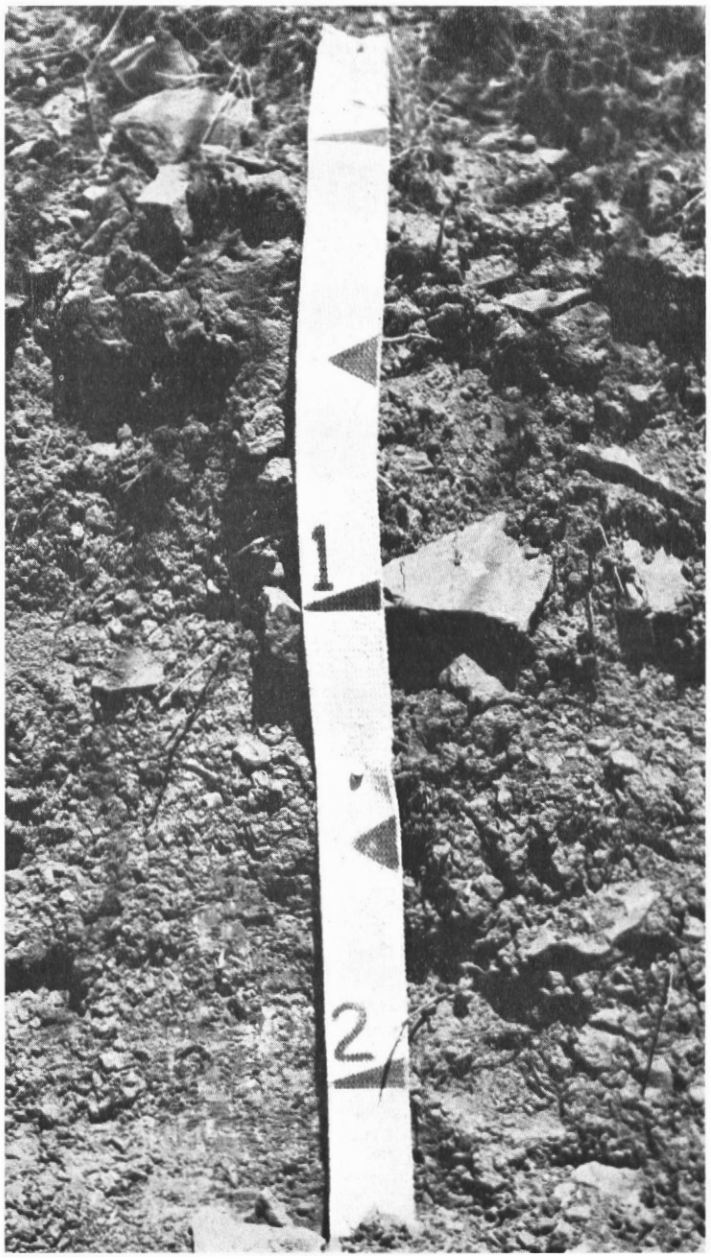

Figure 17.—**Profile of Jekley silt loam, 3 to 7 percent slopes, showing fragments of siltstone.**

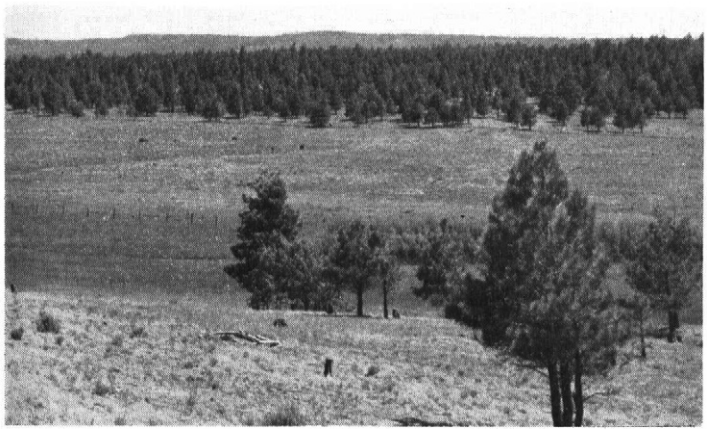

Figure 18.—**The background shows second-growth pine, 30 to 50 years old, on an island of Jekley silt loam, 3 to 7 percent slopes. In the foreground is Jekley stony loam, 10 to 30 percent slopes. Polich and McGaffey soils are on the bottom of the valley.**

to herbage. It is a good habitat for wildlife, as it provides food and concealment. Grazing must be controlled to prevent damage to pine seedlings. (Management group 5)

Jekley stony loam, 10 to 30 percent slopes (Jk).—This soil is shallower and more stony than Jekley silt loam, 3 to 7 percent slopes. It occurs on short upland slopes and breaks, in the interior of the mountain area. Ledges of Abo sandstone are common. The surface litter is sparse and patchy.

Although infiltration is rapid and permeability is moderate, this soil loses more water through runoff than Jekley silt loam, 3 to 7 percent slopes, and it has limited water-holding capacity because it is shallow. The erosion hazard is high. Fertility is medium.

This soil is used for the production of ponderosa pine and for seasonal grazing. It is less productive of either pine or herbage than is Jekley silt loam, 3 to 7 percent slopes. Deer and wild turkey find ample concealment and avenues of escape, and the thickets of Gambel oak provide food. (Management group 7)

Jekley rocky complex, 30 to 40 percent slopes (Jr).—This soil occurs on steep slopes and breaks. A large number of surface stones is characteristic, and exposed ledges are numerous.

Runoff is rapid, and the erosion hazard is high. The water-storage capacity is low, but runoff from this soil supplies water to adjacent lower areas.

This soil is poorly suited to either timber or herbage. Its usefulness for grazing is severely limited by the slope and the rocky ledges. It provides a habitat for deer and wild turkey. (Management group 8)

Kettner series

Dark-colored, noncalcareous, gently undulating and gently rolling to moderately sloping soils make up the Kettner series. These soils are shallow and well drained. They formed in material weathered from granitic schist. They are at elevations of 8,100 to 8,300 feet, where the annual precipitation is 18 to 20 inches. The vegetation consists mainly of ponderosa pine, oak brush, Arizona fescue, pine dropseed, blue grama, mullein, snakeweed, rabbitbrush, and gooseberry.

Kettner soils have a grayish-brown or brown surface layer that is soft when dry and friable when moist and has granular structure. They have a brown or dark-brown subsoil that is hard and has blocky structure. The substratum is yellowish-brown soil material that is hard and contains massive fragments of schist.

Soils of the Kettner series occur in the central and eastern parts of the mountains. They are associated with Zuni and Mirabal soils.

Kettner loam, 3 to 10 percent slopes (Ke).—This soil is on gently undulating to rolling low hills. Included in the areas mapped are areas of Kettner stony loam, 10 to 20 percent slopes. In places there are small outcrops of granitic schist. The included areas make up about 5 percent of the acreage.

The surface layer is grayish-brown or brown, friable loam or fine sandy loam about 8 inches thick. It has a distinctly gritty feel when rubbed between the fingers. Below this is dark-brown, friable loam or sandy loam 9 inches thick, which overlies gravelly sandy loam that contains massive fragments of schist. In most places the depth to bedrock is between 18 and 20 inches, but in a few places it is as little as 13 inches or as much as 24 inches.

Infiltration is moderately rapid, and permeability is moderate. The capacity for water storage is medium to low, as is the capacity for sustained yield. Most of the water that enters the soil passes into the underlying schist. Runoff is slow, and the erosion hazard is moderate. There is no evidence of any serious loss of soil through erosion. Root penetration is shallow. Fertility is medium.

This soil is well suited to herbage and is best used for seasonal grazing. It is only moderately well suited to timber. The present stand of pine is composed mostly of second-growth trees. Clumps of oak brush provide some food for deer, but the smooth, rolling topography does not afford much concealment. (Management group 5)

Kettner stony loam, 10 to 20 percent slopes (Kn).—This soil is shallower than Kettner loam, 3 to 10 percent slopes. About 20 to 30 percent of the surface is covered with granite stones and cobblestones, and there are stones and gravel within the profile. The depth to bedrock is generally about 13 inches, but a few areas are included that have a depth of only 6 to 10 inches.

Runoff is medium, and the erosion hazard is high. The capacity for water storage is low, and there is little or no potential for sustained yield.

This soil is used for seasonal grazing and for production of ponderosa pine, although it is poorly suited to pine and only moderately well suited to herbage. Its use by wildlife is limited because it lacks areas of concealment. (Management group 7)

Kiln series

Dark-colored, well-drained, nearly level to steep soils of the uplands make up the Kiln series. These soils are very shallow or shallow. They formed in material derived from limestone of the San Andres formation. They are at elevations of 7,200 to 7,900 feet, where the annual precipitation is 17 to 20 inches. The vegetation consists of ponderosa pine, a little alligator juniper, and an abundance of Gambel oak. The ground cover consists of Arizona fescue, mountain muhly, and blue grama. In places there is some western wheatgrass.

Kiln soils have a stony, dark-brown surface layer that is soft when dry and very friable when moist and has platy or granular structure. They have a reddish-brown subsoil that is hard and friable and has blocky structure. Immediately under the subsoil is hard, dense limestone. Although derived from limestone, these soils are noncalcareous.

Soils of the Kiln series occur in many parts of the Area and make up about 9 percent of the acreage. They are associated with Fortwingate, Turkeysprings, and Osoridge soils.

Kiln rocky complex, 3 to 20 percent slopes (Kr).—This complex consists of loam soils mixed with limestone rocks, stones, and cobblestones. It is on gently sloping or moderately sloping and rolling uplands in the ponderosa pine forest. About 30 percent of the surface is covered with stones and outcrops, and about 30 percent of the profile consists of stones and cobblestones. Included in the areas mapped are short breaks that have a slope of as much as 25 percent.

The surface layer is dark-brown, very friable, platy stony loam. It is 5 inches thick. The subsoil consists of reddish-brown, friable, blocky clay loam or clay and is about 5 inches thick. Directly under the subsoil is hard, dense, fissured limestone. A 1- or 2-inch layer of pine needles and oak leaves covers most of the surface. The depth to limestone ranges from 8 to 14 inches, but a depth of 10 inches is most common.

Infiltration is moderate, and permeability is moderately slow. The capacity to store water is low, as is the capacity for sustained yield. Runoff is slow, even though the soil is shallow. Apparently, most of the precipitation received passes through the soil and readily penetrates cracks and fissures in the underlying limestone. Some of the water is returned to springs and seep areas along the edges of the limestone exposures. The erosion hazard is moderate, but loss of soil through erosion does not appear to be significant. Roots penetrate easily as far as the limestone, and many enter the fissures in the limestone.

This complex is moderately well suited to timber and to herbage. In areas that have been heavily logged, there is little second-growth pine but an abundance of oak brush. The oak brush provides food for deer and wild turkey. (Management group 7)

Kiln rocky complex, 20 to 40 percent slopes (Kx).—This complex has more outcrops and ledges than Kiln rocky complex, 3 to 20 percent slopes.

Runoff is medium to rapid. The erosion hazard is high, but the rocks and stones protect the soils from serious erosion.

This complex is moderately well suited to timber but only fairly well suited to herbage. It affords some food and cover for wildlife. The surface water that runs off moistens adjacent soils. (Management group 8)

Laporte series

Dark-colored, well-drained, gently sloping or undulating to steep soils of the uplands make up the Laporte series. These soils are shallow, stony, and highly calcareous. They formed in material derived from limestone and calcareous mudstone of the San Andres formation. They are at elevations of 7,000 to 7,500 feet, where the annual precipitation is 14 to 16 inches. The vegetation consists of dense stands of pinyon pine and juniper and an abundance of blue grama and snakeweed. Limestone gravel and cobblestones are common on the surface.

Both the surface layer and the subsoil of Laporte soils are dark grayish brown and stony. They are soft when dry and very friable when moist and have granular structure. The substratum is grayish brown, very stony, soft or friable, and massive.

Laporte stony loam, 3 to 10 percent slopes (La).—This soil is on gently sloping to moderately sloping uplands. It is loose, very soft, and easily excavated. Thin-bedded San Andres limestone occurs as outcrops and also in the soil profile. Gravel and stone-sized fragments of limestone cover 50 percent of the surface in many places. This soil makes up more than 2 percent of the Area. Included in mapping were a few breaks and short slopes that have a gradient of as much as 20 percent.

The surface layer is dark grayish-brown, strongly calcareous stony loam. It is about 5 inches thick. Below this is a layer about 7 inches thick of brown, strongly calcareous stony loam. This overlies a layer of loam and limestone cobblestones and stones that, in turn, abruptly overlies hard limestone. The depth to limestone is 14 inches or more in most places but does not exceed 20 inches. In a few places it is less than 14 inches. Brown and reddish brown are the characteristic colors, but the color varies according to the color of the parent material.

Infiltration and permeability are moderate. Shallowness limits the water-storage capacity, and there is no water yield except for the surface flow that follows severe rainstorms. Surface runoff is slow, except during a torrential rainfall. The erosion hazard is high. Some soil is lost through erosion, and the loss would be greater without the protection afforded by the surface stones and cobblestones. Roots are numerous above the limestone.

The principal use of this soil is summer and fall grazing. Blue grama grows in abundance in openings among the pinyons and junipers. This soil lies below the altitude at which the moisture supply is adequate for ponderosa pine. It is used as winter range by deer and other big game. Its value for that purpose could be improved by introducing adapted browse plants. (Management group 7)

Laporte stony loam, 20 to 40 percent slopes (Lp).—This soil has more limestone outcrops than Laporte stony loam, 3 to 10 percent slopes, but about the same amount of surface gravel and stones. The erosion hazard is high, and some soil washes away during even a light rainstorm.

In use and suitability, this soil is much the same as Laporte stony loam, 3 to 10 percent slopes. It is used less for grazing, however, because it is steeper. (Management group 8)

Larry series

Deep, very dark colored, poorly drained soils of high, wet mountain meadows make up the Larry series. These soils formed in alluvium washed from surrounding granitic slopes. They are at an elevation of 8,700 feet, where the annual precipitation is 20 to 24 inches. Most of the acreage has a dense turf of Kentucky bluegrass mixed with some dandelions and iris.

Larry soils have a dark-gray to black surface layer that is slightly hard when dry and friable when moist and has strong, granular structure. They have a dark-gray to black subsoil that is very hard or friable and has strong,

granular structure. Their substratum is gray material that is hard when dry and has blocky structure. It grades to massive, very gravelly granitic material.

Soils of the Larry series occur in the Mt. Sedgwick area. They are associated with Mirabal and Supervisor soils.

Larry silty clay loam (2 to 5 percent slopes) (Lr).—This soil is deep, poorly drained, and noncalcareous. It occupies nearly level or gently sloping areas of valley fill and receives large amounts of runoff from the surrounding steep mountains. The grass cover is vigorous and forms a dense mat of fibrous roots.

The surface layer is very dark gray to black, friable silty clay loam. It is about 6 inches thick. The subsoil, which is about 13 inches thick, consists of dark-gray, brown, or black, waxy, plastic heavy clay. Under this is about 19 inches of hard silty clay. This material is gray with mottles of various colors. It grades to massive very gravelly silty clay loam. Below a depth of 24 inches, the profile is stratified, and the texture ranges from gravelly loam to gravel-free silty clay.

Infiltration is moderate, and permeability is moderately slow. Runoff is slow to rapid, depending upon the rapidity of snowmelt or the intensity of rainfall. The erosion hazard is low. The capacity for water storage and for sustained yield of water is high. The depth to the water table varies with the season. For several months after the spring thaw, the soil is saturated to the surface. The natural fertility is high.

This soil is useful principally for the production of herbage and for sustained yield of water. It is well suited to herbage and is used as summer range for cattle. It is not suited to ponderosa pine. (Management group 3)

Lava flows

Lava flows (Ls) consists of lava that probably accumulated about a thousand years ago. These areas are devoid of visible soil, but the presence of browse plants shows that soil has accumulated in crevices or beneath the surface material. The surface of the lava is rough and broken, and walking over the flows is precarious. This land type has considerable scenic appeal because of its vast expanse and jagged topography.

Lava flows are in the eastern and southeastern parts of the Area. They are not suitable for range or forest. (Management group 10)

Lava rock land

Lava rock land (Lv) is made up of lava that has spotty accumulations of soil in pockets and small basins. Patches of scrubby ponderosa pine and Douglas-fir grow in these pockets. There are also browse plants, such as mountain-mahogany.

Logging this land type would be difficult, and livestock will not cross the rough, jagged lava. The browse plants, especially along the outer edges of the areas, supply food for deer.

This land type occurs in association with Lava flows. (Management group 10)

McGaffey series

Deep and very deep, well-drained soils on alluvial fans and flood plains make up the McGaffey series. These soils are highly stratified. They formed in alluvial material derived from Abo sandstone, the Chinle formation, and San Andres limestone. They are at elevations of 7,500 to 7,800 feet, where the annual precipitation is 18 to 20 inches. The vegetation consists of ponderosa pine, Arizona fescue, pine dropseed, blue grama, rabbitbrush, and seeded wheatgrass.

McGaffey soils have a reddish-brown surface layer that is soft when dry and very friable when moist and has platy and granular structure. They have a reddish-brown subsoil that is hard or very hard when dry and friable when moist and has blocky structure. Their substratum is reddish brown, hard and friable, and blocky. In many places the substratum is an old buried soil.

Soils of the McGaffey series are widespread in interior mountain valleys. They are associated with Polich, Jekley, and Wilcoxson soils.

McGaffey loam (1 to 3 percent slopes) (Ma).—This soil is on valley and canyon floors. Included in the areas mapped are a few areas along the outer margin of the valley fills where the slope range is 7 to 10 percent. In many areas there are deep gullies and cuts that have nearly vertical walls. There are no outcrops, and most of the profiles are free of stones.

The surface layer is reddish-brown, friable, noncalcareous loam about 15 inches thick. Beneath this is reddish-brown, friable, noncalareous sandy clay loam or silty clay loam about 20 inches thick over stratified sandy clay loam and clay that is calcareous in places. All of the horizons are about the same color. Reddish brown predominates, but in a few places the surface layer is grayish brown. Loam is the predominant texture of the surface layer, but there are small areas of fine sandy loam.

Infiltration is moderately rapid, and permeability is moderate. The capacity for water storage is high, but capacity for sustained yield is only medium and is affected by the gullies and cuts. Runoff is slow to medium, and the erosion hazard is moderate. Roots penetrate deeply. Fertility is high.

This soil is one of the most productive in the Area. It is well suited to both timber and herbage. Large areas have been cleared and once were farmed, but now most of the cleared land is in grass (fig. 19). The small acreage

Figure 19.—**Seeded crested wheatgrass on McGaffey loam. Areas such as this are used for seasonal grazing of livestock.**

still in cultivation is used for oats and wheat. Grain crops are not dependable, because rainfall is unpredictable.

Formerly, this soil supported an excellent stand of pine, but only a few pines are now left. Some isolated spots and stringers still have good stands of ponderosa pines. The deep gullies and cuts prevent the storage of the moisture needed for regeneration of pine. In ungullied areas, pines are reseeding naturally.

Production of herbage and storage of water are the best uses for this soil. Through gully control and improved methods of reforestation, much of the acreage could be returned to the production of ponderosa pine. (Management group 1)

Mirabal series

Shallow, dark-colored, well-drained, gravelly and stony soils on undulating to hilly uplands make up the Mirabal series. These soils are on narrow ridge crests and moderately steep or steep slopes. They formed in material weathered from granite and gneiss. They are at elevations of 7,700 to 9,200 feet, where the annual precipitation is 18 to 24 inches. The vegetation consists of ponderosa pine, Douglas-fir, limber pine, pinyon pine, and juniper, and a ground cover of Arizona fescue, mountain muhly, and blue grama.

Mirabal soils have a gravelly and stony, dark-brown surface layer that is soft when dry and loose when moist and has granular structure. They have a yellowish-brown, gravelly substratum that is slightly hard and is massive or has weak, blocky structure. Coarse fragments on the surface and in the profile make up 5 to 20 percent of the soil mass.

Soils of the Mirabal series occur in the vicinity of Mt. Sedgwick. They are associated with Supervisor, Kettner, Tampico, and Zuni soils.

Mirabal stony loam, 5 to 15 percent slopes (Mb).—This soil is very shallow. It occurs as long, narrow strips on ridgetops and generally is between Mirabal stony loam, 15 to 45 percent slopes, and Supervisor stony loam, 20 to 45 percent slopes.

Generally, the depth to bedrock is between 10 and 12 inches, but in a few places it is as little as 7 inches. About 20 percent of the surface is covered with stones and outcrops. In most places 40 to 60 percent of the profile consists of coarse fragments. Near and under trees there is a layer of litter an inch thick, but in the openings there is little or no litter.

Infiltration and permeability are rapid or moderately rapid. The capacity for water storage and the capacity for sustained yield of water are low. Runoff is medium under gentle precipitation but rapid and heavy after hard rains. The erosion hazard is moderate.

This soil is moderately well suited to timber, but it is poorly suited to herbage. Because of the erosion hazard, careful management for maintenance of the vegetative cover is important. (Management group 4)

Mirabal stony loam, 15 to 45 percent slopes (Mm).—This is a shallow soil on south-facing slopes in the uplands. Stones, cobblestones, and gravel cover about 30 percent of the surface. There are some outcrops. Small benches of Mirabal stony loam, 5 to 15 percent slopes, are included in the areas mapped and make up about 10 percent of the acreage.

The surface layer is grayish-brown, friable stony loam or stony sandy loam about 5 inches thick. It has a gritty feel. Beneath this is yellowish-brown, friable stony and gravelly sandy loam about 8 inches thick that grades to a 5-inch layer of massive stony sandy loam. Below the massive material is hard, somewhat shattered and fractured granite and gneiss. The surface is covered with a ½- to 1-inch layer of needle litter. Generally, the depth to fractured granite and gneiss is about 18 inches, but it may be as little as 15 inches or as much as 22. The substratum is massive and contains angular fragments of granite. The amount of coarse fragments within the profile ranges from 5 to 50 percent.

Infiltration is rapid, and permeability is moderately rapid. The capacity for water storage is medium. The capacity for sustained yield is high, and a number of springs and seeps along the base of steep slopes are active a good part of the year. Runoff is medium, and the erosion hazard is high. Roots penetrate easily to the granite and gneiss. Fertility is moderately high.

This soil is of most use as a water-storage area, as a recreational area, and as a wildlife habitat. It is well suited to ponderosa pine, and the less sloping areas are useful as summer range for cattle. The steep, forest-covered slopes are scenic and provide areas of escape and concealment for deer and turkey. (Management group 4)

Mirabal stony loam, low rainfall, 5 to 20 percent slopes (Mn).—This soil occurs on hilly uplands at an elevation of 7,700 to 8,100 feet. It is well drained or excessively drained. Many stones and pebbles of granite are on the surface and within the profile. Rills and a few small gullies have formed. Outcrops of granite and schist are included in the areas mapped and make up about 5 percent of the acreage.

The surface layer is brown to grayish-brown gravelly stony loam about 4 inches thick. It is soft when dry and friable when moist. Below this is about 6 to 8 inches of brown, reddish-brown, or grayish-brown, soft and friable very gravelly loam. This layer grades to weathered granite and schist mixed with gravelly loam. In most places the depth to bedrock is between 8 and 15 inches, but it may be as little as 6 inches or as much as 20.

Infiltration is rapid, and permeability is rapid. The capacity to store water is low, and the southern and southwestern exposures are somewhat droughty. Sustained yield of water is very low. Normally, runoff is medium, but it is rapid during snowmelt and heavy downpours. Fertility is moderately low. The erosion hazard is high.

This soil is poorly suited to timber, but it is moderately well suited to herbage. Maintenance and improvement of the protective vegetation is needed to control erosion. (Management group 7)

Montoya series

Deep, well-drained, slowly permeable soils on gently sloping alluvial fans, bottom lands, and basins make up the Montoya series. These soils formed in old alluvium washed from the Chinle formation and have been strongly influenced by shale and shaly clay. These soils are at elevations of 6,800 to 7,200 feet, where the annual precipitation is 15 to 18 inches. The vegetation consists chiefly of blue grama, western wheatgrass, and rabbitbrush. There is some pinyon pine and juniper, and there are clumps of Gambel oak at the higher elevations. There

is very little ponderosa pine, and many areas have no pine trees at all. Much of the acreage is bare.

Montoya soils have a reddish-gray, reddish-brown, or red surface layer that is soft when dry and friable when moist and has platy to granular structure. The subsoil is reddish brown or red. It is very hard when dry and friable when moist and has blocky structure. The substratum is reddish brown or red and is strongly calcareous. It is hard when dry and friable when moist. It is massive or has blocky structure.

Soils of the Montoya series occur in the southwestern part of the survey Area. They are associated with McGaffey, Ordnance, Sanchez, and Trail soils.

Montoya clay (0 to 3 percent slopes) (Mo).—This soil occupies alluvial fans and bottom lands. It is the finest textured alluvial soil in the Zuni Mountain Area. It swells when moistened, then shrinks and forms large, deep cracks as it dries. There are no outcrops and only a few surface stones, but small, rounded pebbles are common in the profile. On the upper part of the fans the slope ranges up to 7 percent.

The surface layer is calcareous, reddish clay about 9 inches thick. The subsoil is dark-red, strongly calcareous clay. This layer is about 18 inches thick and grades into massive, very strongly calcareous gravelly clay. In places the profile is strongly calcareous to the surface.

Infiltration is rapid when this soil is dry, but it slows as the soil absorbs water. Permeability is slow or very slow. Runoff is medium. The erosion hazard is high, and susceptibility to rilling is high. Fertility is moderate. The capacity for storage of water is medium, but yield of water is from surface runoff only.

Although this soil occurs chiefly in the ponderosa pine forest, it does not support pine. It is well suited to herbage and is used for summer range. Oak brush provides food for deer and turkey. (Management group 3)

Nathrop series

Well-drained, shallow and moderately deep soils of the uplands make up the Nathrop series. These soils formed in material weathered from San Andres limestone. They are at an elevation of about 7,200 feet, where the annual precipitation is about 13 inches. The vegetation consists of grass, mainly blue grama. There is also some ring muhly and a little juniper and pinyon pine. About 30 percent of the surface is barren.

Nathrop soils have a reddish-brown surface layer that is soft when dry and friable when moist and has platy structure. They have a reddish-brown subsoil that is slightly hard or hard when dry and friable when moist and has blocky structure. The substratum is hard or friable and is massive. It is underlain by limestone and is calcareous.

Soils of the Nathrop series occur in smooth, gently sloping depressions. They are associated with Laporte and Prewitt soils.

Nathrop loam, 0 to 5 percent slopes (Na).—This soil occupies smooth uplands in the northeastern part of the survey Area. It occurs in openings in the forest and is surrounded by Laporte soils, which support dense stands of juniper and pinyon pine. There are only a few stones or cobblestones on the surface and almost none in the profile.

The surface layer is reddish-brown, noncalcareous loam 2 to 4 inches thick. It is soft when dry and friable when moist. Beneath this is brown, noncalcareous, slightly hard or friable heavy clay loam about 3 inches thick. This grades to brown, calcareous, friable clay loam 8 inches thick, which overlies limestone. In most places the depth to limestone bedrock is about 16 inches, but it may be as little as 12 inches or as much as 26.

In places the surface layer is calcareous. The texture of the subsoil may be loam, silt loam, sandy clay loam, clay loam, or silty clay loam.

Infiltration and permeability are moderate. The capacity to store water is low or medium because the soil is thin above the bedrock. Runoff is slow, and the erosion hazard is moderate. Roots penetrate to the bedrock. Fertility is moderate.

This soil is used chiefly for seasonal grazing. It is moderately well suited to herbage but lies below the zone in which the moisture supply is adequate for ponderosa pine. (Management group 9)

Ordnance series

Moderately deep and deep, well-drained soils on gently sloping to moderately sloping and undulating uplands make up the Ordnance series. These soils formed in material derived from thin-bedded, reddish-gray clayey shale and reddish-brown sandstone of the Chinle formation. They have also been influenced by conglomerates. They are at elevations of 7,600 to 8,100 feet, where the annual precipitation is 15 to 19 inches. The vegetation consists mainly of ponderosa pine, pinyon pine, alligator juniper, one-seeded juniper, Gambel oak, and cliffrose. The understory consists of blue grama, weeds, and shrubs.

Ordnance soils have a brown surface layer that is soft when dry and friable when moist and has platy structure. They have a subsoil that is reddish brown, blocky, and extremely hard when dry and firm when moist. Their substratum is reddish gray, very hard or firm, and weakly blocky. It is highly calcareous. The lower part of the substratum contains much partly weathered shale and many concretions of lime.

Soils of the Ordnance series occur in the western part of the survey Area. They are associated with Fortwingate, Kiln, Sanchez, and Thurloni soils.

Ordnance loam (5 to 15 percent slopes) (Od).—Generally, there are some shale outcrops on this upland soil, and fragments of sandstone and shale are common on the surface. In places there is a cover of cherty gravel. Included in the areas mapped are severely eroded areas, a few bare areas of clayey alluvium, and small step breaks that have a slope range of 20 to 25 percent.

The surface layer is brown, friable, noncalcareous loam or heavy sandy loam 4 to 7 inches thick. Beneath this is noncalcareous, firm, reddish-brown clay about 10 inches thick, over reddish-gray, firm, calcareous silty clay or clay about 8 inches thick, which grades to a highly calcareous mixture of clayey sandstone and shale. In many places the surface layer is vesicular, and in some areas the texture is gravelly loam. A layer of litter, generally less than an inch thick, is on the surface in places. The depth to shale or sandstone ranges from 27 to about 45 inches. Some of the profiles have cherty gravel in all horizons. The variation in depth results from undulations of the

subsurface beds of shale and sandstone. The color of the surface layer is light brown, grayish brown, brown, or reddish brown. The color of the subsoil is reddish brown, red, or grayish brown. In many places the substratum is varicolored, like the partly weathered shale. In places these soils are calcareous to the surface.

Infiltration is moderate to slow, and permeability is moderately slow. The capacity for water storage and the capacity for sustained yield of water are low, but surface yield is high after heavy rains. Runoff generally is medium, but it is rapid in cutover areas where the surface is exposed and crusted. The erosion hazard is high, and in places the surface layer has been thinned by erosion. Roots penetrate to a depth of 12 to 18 inches. Fertility is medium.

This soil is poorly suited to timber and is only fairly well suited to herbage. It is used for summer range, and it produces browse plants that provide food for deer. Pine trees grow slowly and are not well formed. (Management group 6)

Osoridge series

Moderately well drained, very stony, shallow soils make up the Osoridge series. These soils formed in material weathered from Glorieta sandstone. They are at elevations of 7,800 to 8,500 feet, where the annual precipitation is 18 to 20 inches. The vegetation consists of scattered ponderosa pine, Gambel oak, pinyon pine, juniper, mountain-mahogany, blue grama, Arizona fescue, and mountain muhly.

Osoridge soils have a grayish-brown or dark grayish-brown surface layer that is soft when dry and friable when moist and has platy structure. They have a subsoil that is reddish brown, extremely hard or firm, and blocky. Their substratum is reddish yellow, is very hard when dry and firm when moist, and has weak, blocky structure. These soils are noncalcareous to the surface.

Soils of the Osoridge series occur as rocky complexes on long dip slopes, mesa tops, and the side slopes of canyons. They are associated with Fortwingate, Kiln, and Sanchez soils.

Osoridge rocky complex, 5 to 20 percent slopes (Or).—This complex consists of very shallow and shallow, stony soils intermingled with sandstone rocks, boulders, stones, and gravel. It occupies high mesas, long dip slopes leading from escarpments, and the side slopes of canyons and draws. Included in the areas mapped are small areas of Rock outcrop, gently sloping, of Rock land, and of Kiln soils. Kiln soils adjoin some areas of the complex.

Large slabs, boulders, and fragments of sandstone cover 50 to 85 percent of the surface. The areas are difficult to cross, either on horseback or on foot.

Osoridge stony fine sandy loam makes up about 75 percent of the complex. Its surface layer is grayish brown, friable, platy, noncalcareous fine sandy loam about 4 inches thick. Beneath this is reddish-brown, firm, blocky, noncalcareous clay 10 to 12 inches thick. In most places this layer abruptly overlies Glorieta sandstone, but it may be separated from the sandstone by a thin layer of clay mixed with partly decomposed sandstone.

Other soils in the complex consist of grayish-brown and reddish-brown sandy loam from the surface to the underlying rock. Still others consist of grayish-brown or reddish-brown sandy loam about 12 inches thick over a 1- or 2-inch layer of blocky, reddish-brown clay over the sandstone bedrock.

In some areas these soils are only 3 to 5 inches deep, but in other places they are as much as 30 inches deep. Generally, the depth to bedrock is between 12 and 20 inches.

Infiltration is rapid, but permeability is impeded by the clayey subsoil. The capacity for water storage and the capacity for sustained yield to springs and seeps are low. Runoff is high because of the many stones, boulders, and slabs on the surface. Much of the water in irrigation lakes adjacent to the Zuni Mountains runs off the soils of this complex. The erosion hazard is high, and rill erosion is evident in many places.

These soils are poorly suited to timber and only moderately well suited to herbage. They are used for summer range, and they produce browse plants that provide food for deer. Ponderosa pines are stunted and of low quality. Natural regeneration of ponderosa pine is slow at best and in places is entirely ineffective. Distribution of grazing is difficult because of a lack of suitable sites for earthen stock tanks. If the herbage cover is reduced or depleted, recovery is very slow. The areas are valuable chiefly as a watershed. (Management group 7)

Osoridge rocky complex, 20 to 40 percent slopes (Ox).—This complex occupies the side slopes of canyons and draws. It contains a great deal of ledge rock, and generally the soils are not more than 12 inches deep. Included in the areas mapped are some areas where the slope is as much as 50 percent.

Runoff is rapid, and the surface yield of water is high. The erosion hazard is high.

These soils are poorly suited to timber and only moderately well suited to herbage. Their usefulness for grazing is limited because of the slope and the barriers of ledge rock. This complex is best managed for surface yield of water. (Management group 8)

Polich series

Deep, nearly level and gently sloping, imperfectly drained to poorly drained soils make up the Polich series. These soils formed in mixed alluvium washed from sandstone, shale, limestone, and granite. They are at an elevation of about 7,600 feet, where the annual precipitation is 18 to 20 inches. The vegetation (fig. 20) consists of iris, crested wheatgrass, Arizona fescue, junegrass, and snakeweed. Ponderosa pine does not grow on these soils.

Polich soils have a dark-brown surface layer that is soft when dry and friable when moist and has platy structure. They have a dark grayish-brown or brown subsoil that is hard or friable and has prismatic or blocky structure. The substratum is reddish brown, is slightly hard or friable, and is massive or has prismatic structure. These soils are calcareous to the surface in places. Buried soils are common.

Soils of the Polich series occur in interior mountain valleys. They are associated with Jekley and McGaffey soils.

Polich loam (0 to 2 percent slopes) (Po).—This soil occupies alluvial bottom lands. Included in the areas mapped are some areas where the surface layer is clay loam, silty clay loam, or fine sandy loam.

The surface layer is dark-brown, friable loam about 15 inches thick. The subsoil is dark-brown, friable clay

Figure 20.—**Native grasses growing on Polich loam (0 to 2 percent slopes). Trees in the background are on Jekley rocky complex, 30 to 40 percent slopes.**

loam or silty clay loam about 26 inches thick. It overlies reddish-brown, friable, weakly calcareous silt loam (fig. 21). In places this soil is calcareous to the surface. Dark brown is the typical color, but in areas where the alluvium was derived largely from red shale and sandstone, the color is dark reddish brown. The subsoil is heavy loam, clay loam, silt loam, or silty clay loam. Fine to coarse mottles of brown and dark reddish brown are few to common in the subsoil and substratum.

Infiltration is moderate, and permeability is moderately slow. The capacity to store water and the capacity for sustained yield to springs and seeps are high. Runoff is slow, and the erosion hazard is low to moderate. Some erosion damage is apparent as streambank cutting along the stream channels and as severe soil loss at the heads of gullies. Fertility is high.

This soil is poorly suited to the production of pine but is highly productive of herbage. It is used for range, chiefly late in spring, in summer, and early in fall. Some of it is cultivated, but a high water table limits its suitability for cultivation. Hay crops that will grow in wet soil are produced in some places. The water table also interferes with the growth of pine. Grazing and water storage are the best uses for this soil. (Management group 1)

Prewitt series

Deep, dark-colored, stratified soils make up the Prewitt series. These soils formed in alluvium washed from San Andres limestone and in material weathered from shale and sandstone of the Chinle formation. They are at elevations of 6,800 to 7,100 feet, where the annual precipitation is 11 to 15 inches. The vegetation consists mainly of blue grama, sleepygrass, Russian-thistle, snakeweed, sunflower, rabbitbrush, and scattered pinyon pines and junipers.

Prewitt soils have a brown, reddish-brown, or reddish-gray surface layer that is soft when dry and friable when moist and has blocky structure. They have a reddish-brown subsoil that is very hard and firm and has blocky structure. Their substratum is brown, is hard when dry and friable when moist, and has weak, blocky structure. Buried profiles are common. In most places these soils are highly calcareous throughout.

Soils of the Prewitt series occur chiefly at elevations below the pine forest. They are associated with Laporte, Nathrop, Savoia, and Trail soils.

Prewitt clay loam (0 to 5 percent slopes) (Pr).—This soil is on alluvial fans, broad bottom lands, and flats. Most areas are gullied. Some of the gullies are wide, are 20 to 30 feet deep, and have vertical walls. Some areas have been severely damaged by interconnected headcuts and gullies. Included in the areas mapped are a few areas that have a surface layer of loam.

The surface layer is reddish-gray to reddish-brown, calcareous, friable clay loam 9 to 13 inches thick. Beneath this is reddish-gray to reddish-brown, friable, calcareous silty clay or clay about 13 inches thick. This layer overlies very hard, friable, reddish-brown, strongly calcareous light clay.

This soil generally overlies an older buried soil. The color is commonly reddish gray or reddish brown but in places is red, dusky red, or brown. The texture of the subsoil is heavy clay loam or clay.

Infiltration is moderate, and permeability is slow to very slow. Runoff is slow, but the erosion hazard is high because of heavy runoff from nearby hills and steep slopes. Fertility is moderately high.

This soil is used as range. It is well suited to herbage, but because the deep and numerous gullies drain off mois-

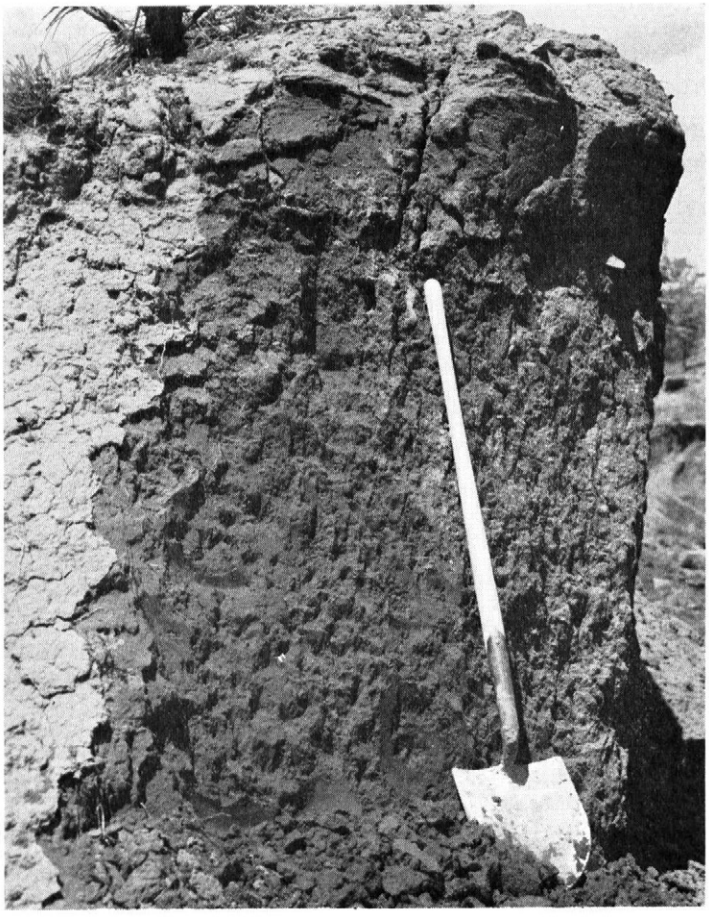

Figure 21.—**Profile of Polich loam.**

ture, the herbage cover is sparse. Erosion is active, and the gullies are susceptible to bank caving and side cutting. Some of the gullies are so large that control presents a formidable problem. Ungullied areas ought to be revegetated with adapted grasses and shrubs. Ponderosa pine does not grow on this soil. (Management group 3)

Rock land

Rock land (5 to 50 percent slopes) (Rk) makes up about 10 percent of the survey Area. It includes two kinds of terrain.

About one-third of the unit consists of large escarpments, steep breaks, rock ledges, rock outcrops, short escarpments, talus slopes, and patches of shallow, moderately deep, and deep soil as a mantle over rock or as pockets among outcrops and ledges. The rock outcrops consist of granite, basalt, shale of the Chinle formation, San Andres limestone, Glorieta sandstone, and Abo and Yeso sandstone. The slope range is 25 to 50 percent. Much of the acreage is vegetated, some densely and some only sparsely. The vegetation consists of ponderosa pine, Douglas-fir, oak brush, pinyon pine, juniper, and such grasses as Arizona fescue, junegrass, blue grama, and squirreltail. These steep areas have scenic value (fig. 22). Their use for grazing is limited by the steep slopes, ledges, and escarpments. Logging is difficult and requires special equipment. Wildlife, particularly deer, find suitable food and avenues of escape and concealment. The surface yield of water is high.

Two-thirds of this unit consists of exposed Glorieta and Gallup sandstone and of pockets of loamy sand or sandy loam ranging from 10 to 40 square feet in area and from 6 to 10 inches in depth. This part is associated with Osoridge and Bond soils. It is sparsely vegetated with stunted ponderosa pine, pinyon pine, juniper, and grass. The slope range is 5 to 25 percent. These less sloping areas are suited to timber, range, and wildlife. Runoff is high, and stock ponds located downslope from these areas are seldom dry. The scenery is spectacular. (Management group 8)

Rock outcrop

Rock outcrop, gently sloping (Ro) consists of outcrops of bare rock. Most of the rock is Glorieta sandstone (fig. 23), but small, isolated outcrops of granite are included in the areas mapped. The Glorieta sandstone occurs as long, continuous strips that are gently sloping and nearly smooth.

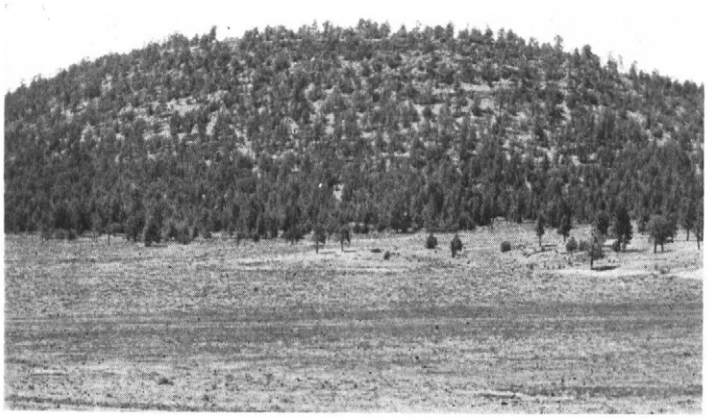

Figure 22.—A steep area of Rock land. Soils in the foreground are of the McGaffey series.

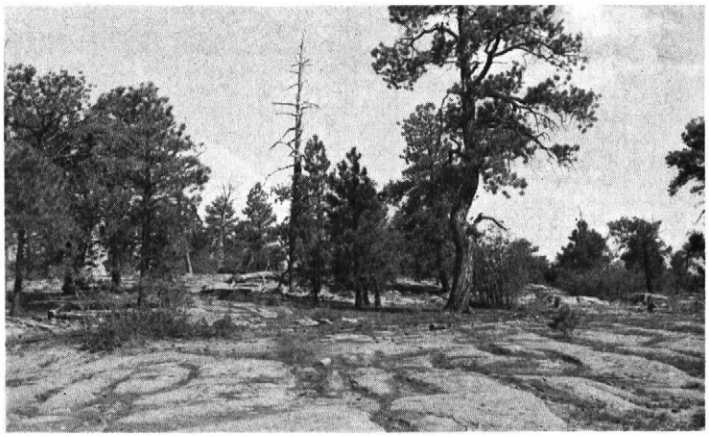

Figure 23.—Outcrop of Glorieta sandstone. The pine trees are growing in pockets of soil.

Runoff is rapid. It supplies water to adjacent lower lying soils. (Management group 10)

Rock outcrop, cliffs (Rp) consists of the steep walls of box canyons, including Zuni Canyon, Pole Canyon, and Nutria Canyon. It also includes the steep escarpment faces that run east and west from Bluewater Canyon and those that run north and south from Zuni Canyon. These very steep slopes, canyon walls, and escarpments (fig. 24) are natural barriers to the movement of livestock and wildlife. In many places they are impassable, either on foot or on horseback, and they affect the location of roads and trails. Many of the canyons and escarpments serve as barriers to the spread of wildfire.

Most of the precipitation that falls on these areas runs off onto the soils downslope or into drainageways. The vegetation is sparse. (Management group 10)

Sanchez series

Shallow and very shallow, well-drained soils of the uplands make up the Sanchez series. These soils formed in material weathered from a gray, sandy member of the Chinle formation. They are at elevations of 7,200 to 7,800 feet, where the annual precipitation is 16 to 19 inches. The vegetation consists of a mixed cover of trees, shrubs, and grasses. Ponderosa pine is the dominant tree, Apache-plume is the dominant shrub, and pine dropseed is the chief grass. Other vegetation includes pinyon pine, juniper, Gambel oak, mountain-mahogany, blue grama, and Arizona fescue.

Sanchez soils have a pinkish-gray, brown, or gray surface layer that is highly porous, soft when dry and very friable when moist, and platy. They have a pinkish-gray to brown subsoil that is very hard and friable and has blocky structure. The substratum is made up of pinkish-gray to reddish-brown material that is very hard or friable and is massive. The profile is free of lime.

Soils of the Sanchez series occur on the northern and southern flanks of the Zuni Mountains. They are associated with Kiln, Ordnance, Showlow, and Thurloni soils.

Sanchez stony complex, 10 to 20 percent slopes (Sa).—This complex consists mainly of Sanchez sandy loam, rock outcrops, and an unclassified shallow sandy soil. It occupies long dip slopes that are concave in places.

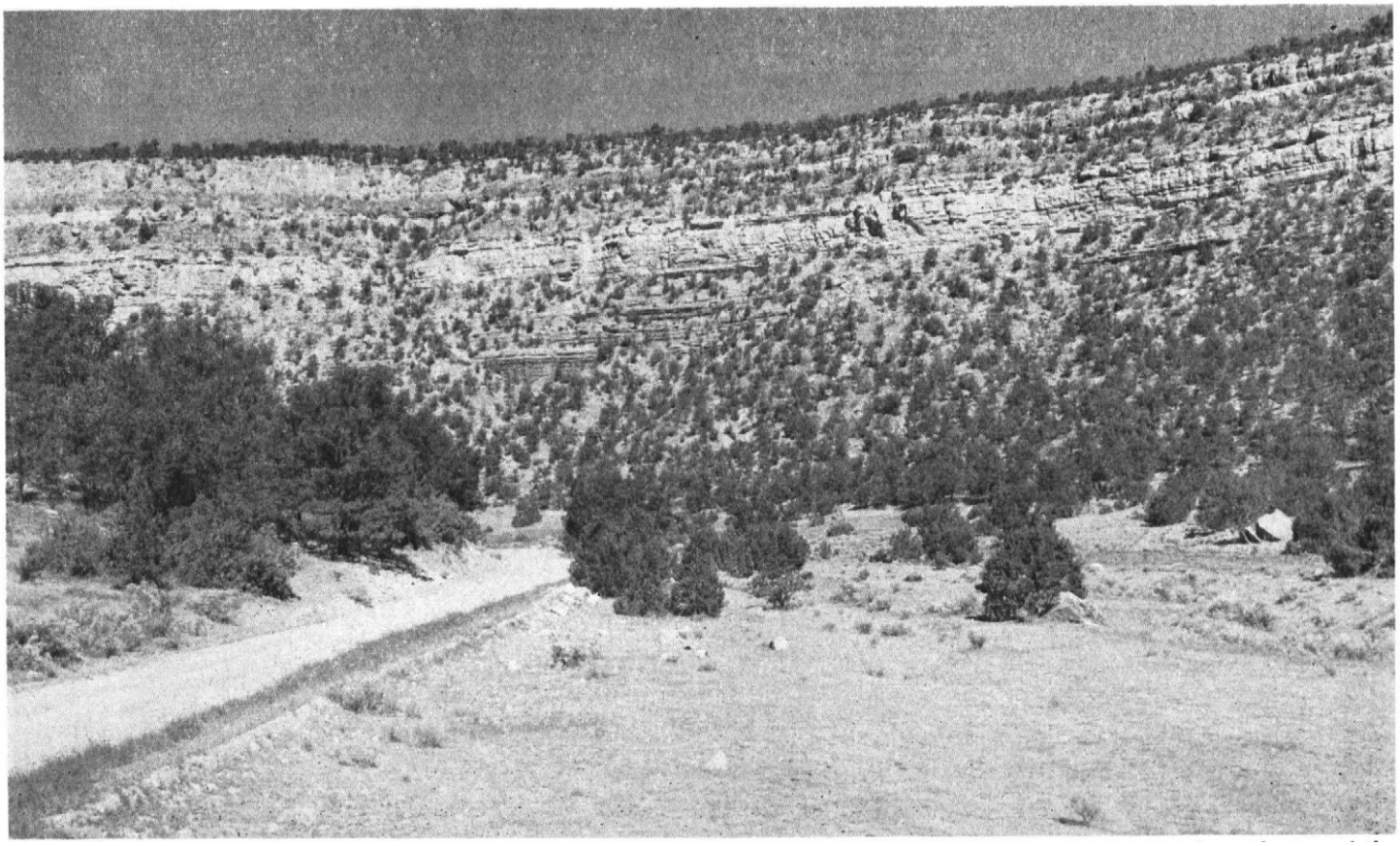

Figure 24.—**Rock outcrop, cliffs. This land type, rising high above the upland valleys, affords a spectacular view from the top of the escarpments. The nearly vertical walls of the canyon and the sweep of the pine forest present a majestic panorama.**

Stones, rocks, and outcrops cover 40 to 50 percent of the surface. Most of the stones and other coarse fragments are pieces of thin-bedded sandstone. Petrified wood is common on the surface and within the profile. Where the vegetation consists of ponderosa pine, a 1-inch layer of organic litter overlies the mineral soil. In barren spots, the surface is crusted. Included in the areas mapped are areas of Kiln, Ordnance, and Thurloni soils, totaling about 10 percent of the acreage. Also included are local breaks where the slope is as much as 40 percent and other areas where the slope is only 5 percent.

The surface layer of the Sanchez soil in this complex is pinkish-gray to brown, friable stony sandy loam about 2 or 3 inches thick. This layer is vesicular and noncalcareous. Beneath it is 5 to 8 inches of reddish-gray or reddish-brown, friable, noncalcareous sandy clay loam or clay loam. This layer either grades into a mixture of soil and sandstone or directly overlies sandstone. Generally, the depth to sandstone is between 8 and 14 inches, but in a few places it is as little as 6 inches or as much as 17 inches.

The unclassified soil is commonly not more than 8 to 10 inches deep. It is predominantly gray and pinkish gray, but in some areas it is brown or reddish brown.

Infiltration is moderate, and permeability is moderate to moderately slow. The water-storage capacity is low, and there is no sustained yield. Runoff is rapid, and the erosion hazard is high.

This complex is well suited to herbage and is used for spring, summer, and fall grazing. It produces browse plants that provide food for deer. It is only fairly well suited to timber. Some commercial timber is produced, but most of the trees grow slowly and are of poor quality. (Management group 8)

Savoia series

Deep and very deep, undulating, gently sloping and moderately sloping, well-drained soils make up the Savoia series. These soils formed in material weathered from sandstone and limestone. In places the parent material included some wind-deposited material. In one area near Oso Ridge, the parent material consisted of wind-deposited material over material weathered from basalt. These soils occur at elevations of 7,100 to 8,000 feet, where the annual precipitation is 17 to 19 inches. At the higher elevations ponderosa pine predominates in the overstory, but there is some Gambel oak. The understory is Arizona fescue, pine dropseed, mountain muhly, and blue grama. At the lower elevations scattered pinyon pine and juniper make up the overstory, and blue grama and squirreltail make up most of the understory.

Savoia soils have a noncalcareous, grayish-brown or reddish-brown surface layer that is soft when dry and very friable when moist and has platy or granular structure. The surface is generally covered by a ½- to 1-inch layer of needle litter. The soils have a reddish-brown to yellowish-red, noncalcareous subsoil that is hard or friable

and has prismatic or blocky structure. In most places the subsoil appears cemented when dry. The substratum is calcareous, reddish brown or yellowish red, and massive. It is hard when dry and friable when moist. The depth to lime varies from place to place.

Soils of the Savoia series occur in many parts of the Area. They are associated with Concho, Jekley, Showlow, and Trail soils.

Savoia fine sandy loam, 2 to 5 percent slopes (Sb).—This soil is on fans, terraces, and uplands extending east and west from the base of the Nutria Hogback, and on fans and foot slopes along the base of Oso Ridge. Rock outcrops occur only where the soil is underlain by basalt. In these areas outcrops cover 15 percent of the surface. Coarse fragments occur on the surface only in spots. Included in the areas mapped are a few places west of the hogback where the slope is as much as 10 percent.

The surface layer is noncalcareous, brown to reddish-brown, friable fine sandy loam about 6 inches thick. It is covered with litter of pine needles and grass. The subsoil is noncalcareous, yellowish-red, friable light sandy clay loam or heavy sandy loam about 24 inches thick. This overlies a thick layer of yellowish-red, massive, calcareous, friable fine sandy loam.

The color of the surface layer is commonly reddish brown, but in places it is brown or grayish brown. The texture of this layer may be fine sandy loam, sandy loam, or light loam. The texture of the subsoil may be sandy loam, sandy clay loam, or light loam. The substrata are fine sandy loam and sandy loam. Most commonly, the depth of the soil is 48 inches, but it may be as little as 36 inches or as much as 60 inches.

Infiltration is moderate to rapid, and permeability is moderate to moderately rapid. Runoff is moderately slow, and the erosion hazard is moderate. In areas where the vegetative cover is depleted, the hazard of wind erosion is severe. The capacity for water storage is high, and the capacity for sustained yield is good at the higher elevations. The capacity to supply moisture to plants is good, and roots penetrate deeply. Fertility is high.

This soil is well suited to timber and herbage. It provides excellent spring, summer, and fall range for cattle, and it produces good ponderosa pine. The trees are thrifty and have good form. There is much young pine, and the capacity for natural regeneration is good. The clumps of oak brush provide forage for deer and turkey. It is important to maintain the high productive capacity of this soil. (Management group 5)

Savoia fine sandy loam, 5 to 20 percent slopes (Sf).—This soil is on toe slopes and on higher fans and terraces than Savoia fine sandy loam, 2 to 5 percent slopes. It occurs in narrow strips that finger into the less sloping fans. The slope breaks sharply at the outer edges of the areas. Runoff is medium, and the erosion hazard is high.

This soil is well suited to timber and herbage. It provides excellent spring, summer, and fall range for cattle, and it produces good ponderosa pine. The clumps of oak brush provide forage for deer and turkey. (Management group 5)

Showlow series

Deep and moderately deep, dark-colored, moderately well drained, fine-textured soils make up the Showlow series. These soils formed in material weathered from clayey shale of the Chinle formation. They are at elevations of 7,500 to 7,800 feet, where the annual precipitation is 15 to 18 inches. The vegetation consists of pinyon pine, juniper, some ponderosa pine, and a ground cover of scattered Arizona fescue, squirreltail, blue grama, yucca, and annual weeds. Oak brush and mountain-mahogany grow in many places.

Showlow soils have a brown to dark reddish-brown surface layer that is soft to slightly hard when dry and friable when moist and has platy to granular structure. They have a dark reddish-brown subsoil that is hard when dry and firm when moist and has blocky structure. Their substratum is dark reddish brown, extremely hard, calcareous, and blocky. The lower part of the substratum contains many fragments of shale. The texture is mainly clay below a depth of 6 inches.

Soils of the Showlow series occur chiefly in the western part of the Area. They are associated with Ordnance, Sanchez, and Thurloni soils.

Showlow loam, 0 to 5 percent slopes (Sh).—This soil is on old alluvial fans and terraces in Dents Valley, north of Ramah Reservoir.

The surface layer is reddish-brown, friable loam about 2 inches thick. The subsoil is reddish-brown, noncalcareous, firm silty clay or clay about 26 inches thick. Beneath this is dusky-red, friable, calcareous silty clay loam about 24 inches thick. In most places this layer contains visible lime. Its lower part is massive. In many places the uppermost 2 or 3 inches are hard when dry, probably as a result of trampling by cattle.

Infiltration is moderate or moderately slow, and permeability is moderately slow. The capacity to store water is medium, but the capacity for sustained yield is low. Runoff is slow, and the erosion hazard is low to moderate. Fertility is moderately high.

This soil is well suited to herbage. It is used for summer range. Blue grama is abundant. There is much pinyon pine and juniper, but little ponderosa pine. Browse for deer is lacking. (Management group 9)

Showlow clay loam, 5 to 15 percent slopes (Sm).—This soil is on old colluvial fans, foot slopes, and upland benches. In local areas outcrops of shale and sandstone occupy as much as 40 percent of the surface. In some places gravel and fragments of shale cover as much as 30 percent of the surface. There are scattered short step breaks where the slope is as much as 20 percent.

The surface layer is dark reddish-brown, noncalcareous, friable clay loam or heavy loam 6 to 8 inches thick. Below this is reddish-brown or red, hard or firm, noncalcareous, plastic clay, 1 to 3 feet thick, that grades into calcareous, shaly clay or sandy clay. In most places this soil is 30 to 36 inches deep, but the depth ranges from 24 inches to more than 48 inches.

The color of the surface layer ranges from reddish brown to brown to gray to black. The color of the subsoil is reddish brown or red, and the color of the substratum is variegated gray and red. The variation in color is caused by the wide range in color of the weathered shale. The soils are noncalcareous above the shaly clay.

Infiltration is moderate to moderately rapid. Permeability of the subsoil and substratum is slow to very slow. The water-storage capacity is low to medium, and there is little chance of sustained yield. Runoff is medium to

rapid. During hard rains, runoff water is laden with sediments. The erosion hazard is high, and much of the acreage is severely eroded. Fertility is medium.

This soil is poorly suited to timber. Ponderosa pine trees are stunted and of poor quality. The capacity for natural regeneration is poor at best, and in many areas ponderosa does not reseed at all. This soil is only moderately well suited to herbage, but it is used for summer range. The oak brush and mountain-mahogany provide food for deer and turkey. The erosion hazard limits the use of this soil. (Management group 6)

Supervisor series

Well-drained, shallow to moderately deep soils make up the Supervisor series. These soils formed in material derived from granite and granitic gneiss. They are at elevations of 8,600 to 9,200 feet, where the annual precipitation is 20 to 25 inches. The vegetation consists of ponderosa pine, Douglas-fir, limber pine, and a ground cover of Arizona fescue, mountain muhly, squirreltail, and wild oats. Wild flowers and wild strawberries grow in profusion.

Supervisor soils have a brown or dark-brown, gritty surface layer that is soft when dry and loose when moist and has granular structure. They have a brown subsoil that is slightly hard when dry and very friable when moist and has weak, blocky structure. It is gravelly and weakly developed. The substratum is brown also. It is soft when dry and loose when moist and has weak, blocky structure. It is gravelly and rests on granite and gneiss.

Soils of the Supervisor series occur on steep, north-facing slopes in the vicinity of Mt. Sedgwick. They are associated with Mirabal, Larry, and Tampico soils.

Supervisor stony loam, 20 to 45 percent slopes (Su).—This soil is on steep, north-facing slopes in the uplands. There are some granite outcrops, and 10 to 15 percent of the surface is covered with gravel, cobblestones, and coarse fragments of rock. Included in the areas mapped are some areas where the texture of the surface layer is gravelly sandy loam or gravelly loam.

The surface is covered with a mat of pine and fir needles 2 or 3 inches thick. The surface layer is dark-brown stony loam about 5 inches thick. It is soft when dry and loose when moist. It has a distinctly gritty feel. The subsoil is dark-brown, friable gravelly loam about 7 inches thick. This is underlain by soft or loose gravelly sandy loam, 8 to 12 inches thick, that rests on unweathered granite.

The depth to fractured bedrock ranges from 12 to 30 inches and is generally more than 20 inches. Gravel makes up approximately 25 to 30 percent of the soil mass. The content of stones and cobblestones increases with depth.

Infiltration is rapid, and permeability is moderately rapid. The capacity for sustained yield of water is very high. Runoff is medium, and the erosion hazard is high. Roots penetrate to the fractured granite. The organic-matter content of the surface layer is high. Fertility is moderate.

This soil is well suited to ponderosa pine and is moderately well suited to herbage. It is used for summer range. The forest-covered slopes are scenic, and they provide areas of escape and concealment for deer and turkey. (Management group 4)

Tabiona series

Deep, well-drained, medium-textured, highly calcareous soils make up the Tabiona series. These soils formed in alluvium and colluvium derived from San Andres limestone and from sandstone of the Yeso formation. They are at an elevation of about 7,500 feet, where the annual precipitation is about 14 inches. The vegetation consists of blue grama, snakeweed, rabbitbrush, and some juniper and pinyon pine.

Tabiona soils have a highly calcareous, reddish-brown surface layer that is soft or loose when dry and very friable when moist and has granular structure. They have a reddish-brown, highly calcareous, blocky subsoil that is slightly hard to hard when dry and very friable when moist. This substratum is reddish brown, calcareous, slightly hard or friable, and massive.

Soils of the Tabiona series occur as fans and valley fill adjacent to the Zuni Canyon escarpment. They are associated with Jekley, McGaffey, and Tampico soils and with Rock outcrop, cliffs.

Tabiona fine sandy loam, 10 to 15 percent slopes (Ta).—This soil occurs in strips along the base of high escarpments. There are only a few stones on the surface. There are some gullies, mostly leading from the base of the escarpments to the main drainageways. These gullies were formed mainly through the force of runoff from the adjacent escarpments and the talus slopes.

The surface layer is reddish-brown, highly calcareous, granular fine sandy loam about 10 inches thick. It is soft when dry and very friable when moist. The subsoil is reddish-brown, highly calcareous, very friable, blocky loam or clay loam about 8 inches thick. The lower part of the subsoil contains visible lime and unweathered fragments of limestone and sandstone. Below this is reddish-brown, strongly calcareous, blocky sandy loam, about 10 inches thick, that grades to very friable, massive sandy loam.

Infiltration and permeability are moderate. The capacity to store water is medium, but the capacity for sustained yield is low. Runoff is generally medium, but it is moderately rapid in areas where the vegetative cover is depleted. The erosion hazard is moderate, but the soil is susceptible to gullying. Root penetration is moderately deep. Fertility is medium.

This soil is moderately well suited to herbage and is used for spring, summer, and fall range. It is below the zone that receives enough moisture for ponderosa pine. There is little pinyon pine or juniper. Browse suitable for big game is lacking. (Management group 9)

Tampico series

Deep, dark-colored, well-drained soils, mainly on bottom lands, make up the Tampico series. These soils formed in alluvium derived from reddish-brown granitic rocks. They are at elevations of 7,700 to 8,500 feet, where the annual precipitation is 18 to 22 inches. The vegetation consists mainly of ponderosa pine. Douglas-fir and aspen are mixed with the pine at the higher elevations. Some pinyon pine and juniper and scattered stands of oak brush also grow on these soils. The ground cover consists chiefly of Arizona fescue, blue grama, mountain muhly, rabbitbrush, and iris. In many places the iris plants are abundant.

Tampico soils have a dark-brown surface layer that is soft when dry and very friable when moist and has platy to granular structure. Both their subsoil and their substratum are reddish brown and gravelly. They are very hard when dry and friable when moist and have blocky structure. These soils have a pronounced gritty feel because of the high content of fine particles of granite.

Soils of the Tampico series occur on the floors of long, narrow valleys and canyons, on alluvial fans, and on gently sloping toe slopes. They are associated with McGaffey, Mirabal, Supervisor, and Zuni soils.

Tampico loam (2 to 10 percent slopes) (Tc).—About 90 percent of this soil is on the floors of drainageways and canyons in areas underlain by granite. The rest is on broad alluvial fans. This soil is noncalcareous. In most places the surface is free of coarse fragments, but in the narrow drainageways there are some granitic cobblestones and stones on the surface.

The surface layer is dark-colored, granular loam about 11 inches thick. It is covered by an inch of organic mulch. The texture of the surface layer may be loam or sandy loam. Beneath this is reddish-brown gravelly clay loam, 18 to 20 inches thick, that grades to reddish-brown very gravelly clay loam or loam. The texture of the subsoil may be loam or sandy clay loam. Considerable micaceous material occurs throughout the profile. In most places this soil is 40 inches deep, but the depth may be as little as 36 inches or as much as 48 inches. In many places a buried soil is exposed along stream channels.

Infiltration is rapid, and permeability is moderate. The capacity for water storage and the capacity for sustained yield are high. Runoff is slow. The erosion hazard is moderate, and most areas are gullied. Root penetration is deep. Fertility is low to moderate.

Ungullied areas on bottom lands are well suited to ponderosa pine. In the gullied areas the trees grow more slowly and are of poorer quality, because the gullies drain off moisture and reduce the supply of water. The bottom-land areas are only fairly well suited to herbage. Their productivity is low, and recovery of the plant cover after grazing is slow. Browse is scarce. The alluvial fans are highly productive of grass but are less suitable for ponderosa pine than the bottom lands. (Management group 2)

Tampico loam, dark variant (1 to 3 percent slopes) (Td).—This soil occupies the narrow alluvial floors of mountain canyons in the vicinity of Mt. Sedgwick. It is highly stratified. In most respects it resembles the lower lying Tampico loam, but it is darker colored and is subject to flooding and seepage. This soil is now well drained, but it formerly had a high water table and was saturated for several months during the year. Probably it was the development of gullies that resulted in improved internal drainage.

The surface layer is dark-gray to black, friable loam or silt loam about 6 inches thick. The subsoil is dark-brown, friable silt loam about 12 inches thick. Below this is dark grayish-brown, friable, gravelly heavy loam or clay loam, about 24 inches thick, that grades to dark grayish-brown gravelly loam. There are few stones in the profile, but some of the layers are gravelly.

Infiltration is rapid, and permeability is moderately rapid. The capacity to store water and to release it to springs and seeps is high. Runoff is slow, but gullies have formed and the erosion hazard is high. Roots penetrate to considerable depth. Fertility is medium.

This soil is very well suited to ponderosa pine and well suited to herbage. It is best used for timber and for water storage. (Management group 2)

Thurloni series

Moderately deep and deep, moderately well drained, fine-textured, strongly calcareous soils make up the Thurloni series. These soils are on uplands. They formed in material weathered from clayey shale of the Chinle formation. They are at elevations of 6,000 to 7,000 feet, where the annual precipitation is 14 to 17 inches. The vegetation consists mainly of pinyon pine and juniper, but there is some ponderosa pine, oak brush, mountain-mahogany, blue grama, western wheatgrass, and squirreltail. Greasewood and shadscale grow in the drier areas. In many places the stands of pinyon and juniper are so dense that there is little other vegetation.

Thurloni soils have a thin, dusky-red surface layer that is very soft when dry and firm to friable when moist and has granular structure. The surface is generally covered with a ½- to 1-inch layer of needle litter. The subsoil and the substratum are weak red or dusky red. They are hard when dry and firm when moist and have blocky structure. These soils are calcareous throughout, and the content of lime increases with depth. Petrified wood is common on the surface, and fragments of limestone occur in some profiles.

The red color is characteristic of the normal soils of the Thurloni series, but a black variant of these soils is also mapped in the Zuni Mountain Area. The variant occurs at elevations of 7,800 to 8,100 feet, where the annual precipitation is 18 to 20 inches. The vegetation includes a great deal of Gambel oak and patches of ponderosa pine.

Soils of the Thurloni series occur on the lower flank of the Zuni Mountains. They are associated with Prewitt, Sanchez, and Ordnance soils.

Thurloni clay, 5 to 20 percent slopes (Th).—This soil occurs in the uplands where the vegetation is mainly pinyon pine and juniper. About 20 percent of the surface is covered with fragments of shale and sandstone. In places there are short breaks where the slope is as much as 30 percent. A small acreage of shaly alluvium is included in the areas mapped.

The surface layer is dusky-red to red, calcareous clay or clay loam about 2 to 4 inches thick. Beneath this is red, plastic, strongly calcareous clay, 12 to 24 inches thick, that grades to a highly calcareous, massive layer that contains much shale.

In most places this soil is 30 inches deep, but the depth ranges from 24 to 40 inches. Generally, the soil is calcareous to the surface, and visible lime is present just a few inches below the surface.

The color of the surface layer is dominantly red and reddish brown, but in places it is grayish brown and brown. The color of the subsoil is generally red, but it may be grayish red or dark gray. The variation is caused by the range in color of the shale beds. When dry, most of this soil is loose or soft, but in places the surface crusts.

Infiltration is generally moderate to rapid. Permeability is slow to moderately slow. The capacity to store water is only medium, and the capacity for sustained yield

is very low. Runoff is slow to medium in most places, but it is rapid on the steeper slopes. The erosion hazard is high, and many areas are gullied or eroded. Fertility is high.

This soil is used chiefly for spring, summer, and fall grazing. It is poorly suited to commercial production of ponderosa pine but is moderately well suited to herbage. Many areas are used as winter range by deer. Careful management is needed to maintain enough vegetative cover to control erosion. (Management group 6)

Thurloni clay, black variant, 3 to 10 percent slopes (Tk).—This soil is like Thurloni clay, 5 to 20 percent slopes, but it has a distinctive black color. It occurs only at the mouth of and immediately adjacent to Dan Valley. Cherty gravel and quartzite are common on the surface and within the profile. In many places nodules of lime occur on the surface. There are some gullies. Rills and cuts form easily.

The texture of the surface layer is generally clay, but it may be silty clay loam or heavy clay loam. The subsoil is clay.

Runoff is slow to medium, and the erosion hazard is high. The capacity for water storage is only medium, and the capacity for sustained yield is low. Fertility is moderately high to high.

This soil is used chiefly for spring, summer, and fall grazing. It is moderately well suited to herbage, but it is poorly suited to timber. It supports a great deal of Gambel oak and islands of ponderosa pine. The thickets of oak brush provide food for deer and turkey. (Management group 6)

Trail series

Deep, well-drained soils on smooth, gently sloping alluvial fans and valley bottoms make up the Trail series. These soils are somewhat stratified and moderately coarse textured. They formed mainly in reddish-brown alluvium washed from adjacent sandstone slopes. Some of the parent material may have been wind deposited. These soils are at elevations of 7,000 to 7,500 feet, where the annual precipitation is 15 to 18 inches. The vegetation is mostly ponderosa pine, but it includes blue grama, oak brush, juniper, filaree, rabbitbrush, mullein, Russian-thistle, sacaton, and squirreltail.

Trail soils have a reddish-brown surface layer that is loose when dry and friable when moist and is single grain or has platy structure. Their subsoil and substratum are reddish brown, soft when dry and friable when moist, and massive or single grain. Generally, these soils are calcareous to the surface. In places they overlie a buried soil.

Soils of the Trail series occur in the southern and southwestern parts of the Area, between the Nutria Hogback and the western flank of the Zuni Mountains. They are associated with Savoia and Prewitt soils.

Trail loamy fine sand (1 to 3 percent slopes) (Tm).—This soil is on smooth alluvial fans and bottoms. The surface is free of stones and outcrops. In places there are pebbles and fine gravel within the soil mass. Deep gullies have formed.

The surface layer is reddish-brown loamy fine sand about 12 inches thick. Reddish brown is the typical color of this soil, but in places brown is the dominant color. The texture of the surface layer is generally loamy fine sand, but local spots have a loamy sand or sandy loam texture. The subsoil is reddish-brown, weakly calcareous fine sandy loam or loamy fine sand that grades to massive, weakly consolidated sandy material.

Infiltration is rapid, and permeability is moderately rapid. Water penetrates deeply. The capacity to store water is high, but the capacity for sustained yield is low to medium. Runoff is slow. The erosion hazard is high, and headcuts form easily once a gully is started. Root penetration is deep. Fertility is moderate.

This soil is moderately well suited to both timber and herbage. It is used for grazing late in spring, in summer, and early in fall. Most of the original pine has been cut, but the second-growth stand is fair. (Management group 2)

Trail loamy fine sand, hummocky (1 to 3 percent slopes) (Tn).—This soil is on north-facing slopes. In most respects it is like Trail loamy fine sand, but it is hummocky and there are some active dunes. It may have been dry-farmed at one time. This soil is highly susceptible to wind erosion.

The vegetation consists chiefly of rabbitbrush, annual weeds, and blue grama. Most of it is on the leeward side of low dunes and in troughs between the dunes. A few ponderosa pines grow in the troughs.

This soil is less suitable for ponderosa pine than the smoother phase of Trail loamy fine sand, but it is moderately well suited to herbage. A good vegetative cover is needed to control erosion. (Management group 2)

Turkeysprings series

Deep, well-drained, calcareous soils on benches and on long, gentle dip slopes make up the Turkeysprings series. These soils formed in material derived from limestone of the San Andres formation and modified in places by highly calcareous clayey shale of the Chinle formation. They are at elevations of 7,200 to 7,800 feet, where the annual precipitation is 19 or 20 inches. These soils are easy to dig, and they feel soft when walked upon. The vegetation consists of ponderosa pine, pinyon pine, juniper, Gambel oak, cliffrose, Apache-plume, blue grama, and Arizona fescue.

Turkeysprings soils have a calcareous, reddish-brown surface layer that is very soft when dry and friable when moist and has platy to granular structure. The subsoil is highly calcareous, reddish brown, and blocky. It is hard to very hard when dry and friable when moist. The reddish-brown, highly calcareous substratum is hard when dry and friable when moist. It is massive or has blocky structure. Limestone bedrock is at a depth of 40 to 50 inches in most places.

Soils of the Turkeysprings series occur on undulating uplands. They are associated with Fortwingate, Kiln, and McGaffey soils.

Turkeysprings clay loam, 2 to 10 percent slopes (Tu).—This soil is on benches and uplands. It is calcareous to the surface. In a few places, on short, sharp breaks, the slope is as much as 20 percent. Included in the areas mapped are areas of Kiln rocky complex, 3 to 20 percent slopes. Also included are areas of a strongly calcareous soil on alluvial fans. The inclusions are about equal in extent and make up approximately 10 percent of the complex.

The surface layer is reddish-brown, friable clay loam or loam about 7 inches thick. In places the color is brown or grayish brown. Most of the surface is covered with a ½- to 1-inch layer of needle litter. The subsoil is reddish-brown, friable clay loam or silty clay loam about 10 inches thick. This is underlain by silty clay or silty clay loam, 20 inches thick, that is massive or has blocky structure. The depth to limestone bedrock is as much as 50 inches in places.

Infiltration is rapid, and permeability is moderate. The capacity for water storage is high, but the capacity for sustained yield of water is only medium at best. Runoff is slow to medium. Root penetration is moderately deep. Fertility is moderately high. Although there is a moderate hazard of erosion, the vegetative cover is adequate for protection, and there is little damage from erosion. The surface layer of the included alluvial soil is highly dispersed and easily eroded. This inclusion has rapid runoff, and rills and gullies are common.

This soil is used for production of ponderosa pine and for seasonal grazing. It is well suited to timber and herbage. Oak brush, cliffrose, and Apache-plume provide good browse for deer. On the included alluvial soil, there are no trees and the vegetation consists of Russian-thistle, snakeweed, reedgrass, rabbitbrush, blue grama, and western wheatgrass. (Management group 5)

Valentine series

Deep, somewhat excessively drained, coarse-textured soils on undulating or hummocky uplands make up the Valentine series. The hummocks formed partly as a result of wind action. These soils developed in old wind-blown deposits and in material derived from sandstone of the Chinle formation. They are at an elevation of 8,200 feet, where the annual precipitation is about 18 inches. The vegetation consists of a mixed cover of ponderosa pine, rabbitbrush, bitterbrush, grass, and forbs. Much of the acreage has been heavily cut over. Regeneration of ponderosa pine is good in most places.

Valentine soils have a brown, single-grain surface layer that is soft when dry and loose when moist. They have a light-brown or brown, single-grain substratum that is slightly hard when dry and loose when moist. The substratum is underlain by soft, massive sandstone that contains many rounded grains of sand.

Soils of the Valentine series occur on the southern flank of Oso Ridge. They adjoin Kiln and Sanchez soils.

Valentine loamy fine sand, 5 to 15 percent slopes (Va).—This soil is on dip slopes. It is free of outcrops and almost free of stones.

The surface layer is brown, very friable, noncalcareous loamy fine sand about 9 inches thick. The texture ranges from fine sand to loamy fine sand to fine sandy loam. Beneath this is brown, loose, noncalcareous fine sand, about 40 inches thick, that grades to massive, soft sandstone. Nearly all of the sand grains are rounded. Typically, the soils are noncalcareous, but lime occurs in spots, probably as a result of the presence of lime in the sandstone. In most places the depth of the soil is between 50 and 55 inches, but it may be as little as 40 inches or as much as 60.

Infiltration is very rapid, and permeability is rapid. The capacity for water storage is moderate, and the capacity for sustained yield of water is low. Runoff is slow, but the erosion hazard is high. Roots penetrate deeply. Fertility is medium.

This soil is well suited to timber and herbage. It is used for production of ponderosa pine and for summer range. Although the pine has been heavily cut, this soil supports a stand of thrifty and vigorous young trees. The understory of shrubs and forbs supplies desirable forage for deer. Careful management is necessary to maintain an adequate cover of vegetation, because wind erosion and water erosion are active in areas where the plant cover is depleted. (Management group 2)

Wilcoxson series

Deep and moderately deep, well-drained soils on gently undulating uplands and terraces make up the Wilcoxson series. They formed in material weathered from Madera limestone. In places the soils have been slightly modified by granite. They are at elevations of 7,600 to 8,000 feet, where the annual precipitation is 18 to 20 inches. The vegetation consists mainly of blue grama and Arizona fescue. There is also snakeweed, rabbitbrush, oak brush, and ponderosa pine.

Wilcoxson soils have a dark reddish-brown or brown surface layer that is soft when dry and friable when moist and has platy to granular structure. They have a reddish-brown subsoil that is very hard when dry and friable when moist and has prismatic to blocky structure. Their substratum is reddish brown and calcareous. It is hard when dry and friable when moist and has weak prismatic to blocky structure. In most places the depth to hard limestone is more than 40 inches.

Soils of the Wilcoxson series occcur in areas abutting the granite uplifts of the Zuni Mountains. They are associated with Andrews, Jekley, McGaffey, and Zuni soils.

Wilcoxson loam, 3 to 5 percent slopes (Wc).—This soil is on old terraces. In some areas, on short breaks, the slope is as much as 15 percent. Included in the areas mapped are areas of Mirabal stony loam, 5 to 15 percent slopes, that make up about 10 percent of the acreage. Also included are small outcrops of granite and small areas of Zuni sandy loam, 2 to 10 percent slopes. Many quartz pebbles are on the surface and within the profile.

The surface layer is brown, friable, noncalcareous loam or fine sandy loam about 8 to 10 inches thick. Under trees there is a 1- or 2-inch layer of needle litter. The subsoil is noncalcareous, reddish-brown or brown clay, about 15 to 20 inches thick, that is hard when dry. This is underlain by a strongly calcareous mixture of clay, fragments of lime, and weathered granite. This layer is commonly at a depth of 36 inches, but in places it is at a depth of only 20 inches.

Infiltration is moderate, and permeability is moderate or moderately low. The capacity for water storage and the capacity for sustained yield of water are medium. Runoff is medium, and the erosion hazard is moderate. Fertility is moderately high.

This soil is well suited to herbage and is used as summer range for cattle. It is well suited or moderately well suited to timber and supports a good stand of young ponderosa pine. Some of the areas were formerly used for oats and other small grains, but none of the acreage is now used for cutivated crops. The old fields have reverted to native grasses. Use of these soils by wildlife is

limited by the scarcity of suitable browse. (Management group 5.)

Wilcoxson clay loam, 3 to 15 percent slopes (Wn).—This soil is on undulating and rolling uplands. In places there are outcrops, and in some areas as much as 30 percent of the surface is covered with gravel and nodules of limestone. Included in the areas mapped are areas of a cherty soil with a thinner, coarser textured surface layer than the Wilcoxson soil. This inclusion makes up 5 percent of the mapping unit. It occurs chiefly in the northeastern part of the survey Area and is 200 to 400 feet lower in elevation than the major part of the mapping unit. It has a good cover of blue grama, pinyon pine, and juniper.

The surface layer of Wilcoxson clay loam, 3 to 15 percent slopes, is reddish-brown, noncalcareous, friable clay loam about 7 inches thick. The texture ranges from silt loam to clay loam, and the color from reddish gray to dark grayish brown or dark reddish brown. The subsoil is reddish-brown, friable heavy clay about 16 inches thick. In most places the texture of the subsoil is clay, and the color is reddish brown or strong brown. The lower part of the subsoil is highly calcareous and contains much visible lime. The subsoil is underlain by reddish-brown clay that contains pebbles and nodules of limestone and is about 20 inches thick. The depth to limestone is normally 40 to 50 inches, but in places the depth to bedrock or to boulders is only 30 inches.

Infiltration is moderate, and permeability is moderately slow. The capacity for water storage is medium to high, but the capacity for sustained yield of water is low. Runoff is slow to medium, and the erosion hazard is moderate. Root penetration is moderately deep, and roots are abundant in the uppermost 12 inches of the profile.

This soil is moderately well suited to timber and herbage. It provides forage for summer grazing, but much of the desirable herbage has been depleted. Most of the mature pine has been logged, and the remaining trees are young. The use of this soil by big game is limited by the scarcity of suitable browse. (Management group 5)

Zuni series

Deep and moderately deep, moderately well drained, noncalcareous soils on gently sloping and gently undulating uplands make up the Zuni series. These soils formed in reddish, medium-textured or fine-textured material weathered from granite. They are at elevations of 7,800 to 8,200 feet, where the annual precipitation is 18 to 20 inches. The overstory consists mainly of second-growth ponderosa pine (fig. 25) but includes some Gambel oak. The understory consists of Arizona fescue, mountain muhly, blue grama, and squirreltail. Most areas of these soils have been heavily logged, but natural regeneration of ponderosa pine is good, and reproduction thickets are common.

Zuni soils have a grayish-brown to brown surface layer that is soft when dry and very friable when moist and has platy to granular structure. In most places the surface is covered by a 1- to 2-inch layer of pine needles and grass litter. The subsoil is reddish brown. It is very hard or extremely hard when dry and friable when moist. It has prismatic to blocky structure. The substratum is also reddish brown. It is slightly hard when dry and friable

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Figure 25.—Zuni sandy loam, 2 to 10 percent slopes, forested with ponderosa pine.

when moist and is massive. It contains much weathered granite. All of the layers have a gritty feel.

Soils of the Zuni series occur in forested areas. They are associated with Mirabal, Wilcoxson, and Tampico soils.

Zuni sandy loam, 2 to 10 percent slopes (Zd).—This soil is on gently sloping to undulating uplands. Included in the areas mapped are areas of Tampico soils in swales and on the floors of narrow canyons. Also included are outcrops of granite and areas of Mirabal stony loam, 5 to 15 percent slopes. These included areas make up about 10 percent of the mapping unit.

The surface layer is brown, light-brown, or grayish-brown, friable sandy loam about 12 inches thick. The subsoil is reddish-brown or brown, friable clay loam or clay about 16 to 20 inches thick. In places the subsoil contains a few pebbles of granite. The substratum is reddish-brown, brown, or yellowish-red, friable sandy clay loam mixed with weathered granite. In most places the depth of the soil is between 36 and 48 inches, but it may be as little as 20 inches or as much as 60. The variation in the color of the soil results from variation in the color of the underlying granite.

Infiltration is moderate in most places, but it is slower in places that do not have a mat of litter, because the surface becomes puddled and crusted. Permeability is moderate in the upper part of the profile but is retarded in the clayey subsoil. The capacity for water storage is medium to high, and the capacity for sustained yield of water is medium. Runoff is generally slow because of the mat of litter, but it is medium to fast in bare areas. The erosion hazard is moderate. Fertility is medium.

This soil is moderately well suited to timber and herbage. Wildlife, mainly deer, inhabit the area, although desirable browse is scarce. Ponderosa pine grows rapidly the first 30 or 40 years, then more slowly. The forests are scenic, and the use of these areas for recreation could be increased. (Management group 5)

Zuni-Mirabal stony loams, 10 to 30 percent slopes (Zm).—This complex consists of intermingled Zuni and Mirabal soils. It occurs in many of the areas that are underlain by granite. The Zuni soils make up 60 percent of the mapping unit and generally occupy the less sloping areas.

Some areas have granite outcrops. In many places stones and cobblestones make up as much as 40 percent of the soil mass. Other areas, mainly of Zuni soils, are almost free of stones. The depth of the soil is 18 to 24 inches in most places, but it may be as little as 10 inches or as much as 35. The Zuni soils have distinct layers, but the Mirabal soils do not. Areas that have not been heavily logged have a layer of needle litter on the surface.

Infiltration is rapid, and permeability is moderately rapid to moderate. In most places runoff is medium, but in areas where the surface is exposed to the sun, infiltration is slowed and runoff is rapid. The water that runs off the surface is collected in stock tanks and ponds. The soils readily transmit underground water to springs and seeps. The erosion hazard is high, and soil loss is serious in lightly vegetated areas. Fertility is medium.

This complex is used for ponderosa pine and for spring, summer, and fall range. Sawtimber is cut from the forest. (Management group 4)

Genesis, Morphology, and Classification of the Soils

This section describes the major factors of soil formation as they exist in the Zuni Mountain Area; discusses briefly the principal processes of soil formation; provides detailed descriptions of soil profiles to illustrate the morphology of the soils that have developed in the Area; and shows how the soils of the Area are classified into categories broader than the series.

Factors of soil formation

The major factors in soil development are parent material, topography, vegetation, climate, and time. The importance of each factor differs from place to place, and each modifies the effect of the other four. The parent material is modified by the action of climate and vegetation. Topography, or relief, largely controls runoff and exposure to sun and wind and, thus, modifies the effectiveness of climate and vegetation. Time affects the depth or degree to which the soil has developed and the number, kind, and character of the horizons. The effect of time is modified by relief and by the nature of the parent material.

Soils are the product of the complex interaction of the various factors. A small variation in one of the factors will produce a different kind of soil. In the Zuni Mountain Area there are differences in climate, parent material, topography, elevation, and kinds and numbers of living organisms. It is common to find variations in one or more of the soil-forming factors within short distances. Consequently, there are great differences among the soils.

With the logging of the pine forest and the development of agriculture, the activities of man have become a factor in soil development. The heavy cutting of the pine, the cultivation of the soils, and prolonged grazing use influence the direction and rate of future soil development. Few results of these practices can be seen as yet. Some may not be evident for many centuries. The balance of factors affecting soil genesis has been changed, however, as a result of man's activities.

PARENT MATERIAL

Igneous rocks, both acid and basic, sedimentary rocks, metamorphic rocks, and unconsolidated deposits have all contributed parent material for the soils of the Zuni Mountain Area. The soils in the uplands developed in residuum weathered from various kinds of rocks. The valley fill and terrace soils developed from mixed sediments that originated in alluvium and in deposits from rocks and soils of the uplands. Dust from adjacent desert lands has been deposited by wind over all parts of the Area, and some of the soils developed in this material.

Sandstone and siltstone are widespread. They have had a strong influence on the development of many of the soils. The fine-grained sandstone and siltstone of the Abo and Yeso formations are the sources of the parent materials of the Jekley and Savoia soils. The reddish and reddish-brown color of these soils is attributed to the color of the sandstone and siltstone. The Fortwingate and Osoridge soils formed from material derived from fine-grained Glorieta sandstone. These soils have a high content of fine sand and very fine sand in their sand fractions. The characteristic reddish-brown color of their B horizon is inherited from the natural color of the parent rock and is influenced by the many iron concretions in the sandstone. The hard Glorieta sandstone is the source of the parent material of very stony and rocky soils, of which those in the Osoridge complexes are examples.

Gallup sandstone is coarse grained. It is the source of the parent material of the Bond soils, and the sand fraction of these soils is coarser than that of any of the other soils derived from sandstone. A reddish-colored B2 horizon is characteristic of the Bond soils; the color is inherited from the rock.

Shale, generally of the Chinle formation, occurs in many parts of the Area. Shale outcrops are common. The soils derived from shale are moderately fine textured or fine textured, alkaline, and calcareous. Soil colors vary widely and follow the color pattern of the shale. The soils are unstable and tend to erode easily. The Showlow and Thurloni soils are representative.

The Chinle formation contains interbedded sandstone and lenses of conglomerate. Outcrops of shale and sandstone are common. Parent materials weathered from this formation are mixed, and the resulting soils occur in complex patterns. The Ordnance and Sanchez soils are representative. In these soils, particularly in the Ordnance soils, the influence of shale is reflected in the clay content of the B horizon.

The soils derived from limestone are high in silt and clay and contain many fragments of the parent rock. A surface accumulation of limestone fragments is characteristic of the Andrews, Kiln, and Laporte soils. The soils that developed over limestone are fairly stable and generally are pervious to air, water, and roots. The texture of the surface layer ranges from loam to clay loam. The most common limestone in the Area is the massive, dense, reddish San Andres limestone. Soils derived from this limestone inherit the color of the parent material, unless they contain enough humus in the surface layer or in the subsoil to make them dark colored. Some of the soils derived from limestone are noncalcareous at the surface, but others are calcareous throughout. Some of the soils have been influenced by calcareous mudstone and are calcareous at the surface.

Granite and associated rocks, such as gneiss and schist, are the source of the parent material of many of the soils in the Area. Many of the soils derived from granite are coarse textured and exhibit weak profile development. This is particularly true of soils at higher elevations or on steep slopes. Soils on the steep, granitic slopes where geologic erosion is common are shallow, and soil characteristics are inherited directly from the parent material. Most of these soils contain many rock fragments and considerable gravel. The Mirabal, Supervisor, and Kettner soils are examples.

Much of the granitic area in the Zuni Mountains is gently sloping, and the granite is fine grained, dense, and reddish. This fine-grained granite contains more clay than do other kinds of granite. The soils derived from this material have a medium-textured surface layer and a B2 horizon of sandy clay or clay. The Zuni soils are examples.

A few of the soils in the Area were derived from basalt, cinders, and other volcanic material. Most of the cinder accumulations are a result of volcanic activity that took place about 1,200 years ago. Soils derived from basalt have developed horizons and are moderately fine textured or fine textured. Their dark-brown or reddish-brown color is inherited from the parent material. Gravelly basalt, cobblestones, and stones are common on the surface and within the soil mass. Soils derived from cinders are shallow, medium textured, and weakly developed. They have a light-brown color. The weak development of the profile results from a lack of strong climatic factors and from resistance of the cinders to weathering. The Gem soils are examples of soils formed from basalt. Bandera soils are examples of soils formed from cinders.

Many of the soils in this Area have been influenced by pumice. Petrographic analysis has shown that pumice minerals are present in the very fine sand fraction of many of the surface soils in various parts of the Area. The many vents and cinder cones along the southern and southeastern boundaries of the Area are probably the sources of the pumice.

Old valley fills, old terrace deposits, and recent alluvial deposits contain a mixture of parent materials that vary widely in composition and texture. Sediments derived from granite and sandstone are sandy and permeable. In places they are gravelly. Sediments derived from limestone and shale are fine textured and less permeable. In the more recent alluvium, the texture may vary widely within very short distances. If limestone or other calcareous materials have contributed to the parent material, the soils are likely to be calcareous. Soils that have a buried A horizon are common in areas of alluvial deposits.

Wind-deposited materials are a part of the parent material of several of the soils. The Valentine soils, the hummocky phase of the Trail soils, and the Savoia soils have all been strongly influenced by dust blown from surrounding areas. The Valentine and Trail soils are being modified by wind at the present time.

TOPOGRAPHY

Topography influences soil formation through its effect on other soil-forming factors. Differences in elevation and aspect are associated with differences in climate and vegetation. Generally, the deeper and more strongly developed soils are in areas of gentle topography, where runoff is slow and the loss of soil through erosion is slight. The shallower, less strongly developed soils are on ridgetops and steep slopes, where runoff is rapid and much soil is lost through erosion.

Soil-forming processes have varied greatly within short distances as a result of abrupt and significant changes in relief. Soils that show little or no development lie next to deep, well-developed soils. For example, the deep, well-developed, gently sloping Wilcoxson soils adjoin the shallow, weakly developed, moderately sloping or steeply sloping Andrews soils. Both soils formed from material weathered from Madera limestone.

Northerly and southerly exposures are markedly different in their effect on soil development in this Area. Especially at the highest elevations and on the steepest slopes, the soils on north-facing slopes have a deeper layer of litter and a darker and thicker A1 horizon than the soils on south-facing slopes. The Supervisor soils on north-facing slopes and the Mirabal soils on south-facing slopes are examples of the differing effect of aspect. At lower elevations and on more gentle topography, differences in aspect have much less effect on soil development.

Soils on bottom lands and on gentle slopes receive considerable runoff from surrounding higher areas. Consequently, they are wet or waterlogged during a large part of the year. The runoff waters also deposit organic matter on these soils, as evidenced by the accumulation of organic material in their A1 horizon. The Larry and Polich soils are examples of bottom-land soils that have been influenced in their development by relief that has caused them to receive runoff water.

VEGETATION

Vegetation adds organic matter to the soil and influences its structure, physical condition, and chemistry. The horizon most significantly affected is the A1.

The soils that developed under ponderosa pine forest have a dark-colored A1 horizon that is 5 to 10 inches thick. This horizon has granular structure, and its pH value ranges from 6.2 to 6.6. In many places the dark color extends into the A3 and B1 horizons. Few of these soils are calcareous.

The soils that developed under pinyon pine and juniper also have a dark-colored A1 horizon, but this layer is only 2 to 5 inches thick and its pH value ranges from 7.0 to about 8.0. It has granular structure. Most of the soils in the pinyon pine-juniper zone are calcareous, and some of them are calcareous to the surface.

The soils in the transitional zone between the pinyon-juniper zone and the ponderosa pine zone are the most acid soils of the Area. They have a dark-colored A1 horizon that is 5 to 10 inches thick. They are noncalcareous.

The soils that developed under semidesert grass vegetation have a dark-colored A1 horizon that is somewhat alkaline. The structure of the A1 horizon is granular.

CLIMATE

With elevations ranging from 6,500 to 9,100 feet, the Zuni Mountain Area has a considerable range in temperature and precipitation. The warm, sunny weather that is usual throughout the year favors the chemical reactions that are essential in soil formation, but the rate and intensity of these reactions depend upon the amount of precipitation. The amount of precipitation is least in the

lowest parts of the Area and increases with increasing altitude. Consequently, the soils at lower elevations have less well expressed horizons than those at higher elevations, and they are also lower in organic-matter content.

The soils in this Area become saturated, or nearly so, only at two times during the year—after snowmelt in spring, and after the 2-month rainy period in summer. Thus, they go through a wet-dry cycle only twice a year, and as a result they probably develop much more slowly than soils in more humid regions, where the wet-dry cycle is repeated numerous times each year.

Repeated freezing and thawing can occur in this Area. Even at the higher elevations, the maximum temperature on a warm day in winter may be higher than 60° F., and the minimum temperature at night may be −30° or lower. A daily temperature range of 50° is common in winter.

Aspect influences microclimate and thus affects soil properties and vegetation. Soils on north-facing slopes are generally deeper, more strongly developed, and higher in organic-matter content than those on south-facing slopes. Vegetation generally is thicker on north-facing slopes. The greater the amount of precipitation, the more pronounced is the difference between soils on south-facing slopes and soils on north-facing slopes.

TIME

The age of a soil is judged by the depth, the degree of horizonation, the intensity of weathering and leaching, and the accumulation of clay in the profile. The effect of time as a factor in soil formation depends, to a considerable degree, on the influence exerted by climate and living organisms and on the modifying effects of relief and parent material.

Most of the upland soils of the Zuni Mountain Area have distinct horizons. Some of these—the Fortwingate and Zuni soils, for example—developed in material weathered from very hard, resistant rocks. Formation of these soils must have required an extremely long period of time, and it seems likely that, for a part of that time, the climate was more humid than it now is. Many of the alluvial soils in this Area have distinct horizons and have developed to a higher degree than is typical of alluvial soils. Apparently the deposits have been in place and subject to soil-forming processes for a long time.

The youthful soils in this Area are mostly on steep slopes and ridgetops, where erosion removes soil material almost as fast as it forms and so counterbalances the effect of time.

In the Concho, Trail, Montoya, McGaffey, Prewitt, and Tampico soils, deep gullies and cuts expose buried profiles. As many as three separate profiles may occur in a vertical sequence. The depth of the alluvial deposits and the arrangement of the different profiles indicate that the valley-filling processes have been active over a long period. Also, the presence of several profiles is evidence of ancient erosion cycles. Drastic changes in climate must have taken place during past ages to account for the chain of erosion activity.

Morphology of the soils

Soil morphology in the Zuni Mountain Area has a wide range of expression. Some of the soils have distinct horizons; some have horizons expressed chiefly by differences in color or structure. In other soils the development of horizons is in an early stage, and the horizons are indistinct.

The differentiation of horizons in the soils may be traced to one or more of the following processes: (1) accumulation of organic matter, (2) leaching of carbonates and salts more soluble than calcium carbonate, (3) translocation of silicate clay minerals, and (4) alteration and translocation of iron compounds. Many of the soils have been influenced by two or more of these processes. For example, the first, third, and fourth have affected the morphology of the Zuni soils.

Organic matter has accumulated in the surface layer of all the soils to form an A1 horizon. The organic-matter content and the thickness of the A1 horizons vary. The Nathrop, Ordnance, Osoridge, and Showlow soils have a thin A1 horizon, and the McGaffey, Polich, and Larry soils have a thick A1 horizon. The others have an A1 horizon that is 5 to 8 inches thick.

Leaching of carbonates and salts has probably occurred in all of the soils of the Area, but the degree of leaching varies. Carbonates and salts have been leached from the profiles of the Fortwingate, Kiln, and Zuni soils. The Concho, Montoya, and Prewitt soils still contain carbonates and soluble salts. Leaching of carbonates from the Andrews, Laporte, Ordnance, Thurloni, and Turkeysprings soils has been minimal.

The effect of translocation of silicate clay minerals differs from one soil to another. The Fortwingate, Ordnance, Osoridge, Sanchez, and Zuni soils have a bleached A2 horizon and a distinct B2 horizon with clay films. The Bond, Jekley, Showlow, and Wilcoxson soils also have a well-developed B2 horizon with clay films. The Andrews, Bandera, Laporte, Mirabal, and Supervisor soils show little or no accumulation of translocated silicate clay minerals.

The alteration and translocation of iron compounds is evident in the brown and reddish-brown color of the B2 horizon of many of the soils. This process, including reduction of iron, is also evident in the gleying of the Larry soils. Segregated iron has formed yellowish-red and strong-brown mottles in some of the Polich soils.

The comparative effect of factors influencing horizon differentiation are shown in the detailed descriptions of representative profiles in the section "Classification of the Soils."

Classification of the soils

The system of soil classification (*5*) used in the United States has six categories. Beginning with the most inclusive, the six categories are the order, the suborder, the great soil group, the family, the series, and the type. Only four of the categories—order, great soil group, series, and type—have been widely used.

In the highest category of the classification scheme are the zonal, intrazonal, and azonal orders. All three orders are represented in the Zuni Mountain Area. Seven of the great soil groups are represented: Brown soils, Chestnut soils, Reddish Chestnut soils, Gray Wooded soils, Humic Gley soils, Alluvial soils, Lithosols, and Regosols. The relationship between the order, the suborder, the great soil group, and the series is shown in table 3.

A classification system now being put into use defines classes in terms of observable or measurable properties of

soils. This system is designed to accommodate all soils. It has six categories, like the earlier system, but the categories are slightly different. Beginning with the most inclusive, they are the order, the suborder, the great group, the subgroup, the family, and the series.[3] The soil series identified in this Area are tentatively classified into the new system in table 4.

In the following pages the classification of the soils is discussed in terms of the system used before 1965.

TABLE 3.—*Classification of soils in Zuni Mountain Area according to 1938 system*

Order and suborder	Great soil group and series
Zonal—	
Light-colored soils of arid regions.	Brown soils—
	Concho.
	Friana.
Dark-colored soils of semiarid, subhumid regions.	Chestnut soils—
	Bond.
	Cabezon.
	Gem.
	Jekley.
	Kiln.
	Nathrop.
	Savoia.
	Turkeysprings.[1]
	Wilcoxson.
Dark-colored soils of semiarid, subhumid regions.	Reddish Chestnut soils—
	Showlow.[2]
Light-colored, podzolized soils of timbered regions.	Gray Wooded soils—
	Fortwingate.
	Ordnance.
	Osoridge.
	Sanchez.
	Zuni.
Intrazonal—	
Hydromorphic soils of marshes, swamps, seep areas, and flats.	Humic Gley soils—
	Larry.
Azonal—	
(No suborders)	Alluvial soils—
	McGaffey.
	Polich.[3]
	Prewitt.
	Tabiona.
	Tampico.
	Trail.
	Lithosols—
	Andrews.
	Bandera.
	Kettner.
	Laporte.
	Mirabal.
	Supervisor.
	Regosols—
	Montoya.
	Thurloni.
	Valentine.

[1] Intergrade to Regosols.
[2] Intergrade to Grumusols.
[3] Intergrade to Humic Gley soils and to Chernozems.
[4] Intergrade to Brown Forest soils.

[3] UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL SURVEY STAFF, SCS. SOIL CLASSIFICATION, A COMPREHENSIVE SYSTEM, 7TH APPROXIMATION. 1960. [Amended June 1964]

TABLE 4.—*Classification of soils in Zuni Mountain Area according to Comprehensive System, 7th Approximation*

Order, suborder, great group, and subgroup	Family	Series
ENTISOL		
Orthent:		
Haplorthent—		
Lithic	Loamy, mixed, nonacid, frigid.	Kettner.
Typic	Loamy skeletal, mixed, nonacid, frigid.	Mirabal, Supervisor.
Psamment:		
Normipsamment—		
Typic	Sandy, mixed, nonacid, mesic.	Trail, Valentine.
ARIDISOL		
Orthid:		
Camborthid—		
Mollic	Fine, mixed, mesic	Concho.
MOLLISOL		
Aquoll:		
Haplaquoll—		
Typic	Fine, mixed, frigid	Larry.
Udoll:		
Argiudoll—		
Typic	Fine, montmorillonitic, mesic.	Wilcoxson.
Hapludoll—		
Cumulic	Fine loamy, mixed, frigid.	Polich.
Ustoll:		
Argiustoll—		
Lithic	Clayey, montmorillonitic, mesic.	Cabezon.
Lithic	Loamy, mixed, mesic	Kiln.
Typic	Fine, montmorillonitic, mesic.	Friana, Gem.
Typic	Fine silty, mixed, frigid.	Jekley.
Typic	Loamy, mixed, mesic	Nathrop.
Typic	Fine, mixed, mesic	Showlow.
Calciustoll—		
Haplic	Fine, mixed, mesic	Turkeysprings.
Lithic	Loamy, mixed, frigid	Andrews.
Haplustoll—		
Cumulic	Fine loamy, mixed, frigid.	McGaffey.
Entic	Fine loamy, mixed, mesic.	Prewitt.
Entic	Coarse loamy, mixed, mesic.	Tabiona.
Entic, Andic	Fine loamy, mixed, frigid.	Bandera.
Lithic	Fine loamy, mixed, mesic.	Laporte.
Typic	Fine loamy, mixed, frigid.	Tampico.
Typic	Fine, montmorillonitic, mesic.	Montoya, Thurloni.
ALFISOL		
Udalf:		
Normudalf—		
Lithic	Loamy, mixed, mesic	Bond, Sanchez.
Mollic	Fine loamy, mixed, mesic.	Savoia.
Typic	Fine loamy, mixed, frigid.	Fortwingate.
Typic	Fine, montmorillonitic, frigid.	Ordnance, Osoridge.
Typic	Fine, mixed, frigid	Zuni.

ZONAL ORDER

Zonal soils are those having well-developed characteristics that reflect the influence of the active forces of soil genesis—living organisms, chiefly vegetation, and climate (*6*). The zonal order is represented in the Zuni Mountain Area by the Brown soils, the Chestnut soils, the Reddish Chestnut soils, and the Gray Wooded soils.

BROWN SOILS

Brown soils develop in a temperate or cool semiarid climate, under native vegetation of short grasses, bunchgrasses, and shrubs. They have a brown surface layer, and the subsoil grades to a light-gray or white calcareous layer at a depth of 1 to 2 feet. The Brown great soil group is represented in the Zuni Mountain Area by the Concho and Friana soils. These soils developed in old alluvial deposits. The parent material of the Concho soils is a mixture of sediments weathered from sandstone and shale of the Mesaverde formation; that of the Friana soils is alluvium washed from basalt.

Concho Series

The Concho series consists of deep, well-drained, gently sloping soils on alluvial fans and bottom lands. These soils occur at elevations of 6,500 to 7,000 feet, where the annual precipitation is 12 to 15 inches and the average annual temperature is about 47° F. They developed in old, calcareous alluvium washed from sandstone and shale. They are characterized by a dark-colored A horizon, a B horizon that has distinctive structure and clay accumulation, and a horizon of lime accumulation.

The Concho soils are associated with the Savoia and Bond soils. They are less red than the Savoia soils. They are deeper than the Bond soils, which developed in place over coarse-grained sandstone.

Typical profile of Concho clay loam, in a virgin area under a cover of blue grama and western wheatgrass, on a broad alluvial flat near the western boundary of Cibola National Forest; SE¼ sec. 15, T. 13 N., R. 17 W., McKinley County:

A1—0 to 4 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; loose when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant fine grass roots; noncalcareous; pH 7.5; clear boundary.

B1—4 to 15 inches, dark-brown (10YR 4/3) clay loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, moderately sticky and moderately plastic when wet; abundant medium roots; noncalcareous; pH 7.8; gradual boundary.

B2t—15 to 32 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) when moist; moderate, medium, subangular and angular blocky structure; clay films in voids and on structural units; hard when dry, firm when moist, sticky and plastic when wet; strongly calcareous; pH 8.2; gradual boundary.

C—32 to 47 inches, brown (10YR 5/3) sandy loam to sandy clay loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure to massive; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; strongly calcareous; pH 8.2; gradual boundary.

47 inches +, buried profile.

Many areas have a recently deposited overburden that is somewhat reddish and ranges from 1 to 3 inches in thickness. The areas on alluvial fans have more runoff than those on bottom lands. The content of soluble salts varies from place to place, but most areas are nonsaline.

Friana Series

The Friana series consists of deep, well-drained, gently sloping soils on valley floors and alluvial fans. These soils occur at an elevation of about 7,600 feet, where the annual precipitation is about 15 inches and the average annual temperature is about 47° F. They developed in alluvium washed from basalt. They are characterized by a dark-colored A horizon and by a B horizon in which some clay has accumulated. In a few places the B horizon has a weak zone of accumulated lime.

The Friana soils are associated with the Gem and Bandera soils. The Gem soils developed in residuum over basalt. The Bandera soils formed in volcanic cinders.

Typical profile of Friana silt loam, in a virgin area under a cover of grama; SW¼ sec. 17, T. 9 N., R. 12 W., Valencia County:

A11—0 to 2 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, thin, platy structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; few fine pores; pH 6.4; clear boundary.

A12—2 to 6 inches, grayish-brown (10YR 5/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist, moderately sticky and moderately plastic when wet; few fine pores; pH 6.8; clear boundary.

A3—6 to 18 inches, very dark grayish-brown (10YR 3/2) silty clay, very dark brown (10YR 2/) when moist; strong, fine, subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; common medium-sized pores; pH 7.0; gradual boundary.

B2t—18 to 34 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) when moist; moderate to strong, fine, angular blocky structure; extremely hard when dry, firm when moist, sticky and plastic when wet; very few pores; few thin clay films; pH 7.2; gradual boundary.

B3—34 to 44 inches, reddish-brown (5YR 5/4) clay, dark reddish brown (5YR 3/4) when moist; weak, medium, blocky structure; hard when dry, friable when moist, moderately sticky and moderately plastic when wet; no pores; pH 7.4; gradual boundary.

C—44 inches +, variegated yellowish-red (5YR 5/6) and reddish-brown (5YR 4/4) fine sandy clay loam, dark reddish brown (5YR 3/4) when moist; very weak, medium, subangular blocky structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; pH 7.8.

The texture of the B2 horizon ranges from heavy clay loam to clay. The color of that horizon ranges from dark brown to reddish brown.

CHESTNUT SOILS

Chestnut soils develop under mixed tall and short grasses in a temperate to cool, subhumid or semiarid climate. They have a dark-brown surface horizon, which grades into lighter colored horizons and, finally, into a horizon of lime accumulation. In this area Chestnut soils have a cover of ponderosa pine, pinyon pine, juniper, and Gambel oak, mixed with grasses.

The Chestnut great soil group is represented in the Zuni Mountain Area by the Bond, Cabezon, Gem, Jekley, Kiln, Nathrop, Savoia, Turkeysprings, and Wilcoxson soils. The Bond soils developed in material weathered from

coarse-grained sandstone. Soils of the Jekley series formed in material weathered from red siltstone and fine-grained sandstone. The parent material of the Gem soils weathered from basalt; that of the Turkeysprings and Wilcoxson soils weathered from limestone. The Nathrop soils developed in limestone residuum, and the Savoia soils developed in outwash from sandstone and limestone.

The sequence of major horizons is the same in all the Chestnut soils of the Area, but the degree of horizon development differs. The Gem and Wilcoxson soils have maximal development; the Cabezon, Jekley, Kiln, Savoia, Bond, and Turkeysprings soils have medial development, and the Nathrop soils have weak development. All except the Cabezon, Bond, and Jekley soils have a distinct zone of lime accumulation.

Bond Series

The Bond series consists of shallow, well-drained, stony soils on gently undulating or sloping uplands. These soils occur at elevations of 7,000 to 7,500 feet, where the annual precipitation is 15 to 17 inches and the average annual temperature is about 47° F. They formed in material weathered from coarse-textured, red Gallup sandstone. They are characterized by a dark-colored A horizon and a B2 horizon that has a significantly greater amount of clay than the A horizon. These soils have no accumulated lime. The vegetation consists of ponderosa pine, pinyon pine, juniper, shrubs, and grass.

The Bond soils are associated with the Concho and Savoia soils. They are thinner than those soils, but they have a more strongly developed B2 horizon. They lack the horizon of accumulated lime that is characteristic of the Concho and Savoia soils.

Typical profile of Bond sandy loam, in an area of cutover ponderosa pine; SW¼ sec. 28, R. 16 W., T. 11 N., McKinley County:

O1—O2—¾ inch to 0, ponderosa pine needles, oak leaves, and pinyon pine needles, in various stages of decay; considerable mycelial fungi in the decomposing organic material; the white mycelia are difficult to wet; pH 5.8 or less.

A11—0 to 2 inches, reddish-brown (5YR 5/3) sandy loam, dark reddish brown (5YR 3/3) when moist; single grain; loose when dry, very friable when moist; noncalcareous; pH 7.1; clear boundary.

A12—2 to 4 inches, reddish-brown (5YR 5/3) sandy loam, dark reddish brown (5YR 3/4) when moist; weak, very fine, subangular blocky structure or single grain; soft when dry, friable when moist; noncalcareous; pH 7.0; clear boundary.

B1—4 to 8 inches, reddish-brown (5YR 4/4) sandy clay loam; weak, fine to medium, subangular blocky structure; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 7.0; clear boundary.

B2t—8 to 13 inches, reddish-brown (5YR 4/4) sandy clay, dark reddish brown (5YR 3/4) when moist; weak, medium, prismatic structure breaking to moderate, fine, angular and subangular blocky; many clay films on structural units; hard when dry, very firm when moist, sticky and plastic when wet; noncalcareous; pH 6.9; clear, wavy boundary.

B3t—13 to 17 inches, yellowish-red (5YR 5/6) sandy clay loam containing pebbles and fragments of sandstone; yellowish red (5YR 4/6) when moist; weak, fine, subangular blocky structure to massive; thin, patchy clay films on structural units; hard when dry, firm when moist, moderately sticky and moderately plastic when wet; noncalcareous; pH 7.0; abrupt boundary.

R—17 inches +, pink (5YR 7/4) sandstone, reddish brown (5YR 5/4) when moist; very hard when dry; slightly weathered; some banding with lighter color along cracks; noncalcareous; pH 7.1.

The stone content ranges from 0 to 30 percent and varies considerably within short distances. The depth to bedrock ranges from 12 to 20 inches. In places a distinct A2 horizon underlies the A1.

Cabezon Series

The Cabezon series consists of shallow, dark-colored soils on undulating uplands. These soils occur at elevations of 7,500 to 8,000 feet, where the annual precipitation is 15 to 18 inches and the average annual temperature is about 47° F. In most places the slope is less than 10 percent. These soils formed in residuum weathered from basalt. They are characterized by an A horizon of dark-colored stony loam and a B2 horizon of blocky, reddish-brown clay. The B2 horizon lies directly on basalt. The vegetation consists of blue grama and forbs and some ponderosa pine, pinyon pine, and juniper.

The Cabezon soils are associated with the Bandera and Gem soils. They have a textural B2 horizon, which the Bandera soils lack. They are similar to the Gem soils but are shallow over bedrock.

Typical profile of Cabezon stony loam, under grass and ponderosa pine; NW¼ sec. 28, T. 9 N., R. 12 W., Valencia County:

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) stony loam, very dark brown (10YR 2/2) when moist; weak, thin, platy structure to weak, fine, granular; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abundant fine roots; noncalcareous; pH 6.2; clear boundary.

B1—4 to 8 inches, brown (10YR 4/3) stony clay loam, dark brown (10YR 3/3) when moist; moderate, fine, subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; cobblestones and stones make up about 30 percent of the horizon, by volume; plentiful fine and medium roots; noncalcareous; pH 6.4; clear boundary.

B2t—8 to 15 inches, reddish-brown (5YR 4/3) stony clay, dark reddish brown (5YR 3/3) when moist; weak, medium, prismatic structure breaking to strong, fine, subangular blocky; very hard when dry, firm when moist, sticky and plastic when wet; thin, continuous clay films; cobblestones and stones make up about 30 percent of the horizon, by volume; noncalcareous; pH 7.0; abrupt boundary.

R—15 to 18 inches +, hard, dense basalt; upper 2 inches partly weathered and fractured.

The color range of the A1 horizon includes hues of 7.5YR and 10YR. The texture of the surface layer ranges from stony loam to stony clay loam. The color of the B horizon ranges in hue from 2.5YR to 7.5YR, but 5YR is most common. The depth to bedrock ranges from 8 to 20 inches.

Gem Series

The Gem series consists of well-drained, gently sloping to moderately sloping soils on smooth to undulating uplands. These soils occur at elevations of 7,500 to 8,000 feet, where the annual precipitation is 16 to 18 inches and the average annual temperature is about 47° F. They developed in material weathered in place from basalt. They are characterized by a dark-colored A horizon, a well-developed B2 horizon that has a distinct accumulation of clay, and a weak zone of accumulated lime.

The Gem soils are associated with the Friana and Bandera soils. The Friana soils occupy alluvial fans. The Bandera soils developed from volcanic cinders.

Typical profile of Gem stony loam, under blue grama and ponderosa pine; NW¼ sec. 20, T. 9 N., R. 12 W., Valencia County:

A1—0 to 3 inches, brown (10YR 4/3) stony loam, dark brown (10YR 3/3) when moist; moderate, thin, platy structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; few fine pores; pH 6.3; clear boundary.

A3—3 to 9 inches, brown (10YR 4/3) stony loam, dark brown (10YR 3/3) when moist; weak, fine, subangular blocky structure to weak, fine, granular; slightly hard when dry, friable when moist, moderately sticky and moderately plastic when wet; plentiful medium pores; pH 6.6; clear boundary.

B1—9 to 13 inches, brown (7.5YR 5/4) clay loam, dark brown (7.5YR 3/4) when moist; moderate to strong, fine, subangular and angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; pH 6.8; abrupt, wavy boundary.

B21—13 to 28 inches, brown (7.5YR 5/4) clay, dark brown (7.5YR 3/4) when moist; strong, medium, prismatic structure breaking to moderate, medium and coarse, angular blocky; very hard when dry, firm when moist, sticky and plastic when wet; thin, continuous clay films on peds; pH 7.0; clear boundary.

B22—28 to 38 inches, reddish-brown (5YR 5/4) clay, reddish-brown (5YR 4/4) when moist; moderate, medium, prismatic structure breaking to moderate, medium and coarse, angular blocky; very hard when dry, firm when moist, sticky and plastic when wet; thin, continuous clay films on peds; pH 8.0; noncalcareous, except for a few specks and splotches of lime; gradual boundary.

R—38 inches +, basalt.

Some areas of this soil have a thin O1 horizon. The texture of the surface layer is commonly loam, but in some places it is sandy clay loam, clay loam, or stony loam. In places the A1 horizon is somewhat vesicular. In most places the texture of the B horizon is clay, but in some places it is clay loam. Depth to bedrock ranges from 25 to 40 inches.

Jekley Series

The Jekley series consists of well-drained, shallow to moderately deep soils on undulating to steep uplands. These soils occur at elevations of 7,800 to 8,200 feet, where the annual precipitation is 19 to 21 inches and the average annual temperature is 44° F. They formed in material weathered from siltstone and from fine-grained sandstone of the Abo formation. In some areas the parent material weathered from the red, silty members of the Chinle formation. These soils are characterized by a dark-colored A horizon, a distinct B2 horizon in which clay has accumulated, and, in some places, a weakly developed horizon of lime accumulation. The vegetation is ponderosa pine forest.

The Jekley soils are associated with the Kiln, Fortwingate, and Zuni soils. They are deeper and better developed than the Kiln soils, which formed in material weathered from limestone. They are thinner than the Fortwingate and Zuni soils. Also, they lack the A2 horizon which is characteristic of those soils.

Typical profile of Jekley silt loam, in a virgin area under ponderosa pine and grass; NE¼ sec. 13, T. 13 N., R. 16 W., McKinley County:

O1&O2—2 inches to 0, needles, leaves, and partly decomposed organic material containing mycelial fungi; pH 6.8.

A1—0 to 5 inches, reddish-brown (5YR 4/3) silt loam, dark reddish brown (5YR 3/3) when moist; moderate, thick, platy structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; many roots; some fragments of sandstone; noncalcareous; pH 6.5; clear boundary.

A3—5 to 8 inches, reddish-brown (2.5YR 4/4) heavy silt loam, dark reddish brown (2.5YR 3/4) when moist; moderate, fine and very fine, subangular blocky structure or medium, granular structure; hard when dry, friable when moist, moderately sticky and moderately plastic when wet; many fine pores and roots; noncalcareous; pH 6.5; gradual boundary.

B1—8 to 14 inches, reddish-brown (2.5YR 4/4) silty clay loam, dark reddish brown (2.5YR 3/4) when moist; moderate, fine, subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; many fine pores and roots; noncalcareous; pH 6.5; diffuse boundary.

B21t—14 to 17 inches, reddish-brown (2.5YR 4/4) silty clay, dark reddish brown (2.5YR 3/4) when moist; strong, fine and very fine, subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; few very fine pores; many patchy clay films; noncalcareous; pH 6.4; diffuse boundary.

B22t—17 to 22 inches, reddish-brown (2.5YR 4/4) silty clay loam containing many slightly weathered plates and fragments of sandstone; dark reddish brown (2.5YR 3/4) when moist; weak, fine subangular blocky structure; slightly hard when dry, friable when moist, moderately sticky and moderately plastic when wet; some patchy clay films; noncalcareous; pH 6.4; diffuse, irregular boundary.

R—22 inches +, reddish-brown (2.5YR 4/4) sandstone; platy; fine grained; very hard; many clay flows between the plates of sandstone; pH 7.0.

The depth to the parent rock ranges from 10 to 22 inches. The degree of development of the B2 horizon ranges from weak to strong; in most areas this horizon is strongly developed. The content of sandstone fragments ranges from 0 to about 20 percent.

Kiln Series

The Kiln series consists of very shallow and shallow, well-drained, stony soils on nearly level to steeply sloping uplands. These soils occur at elevations of 7,200 to 7,900 feet, where the annual precipitation is 17 to 20 inches and the average annual temperature is about 44° F. They formed in material weathered from San Andres limestone. They are characterized by a dark-colored A horizon and by a distinctly reddish-brown B horizon. The vegetation consists of ponderosa pine, grass, and much Gambel oak. Most of the Gambel oak is in areas that have been heavily logged.

These soils are associated with the Turkeysprings, Fortwingate, and Osoridge soils. They are shallower than the Turkeysprings and Fortwingate soils. They are less well developed than the Turkeysprings and Osoridge soils.

Typical profile of Kiln stony loam, in a virgin area of cutover ponderosa pine, about 2½ miles south of McGaffey; NE¼ sec. 21, T. 13 N., R. 16 W., McKinley County:

A11—0 to 2 inches, brown (7.5YR 5/4) stony loam, dark brown (7.5YR 4/3) when moist; weak, thin, platy structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; many fine roots; fragments and pieces of limestone cover 30 percent of the surface; noncalcareous; pH 7.6; clear boundary.

A12—2 to 5 inches, brown (7.5YR 5/4) stony loam, dark brown (7.5YR 3/3) when moist; weak, thin, platy structure breaking to weak, very fine, granular; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; few fine pores; many fine roots; noncalcareous; pH 7.4; clear, smooth boundary.

B2t—5 to 10 inches, reddish-brown (5YR 5/3) stony clay, reddish brown (5YR 4/3) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; thin, continuous clay films; noncalcareous; pH 7.6; abrupt boundary.

R—10 inches +, pink (5YR 8/3) limestone, light reddish brown (5YR 6/3) when moist; extremely hard; dense.

The texture of the B horizon ranges from loam to silt loam to stony clay to clay. The depth to the underlying rock ranges from 10 inches to about 18 inches. The reaction is slightly acid to mildly alkaline.

Nathrop Series

The Nathrop series consists of well-drained, gently sloping soils in smooth depressions or in small, narrow valleys in the uplands. These soils occur at an elevation of about 7,200 feet, where the annual precipitation is 13 inches and the average annual temperature is 48° F. They formed in calcareous material weathered from San Andres limestone. They have reached a weak or medial stage of development. The are characterized by a thin, dark-colored A horizon and by a B2 horizon in which clay has accumulated, and also a prominent horizon of lime accumulation. The vegetation differs from that on the other Chestnut soils in the Area in that there is no ponderosa pine.

The Nathrop soils are closely associated geographically and geologically with the Laporte soils, which are Lithosols.

Typical profile of Nathrop loam, in a virgin area under a cover of blue grama; SE¼ sec. 8, T. 11 N., R. 11 W., Valencia County:

A1—0 to 2 inches, reddish-brown (5YR 5/3) loam, reddish brown (5YR 4/3) when moist; moderate, thin, platy structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 7.6; clear boundary.

B1—2 to 5 inches, reddish-brown (5YR 5/4) light clay loam, reddish brown (5YR 4/4) when moist; moderate, thick, platy structure; soft when dry, friable when moist, moderately sticky and moderately plastic when wet; noncalcareous; pH 7.6; clear boundary.

B2t—5 to 8 inches, reddish-brown (5YR 4/4) heavy clay loam, dark reddish brown (5YR 3/4) when moist; moderate to weak, medium, prismatic structure breaking to moderate to weak, fine and very fine, subangular blocky; slightly hard when dry, friable when moist, moderately sticky and moderately plastic when wet; a few thin clay films on peds and in voids; noncalcareous; pH 7.6; clear boundary.

B2tca—8 to 12 inches, brown (7.5YR 5/4) heavy clay loam, brown (7.5YR 4/4) when moist; weak, fine, angular and subangular blocky structure; very hard when dry, friable when moist, moderately sticky and moderately plastic when wet; a few thin clay films; much visible lime and many fine concretions of lime; pH 8.0; gradual boundary.

C—12 to 16 inches, pink (7.5YR 8/4) clay loam, brown (7.5YR 5/4) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; calcareous; pH 8.2; gradual boundary.

C/R—16 inches +, white (10YR 8/2) fragments of limestone and lime-coated fragments of sandstone mixed with clay loam from the C horizon, very pale brown (10YR 7/4) when moist; hard when dry, firm when moist; pH 8.2.

Savoia Series

The Savoia series consists of deep, well-drained soils on gently sloping and undulating uplands and old alluvial fans, terraces, and aprons. These soils occur at elevations of 7,100 to 8,000 feet, where the annual precipitation is 17 to 19 inches and the average annual temperature is about 47° F. They formed in residuum from fine-grained sandstone and in alluvial deposits washed from sandstone and limestone. They are characterized by a brown or reddish-brown A horizon, a distinct textural B horizon, and a weak, but definite, horizon of lime accumulation.

The Savoia soils are associated with the Bond, Concho, Jekley, and Trail soils. They are deeper than the Bond and Jekley soils and do not contain as many coarse fragments. They are better developed than the Concho soils. They are finer textured than the Trail soils, which occupy adjacent alluvial bottom lands and flats.

Typical profile of Savoia fine sandy loam, in an area of cutover ponderosa pine, with a ground cover of blue grama; NE¼NW¼ sec. 11, T. 11 N., R. 16 W., McKinley County:

O1&O2—½ inch to 0, mixture of ponderosa pine needles, twigs, and grass.

A11—0 to 2 inches, brown (7.5YR 4/4) fine sandy loam, dark brown (7.5YR 3/2) when moist; weak, thin, platy structure breaking to weak, fine, granular; soft when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 6.8; clear, smooth boundary.

A12—2 to 6 inches, reddish-brown (5YR 5/3) fine sandy loam, dark reddish brown (5YR 3/3) when moist; weak, thin, platy structure; slightly hard when dry, friable when moist, slightly sticky but nonplastic when wet; noncalcareous; pH 6.4; gradual, wavy boundary.

B1—6 to 12 inches, reddish-brown (5YR 5/4) heavy fine sandy loam, reddish brown (5YR 4/4) when moist; weak, medium, prismatic structure breaking to weak, medium, subangular blocky; hard when dry, friable when moist, moderately sticky but nonplastic when wet; many medium-sized pores; few thin clay films; noncalcareous; pH 6.9; gradual, wavy boundary.

B2t—12 to 24 inches, yellowish-red (5YR 5/6) fine sandy clay loam, yellowish red (5YR 4/6) when moist; moderate medium, prismatic structure breaking to moderate, medium, subangular blocky; very hard when dry, friable when moist, moderately sticky and moderately plastic when wet; medium-sized pores common; thin, continuous clay films; noncalcareous; pH 7.0; diffuse boundary.

B3—24 to 33 inches, yellowish-red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) when moist; weak, coarse, prismatic structure breaking to massive lumps; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; medium-sized pores; no clay films; noncalcareous; pH 7.2; clear, wavy boundary.

Cca—33 to 42 inches +, reddish-yellow (5YR 6/6) fine sandy loam, yellowish red (5YR 5/6) when moist; massive breaking to irregularly shaped lumps; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; very few fine pores; some unweathered sandstone; visible streaks of lime; calcareous; pH 8.2.

The depth to lime ranges from 24 to 40 inches. In places the soil overlies basalt and may have developed in wind-deposited material.

Turkeysprings Series

The Turkeysprings series consists of deep, well-drained upland soils on dip slopes. These soils occur at elevations of 7,200 to 7,800 feet, where the average annual precipitation is 19 to 20 inches and the average annual temperature is about 44° F. They developed in material weathered from San Andres limestone. They are characterized by a

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dark-colored A horizon, a B horizon in which clay has accumulated, and a horizon of lime accumulation.

Although the Turkeysprings soils are classified as Chestnut soils, they resemble Regosols in color and in texture.

The Turkeysprings soils are associated with the Kiln and Fortwingate soils. They are deeper and less stony than the Kiln soils. They are calcareous throughout the profile and lack an A2 horizon, which is present in the noncalcareous Fortwingate soils.

Typical profile of Turkeysprings clay loam, in a virgin area under cutover ponderosa pine, about 4 miles north of McGaffey; SW¼NE¼ sec. 29, T. 14 N., R. 16 W., McKinley County:

A11—0 to 3 inches, reddish-brown (2.5YR 4/4) clay loam, dark reddish brown (2.5YR 3/4) when moist; weak, thin, platy structure; soft when dry, friable when moist, moderately sticky and moderately plastic when wet; many very fine roots; calcareous; pH 7.6; gradual boundary.

A12—3 to 7 inches, reddish-brown (2.5YR 4/4) clay loam, dark reddish brown when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist, sticky and plastic when wet; many fine roots; few fine pores; strongly calcareous; pH 7.8; gradual boundary.

B1—7 to 10 inches, reddish-brown (2.5YR 4/4) clay loam, dark reddish brown when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few fine pores; few fine roots; strongly calcareous; pH 8.0; clear boundary.

B2t—10 to 17 inches, reddish-brown (2.5YR 4/4) silty clay, dark reddish brown (2.5YR 3/4) when moist; weak, medium, prismatic structure breaking to strong, medium, subangular blocky; very hard when dry, firm when moist, sticky and plastic when wet; many fine pores; thin, continuous clay films; strongly calcareous, with mycelial lime; pH 8.2; gradual boundary.

B3ca—17 to 33 inches, reddish-brown (2.5YR 5/4) silty clay, reddish brown (2.5YR 4/4) when moist; weak, medium, prismatic structure breaking to strong or moderate, medium, subangular blocky; hard when dry, friable when moist, sticky and plastic when wet; few patches of clay film; many fine pores; strongly calcareous, with much visible lime; pH 8.5; diffuse boundary.

C—33 to 54 inches, light reddish-brown (2.5YR 6/4) silty clay loam, reddish brown (2.5YR 4/4) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; few small pores; strongly calcareous, with mycelial lime; pH 8.6.

The A1 horizon is weak red to dark brown when dry. The color of the B horizon and of the underlying limestone ranges from reddish brown to red to yellowish red and strong brown. The clay content of the B horizon ranges from 35 to 40 percent. The depth to limestone ranges from 30 to 60 inches.

Wilcoxson Series

The Wilcoxson series consists of well-drained, strongly developed soils on gently undulating uplands. These soils occur at an elevation of 7,600 to 8,000 feet, where the annual precipitation is about 18 to 20 inches and the average annual temperature is about 44° F. They formed in place in material weathered from limestone of the Madera formation. They are characterized by a dark-colored A horizon, a B2 horizon in which clay has accumulated, and a prominent horizon of lime accumulation.

The Wilcoxson soils are associated with the Jekley, Andrews, Zuni, and McGaffey soils. They are more strongly developed than the Jekley soils.

Typical profile of Wilcoxson clay loam, in a virgin area under grass; SE¼ sec. 21, T. 11 N., R. 13 W., Valencia County:

A1—0 to 3 inches, dark reddish-brown (5YR 3/2) clay loam, dark reddish brown when moist; moderate, thin, platy structure; soft when dry, friable when moist, moderately sticky and moderately plastic when wet; few fine pores; noncalcareous; pH 7.2; clear boundary.

A3—3 to 7 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, moderately sticky and moderately plastic when wet; few fine pores; noncalcareous; pH 7.2; clear boundary.

B21t—7 to 12 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) when moist; moderate, medium, prismatic structure breaking to moderate, fine, angular blocky; very hard when dry, firm when moist, very sticky and very plastic when wet; thin, continuous clay films on peds; few fine pores and few fine roots; noncalcareous; pH 7.0; clear boundary.

B22t—12 to 23 inches, variegated reddish-brown (2.5YR 4/4) and light reddish-brown (2.5YR 6/4) clay, dark reddish brown (2.5YR 3/4) and reddish brown (2.5YR 5/4) when moist; weak, medium, prismatic structure breaking to weak, medium, angular blocky; very hard when dry, firm when moist, very sticky and very plastic when wet; thin, continuous clay films on peds; very few roots; calcareous, with some visible splotches of lime; pH 8.2; gradual boundary.

B3ca—23 to 44 inches, light reddish-brown (2.5YR 6/4) clay, reddish brown (2.5YR 4/4) when moist; weak, medium, prismatic structure breaking to weak, medium, angular blocky; hard when dry, friable when moist, very sticky and very plastic when wet; calcareous, with many concretions of lime; pH 8.2; abrupt boundary.

R—44 inches +, hard, reddish limestone.

The color of the A horizon ranges from reddish gray to dark grayish brown to dark reddish brown. The color of the B horizon ranges from reddish brown to strong brown. The texture of the A horizon is loam, silt loam, or clay loam. The depth to limestone ranges from 40 to 60 inches.

REDDISH CHESTNUT SOILS

Reddish Chestnut soils develop in a warm-temperate, semiarid or subhumid climate. The surface layer is typically brown to reddish brown. Under it is dull reddish-brown or red material of finer texture, and under that a horizon of lime accumulation. Reddish Chestnut soils normally have a vegetative cover of shrubs and short grasses, but those in the Zuni Mountain Area have a cover of ponderosa pine, pinyon pine, juniper, and grasses. The Reddish Chestnut great soil group is represented in the Zuni Mountain Area by the Showlow series.

Showlow Series

The Showlow series consists of deep or moderately deep, moderately well drained soils on gently to moderately sloping foot slopes in the uplands. These soils occur at elevations of 7,500 to 7,800 feet, where the annual precipitation is 15 to 18 inches and the average annual temperature is 47° F. They formed in material weathered from reddish, clayey shale of the Chinle formation. They are characterized by a dark-colored A horizon, a structured B2 horizon in which clay has accumulated, and a horizon of lime accumulation. The parent material and the climate have had a strong influence on the Showlow soils. The underlying shale has yielded the heavy clay subsoil,

and the climate has kept the soils moist for periods long enough to allow a B horizon to develop.

Although the Showlow soils are classified as Reddish Chestnut soils, they have some characteristics of Grumusols. Their texture below a depth of 6 inches is clay. They swell and contract with changes in moisture content, and they have less distinct horizonation than other zonal soils. They have a more pronounced B horizon than the Grumusols, however.

The Showlow soils are associated with Ordnance and Thurloni soils. They are less calcareous and better developed than the Thurloni soils and less sandy than the Ordnance soils.

Typical profile of Showlow clay loam, in a virgin area under ponderosa pine, oak brush, and blue grama; NE¼SW¼ sec. 18, T. 13 N., R. 16 W., McKinley County:

O1&O2—1 inch to 0, needles, leaves, and twigs, in various stages of decomposition.

A11—0 to 2 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) when moist; weak, thin, platy structure; soft when dry, friable when moist, moderately sticky and moderately plastic when wet; noncalcareous; pH 6.8; smooth, gradual boundary.

A3—2 to 6 inches, dark reddish-brown (5YR 3/2) clay loam, dark reddish brown (5YR 2/2) when moist; weak, medium, granular structure breaking to weak, fine, subangular blocky; hard when dry, friable when moist, sticky and plastic when wet; many medium-sized pores; noncalcareous; pH 6.7; smooth, gradual boundary.

B1—6 to 12 inches, reddish-brown (5YR 4/3) 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; few medium-sized pores; noncalcareous; pH 6.8; irregular, gradual boundary.

B21t—12 to 20 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) when moist; weak, medium, prismatic structure breaking to moderate, medium and coarse, angular blocky; very hard when dry, very firm when moist, very sticky and very plastic when wet; thick clay films, many in pockets; noncalcareous; pH 7.0; irregular, gradual boundary.

B22t—20 to 35 inches, weak-red (2.5YR 4/2) clay, dusky red (2.5YR 3/2) when moist; weak, medium, prismatic structure breaking to moderate, medium and coarse, angular blocky; very hard when dry, very firm when moist, very sticky and very plastic when wet; thick, continuous clay films; some distinct slickensides or pressure faces; no distinct pores; noncalcareous; pH 7.2; irregular, gradual boundary.

B3—35 to 52 inches, weak-red (2.5YR 4/2) clay, dusky red (2.5YR 3/2) when moist; weak, coarse, angular blocky structure to massive; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; weakly calcareous in spots; pH 7.8; irregular, gradual boundary.

C—52 to 56 inches, reddish-brown (2.5YR 5/4) shaly clay, reddish brown (2.5YR 4/4) when moist; massive; very hard when dry, firm when moist, very sticky and very plastic when wet; much unweathered shale; strongly calcareous, with segregated lime; pH 8.2.

The color of the surface layer is black, dark brown, or dark reddish brown. The texture of this layer is loam or clay loam. Reddish colors like the color of the parent shale are dominant in the underlying material. The content of gravel and shale fragments ranges from 0 to 40 percent.

GRAY WOODED SOILS

Gray Wooded soils develop in a cool, mesothermal or microthermal, subhumid or semiarid climate under a cover of coniferous, deciduous, or mixed forest. They generally have a thin, organic-mineral A1 horizon and a light-colored, bleached A2 horizon overlying a brown, more clayey, blocky B2 horizon that grades to lighter colored, more friable horizons. The B horizons of these soils are generally lower in chroma than those of Podzols. The A2 horizon is about twice as thick as that of most of the Podzols in North America. Many of the Gray Wooded soils have a horizon of calcium carbonate accumulation below the B2 horizon. Strongly acid soils are exceptional (*5*).

The Gray Wooded great soil group is represented in the Zuni Mountain Area by the Fortwingate, Ordnance, Osoridge, Sanchez, and Zuni soils. The Zuni soils developed in material weathered from granite. The Fortwingate, Sanchez, and Osoridge soils formed in material weathered from sandstone. The Ordnance soils developed mainly in material weathered from shale but have been influenced by sandstone. The vegetation consists chiefly of ponderosa pine.

Fortwingate Series

The Fortwingate series consists of well-drained, gently undulating, upland soils that have east and northeast exposures. These soils occur at elevations of 7,800 to 8,000 feet, where the annual precipitation is 18 to 20 inches and the average annual temperature is about 44° F. They developed under forest in residuum weathered from Glorieta sandstone. They are characterized by an A1 horizon, 3 to 5 inches thick, a thin A2 horizon, and a B2 horizon that has distinct structure and contains an accumulation of clay.

The Fortwingate soils are associated with the Osoridge and Kiln soils, but they are deeper than those soils. They are less sloping and less stony than the Osoridge soils. They are redder than the Kiln soils, which formed in material weathered from limestone.

Typical profile of Fortwingate loam, in a virgin area under a cover of ponderosa pine, southwest of McGaffey; NW¼ sec. 9, T. 13 N., R. 16 W., McKinley County:

O1—1 inch to 0, mat of pine needles, oak leaves, and grass.

A1—0 to 5 inches, brown (7.5YR 5/2) loam, dark brown (7.5YR 3/2) when moist; weak, thin, platy structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; few fine pores; many fine roots; noncalcareous; pH 6.2; clear, wavy boundary.

A2—5 to 10 inches, pinkish-gray (7.5YR 6/2) fine sandy loam, brown (7.5YR 4/4) when moist; weak, thin, platy structure; hard when dry, friable when moist, nonsticky and nonplastic when wet; many fine pores; many fine and medium roots; very high content of clean sand; noncalcareous; pH 6.6; gradual, wavy boundary.

A3—10 to 13 inches, light-brown (7.5YR 6/4) very fine sandy clay loam, brown (7.5YR 4/4) when moist; weak, fine and medium, subangular blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine pores; many fine and large roots; noncalcareous; pH 6.6; abrupt, wavy boundary.

B21t—13 to 23 inches, reddish-brown (5YR 5/4) sandy clay or clay, reddish brown (5YR 4/4) when moist; moderate, fine, prismatic structure breaking to moderate, fine, angular blocky; extremely hard when dry, firm when moist, sticky and plastic when wet; clay films on peds and in structural cracks; few or no pores; noncalcareous; pH 6.0; gradual boundary.

B22t—23 to 32 inches, reddish-brown (2.5YR 5/4) clay, reddish brown (2.5YR 4/4) when moist; strong, medium, prismatic structure breaking to moderate, medium, angular blocky; extremely hard when dry, firm when

moist, very sticky and very plastic when wet; thick, continuous clay films; no visible pores; many old root channels; noncalcareous; pH 7.0; abrupt, wavy boundary.

R—32 inches +, pink (5YR 7/4) sandstone, reddish yellow (5YR 6/6) when moist; fine grained; dense; calcareous in places; pH 7.8 to 8.0.

The depth to bedrock ranges from about 24 inches to more than 5 feet. The range in depth is attributed to the undulation of the sandstone. The depth to the horizon containing the most clay ranges from 12 to 30 inches. The color of the B horizon ranges from reddish brown to strong brown. The surface layer is soft when dry, but the lower horizons are hard to extremely hard.

Ordnance Series

The Ordnance series consists of deep and moderately deep, well-drained soils on gently undulating uplands. These soils occur at elevations of 7,600 to 8,100 feet, where the average annual precipitation is 15 to 19 inches and the average annual temperature is about 44° F. They are derived from thin-bedded, reddish-gray, clayey shale and reddish-brown sandstone of the Chinle formation. They are characterized by a thin A1 horizon, a thin but distinct A2 horizon, a B2 horizon that contains accumulated clay, and a prominent horizon of lime accumulation. Although these soils occur in the pine forest, they support more pinyon and juniper than the other Gray Wooded soils.

The Ordnance soils are associated with the Thurloni and Showlow soils. They have been more influenced by sandstone than the Showlow soils, which are Reddish Chestnut soils. They are less calcareous and better developed than the Thurloni soils, which are clayey Regosols.

Typical profile of Ordnance loam, in a virgin site in a cutover area about 3 miles north and 1½ miles west of McGaffey; NW¼ sec. 29, T. 14 N., R. 16 W., McKinley County:

O1&O2—1 inch to 0, mat of needles, leaves, and twigs; considerable mycelial fungi; pH 6.0.

A1—0 to 2 inches, brown (7.5YR 5/4) loam or sandy loam, dark brown (7.5YR 4/4) when moist; weak, thin, platy structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; vesicular in places; noncalcareous; pH 6.6; clear boundary.

A2—2 to 4 inches, pinkish-gray (7.5YR 6/2) very fine sandy loam, dark brown (7.5YR 4/2) when moist; moderate to strong, thin, platy structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine pores and high content of clean sand; noncalcareous; pH 6.4; clear boundary.

B1—4 to 7 inches, reddish-brown (5YR 5/3) loam, reddish brown (5YR 4/3) when moist; moderate to strong, fine, subangular blocky structure; hard when dry, friable when moist, moderately sticky and moderately plastic when wet; many large pores; noncalcareous; pH 6.4; abrupt, wavy boundary.

B21t—7 to 11 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) when moist; weak, medium, prismatic structure breaking to weak to moderate, fine and medium, angular blocky; extremely hard when dry, firm when moist, sticky and plastic when wet; continuous clay films; very few visible pores; some old root channels; noncalcareous; pH 6.6; diffuse boundary.

B22t—11 to 17 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) when moist; weak, medium, prismatic structure breaking to weak to moderate, fine and medium, angular blocky; extremely hard when dry, firm when moist, sticky and plastic when wet; patchy clay films; noncalcareous; pH 7.2; diffuse boundary.

B3ca or C1—17 to 27 inches, reddish-gray (5YR 5/2) silty clay, dark reddish gray (5YR 4/2) when moist; weak, medium, angular blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; very thin, patchy clay flows; strongly calcareous; pH 7.8; diffuse boundary.

C2/R—27 to 33 inches, pinkish-gray (5YR 6/2) mixture of clay and partly weathered shale, dark reddish gray (5YR 4/2) when moist; weak, fine, angular blocky structure, or massive; very hard when dry, very firm when moist, very sticky and very plastic when wet; strongly calcalcareous, with some concretions of lime; pH 8.2.

The color of the A1 horizon ranges from grayish brown to brown. The B horizon is reddish brown, but the hue varies between 2.5YR and 5YR. The C horizon is gray, dark reddish gray, and dark reddish brown. The depth to clayey shale ranges from 20 to 36 inches. In most places the profile is free of coarse fragments to a depth of 20 inches or more; in other places there are many fragments of shale and sandstone. The variations in composition and color are attributed to variations in the parent shale.

Osoridge Series

The Osoridge series consists of shallow, very stony, moderately sloping to steep, moderately well drained soils on long dip slopes and mesa tops. These soils occur at elevations of 7,800 to 8,500 feet, where the annual precipitation is 18 to 20 inches and the average annual temperature is about 44° F. They formed in material weathered from Glorieta sandstone. They are characterized by a soft, thin A1 horizon, a mixed A2 and A3 horizon, and a B2 horizon that has a strong accumulation of clay. They have no zone of lime accumulation. The clayey B horizons are the most acid layers in the profile.

The Osoridge soils are associated with the Fortwingate and Kiln soils. They are shallower and more stony than the Fortwingate soils, and their A2 horizon is less distinct. They are less alkaline than the Kiln soils and generally deeper. The Kiln soils do not have an A2 horizon.

Typical profile of Osoridge very stony fine sandy loam, in a virgin area of cutover ponderosa pine; SE¼NE¼ sec. 25, T. 13 N., R. 15 W., McKinley County:

O1&O2—½ inch to 0, decomposing needles, leaves, and twigs, with considerable mycelial fungi.

A1—0 to 2 inches, dark grayish-brown (10YR 4/2) very stony fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, thin, platy structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine pores; noncalcareous; pH 6.4; abrupt, wavy boundary.

A2&A3—2 to 6 inches, brown (10YR 4/3) clay loam, dark brown (10YR 3/3) when moist; weak, fine to medium, subangular blocky structure; slightly hard when dry, firm when moist, sticky and plastic when wet; few fine pores; many clean sand grains; noncalcareous; pH 6.4; abrupt, wavy boundary.

B21t—6 to 11 inches, reddish-brown (5YR 5/3) clay, reddish brown (5YR 4/3) when moist; yellowish-red (5YR 5/6) specks; strong, coarse, prismatic structure breaking to strong, very fine, angular blocky; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; thick, continuous clay films; very few pores; some sand grains; noncalcareous; pH 6.0; gradual boundary.

B22t—11 to 19 inches, light yellowish-brown (10YR 6/4) clay, brown, (7.5YR 5/4) when moist; strong, coarse, prismatic structure breaking to strong, very fine, angular blocky; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; thick, continuous clay films; noncalcareous; pH 5.6; gradual boundary.

B3—19 to 23 inches, light olive-gray (5Y 6/2) and reddish-yellow (7.5YR 6/6) clay, olive gray (5Y 5/2) and strong brown (7.5YR 5/6) when moist; strong, coarse, prismatic structure breaking to strong, very fine, angular blocky; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; some unweathered minerals; noncalcareous; pH 5.8; abrupt boundary.

R—23 inches +, sandstone.

Stones and boulders, 1 to 3 feet in diameter, cover 80 to 95 percent of the surface of these soils, and the thickness and stoniness of the horizons vary considerably within a distance of a few feet. In many profiles the B2 horizon contains fragments and slabs of sandstone. In some areas a strongly developed A2 horizon abruptly overlies the B2 horizon. In places the B2 horizon appears to have been forced and squeezed to the surface. Some areas lack a B2 horizon; these sites are generally adjacent to large tilted slabs of rock that extend into the R horizon. In places the horizon directly above bedrock contains the highest percentage of clay. The depth to bedrock is commonly 18 to 22 inches but may be as little as 10 inches or as much as 25 inches.

Sanchez Series

The Sanchez series consists of shallow and very shallow, well-drained, stony soils on long dip slopes. These soils are hilly or moderately steep, and the slopes are concave in many places. They occur at elevations of 7,200 to 7,800 feet, where the annual precipitation is 16 to 19 inches and the average annual temperature is 45° F. These soils formed in grayish, noncalcareous material weathered from sandstone of the Chinle formation. They are characterized by a thin A2 horizon that grades to a weakly expressed B horizon. These soils do not have a horizon of lime accumulation. The vegetation consists of ponderosa pine, pinyon pine, juniper, shrubs, and grasses.

These soils are associated with the Thurloni, Kiln, and Osoridge soils. They are shallower, less reddish, and coarser textured than the Thurloni soils. They are less well developed than the Osoridge soils, which formed in material weathered from Glorieta sandstone. They have a distinct A2 horizon, which the Kiln soils lack. They formed in material weathered from sandstone; the Kiln soils formed in material weathered from limestone.

Typical profile of Sanchez sandy loam, in a virgin area of cutover ponderosa pine; NE¼NE¼ sec. 26, T. 14 N., R. 16 W., McKinley County:

O1&O2—2 inches to 0, pine needles, twigs, and decomposing organic matter; high content of mycelial fungi; pH 6.8.

A2—0 to 2 inches, pinkish-gray (7.5YR 6/2) sandy loam, brown (7.5YR 4/2) when moist; weak, thin, platy structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; many clean sand grains; strongly vesicular; 20 percent gravel and channery fragments and chips of petrified wood; noncalcareous; pH 6.8; clear boundary.

A2&B2—2 to 7 inches, pinkish-gray (7.5YR 7/2) sandy clay loam, brown (7.5YR 4/2) when moist; weak, thick or very thick, platy structure breaking to weak, fine, subangular blocky; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few small pores; some clean sand grains; noncalcareous; pH 6.4; diffuse boundary.

B2t—7 to 11 inches, pinkish-gray (5YR 7/2) heavy clay loam, reddish gray (5YR 5/2) when moist; weak, fine, subangular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; thin, continuous clay flows; many small pores; noncalcareous; pH 5.9; diffuse boundary.

C—11 to 17 inches, pinkish-gray (5YR 7/2) sandy clay loam, reddish gray (5YR 5/2) when moist; some yellowish-red mottles; massive; very hard when dry, firm when moist, sticky and plastic when wet; many pores; noncalcareous; pH 5.9; abrupt, clear boundary.

R—17 inches +, pinkish-gray (7.5YR 7/2) sandstone, brown (7.5YR 5/2) when moist; very fine grained; hard; reddish coatings in cavities and along structural breaks; noncalcareous; pH 6.2.

The pinkish-gray and light brownish-gray colors of the soils are similar to the color of the undecomposed rock. Also, much of the prevalent grayish tinge is inherited from the color of the original parent material, rather than resulting from bleaching during soil development. The number of rock fragments on the surface and in the profile varies widely. The development of the B horizon ranges from very weak to moderate. In places the uppermost half inch of soil is a vesicular surface crust.

Zuni Series

The Zuni series consists of deep or moderately deep, well-drained, gently sloping and gently undulating soils on the uplands. These soils occur at elevations of 7,800 to about 8,200 feet, where the annual precipitation is 18 to 20 inches and the average annual temperature is about 44° F. They formed in material weathered from reddish granite. They are characterized by a thin A1 horizon, a thick A2 horizon, and a B2 horizon that has distinct structure and an accumulation of clay. In places these soils have a C horizon that contains much decomposed granite. The vegetation consists of pine forest.

The Zuni soils are associated with the Mirabal, Wilcoxson, and Tampico soils. They are less sloping, better developed, deeper, and less stony than the Mirabal soils. They lack the limestone influence of the Wilcoxson soils. They are better developed than the Tampico soils, which formed in alluvium.

Typical profile of Zuni sandy loam, in an area of cutover ponderosa pine, about 5 miles southeast of McGaffey; NE¼ sec. 31, T. 13 N., R. 15 W., McKinley County:

O1&O2—2 inches to 0, pine needles, grass, twigs, and matted, decomposed organic matter.

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) gritty sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, thin, platy structure breaking to weak, medium, granular; loose when dry, very friable when moist, nonsticky and nonplastic when wet; many fine pores and a few fine roots; noncalcareous; pH 6.5; clear boundary.

A21—3 to 6 inches, pinkish-gray (7.5YR 6/2) sandy loam, dark brown (7.5YR 4/4) when moist; weak, medium, granular structure to massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; many fine pores; many clean sand grains; some fine roots; noncalcareous; pH 6.4; clear boundary.

A22—6 to 8 inches, light reddish-brown (5YR 6/3) fine sandy loam, reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure to massive; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; many fine pores; much clean sand; noncalcareous; pH 6.4; clear, smooth boundary.

A3—8 to 11 inches, reddish-brown (5YR 5/4) loam, reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slighty plastic when wet; some clean sand in cracks and along structural breaks; noncalcareous; pH 6.3; clear, wavy boundary.

B1—11 to 16 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) when moist; moderate, medium, subangular blocky structure; hard when dry, firm when moist, moderately sticky and moderately plastic when wet; noncalcareous; pH 6.4; abrupt boundary.

B2t—16 to 36 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) when moist; moderate, medium, prismatic structure breaking to moderate, medium, angular blocky; extremely hard when dry, firm when moist, sticky and plastic when wet; thick, continuous clay films on prisms and blocks; very few pores; some fine roots; many splotches of organic matter; noncalcareous; pH 6.4; clear, wavy boundary.

B3—36 to 43 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; massive; hard when dry, firm when moist, moderately sticky and moderately plastic when wet; some thin, patchy clay films on peds; many particles of decomposed granite; noncalcareous; pH 6.8; clear boundary.

C—43 inches +, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; soil material is mixed with much slightly decomposed granite; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 7.2.

In places the A1 horizon is very thin. The texture of the surface layer is sandy loam or gritty loam. In places the B2 horizon directly overlies granite; in other places a gravelly layer of decomposed granite overlies the bedrock. The depth to bedrock is commonly 38 to 48 inches, but it may be as little as 20 inches or as much as 70 inches.

INTRAZONAL ORDER

Intrazonal soils have evident, genetically related horizons that reflect the dominant influence of some local factor of relief or parent material over the normal effect of climate and vegetation. In this Area the intrazonal order is represented by the Humic Gley great soil group. The soils of this group are characterized by impeded drainage.

HUMIC GLEY SOILS

Hume Gley soils are poorly drained or very poorly drained hydromorphic soils that have a dark-colored organic-mineral horizon of moderate thickness underlain by a gleyed mineral horizon. The Humic Gley great soil group is represented in the Zuni Mountain Area by the Larry soils, which developed in granitic alluvium.

Larry Series

The Larry series consists of deep, very dark colored, nearly level, poorly drained soils on bottom lands in high mountain valleys. They occur in positions where excess moisture accumulates, and they stay wet for long periods. Seepy and boggy spots are common. The water table is at a depth of 2 to 3 feet, but the water level varies with the season. The vegetation on these soils consists of a dense cover of grass and water-tolerant meadow plants. There is no ponderosa pine.

These soils are at an elevation of 8,700 feet, where the average annual precipitation is about 20 to 24 inches and the average annual temperature is about 42° F. They are characterized by a moderately thick, very dark gray or black A1 horizon of noncalcareous silty clay loam or silty clay, underlain by a gleyed horizon of noncalcareous, gray and light-gray clay. The lower part of this gleyed horizon is gravelly.

The Larry soils are associated with Mirabal and Supervisor soils, which developed in place and occupy slopes adjacent to the Larry soils.

Typical profile of Larry silty clay loam; SW¼ sec. 22, R. 12 W., T. 11 N., Valencia County:

A11—0 to 6 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; strong fine, granular structure; hard when dry, friable when moist; neutral; clear boundary.

A12—6 to 19 inches, very dark gray (10YR 3/1) silty clay, black (2.5YR 2/0) when moist; strong, fine, angular blocky structure; very hard when dry, firm when moist; pH 6.6; gradual boundary.

C1g—19 to 23 inches, gray (5Y 5/1) clay, dark gray (5Y 4/1) when moist; weak, medium, angular blocky structure; very hard when dry, firm when moist; pH 6.8; clear boundary.

C2g—23 to 38 inches, light-gray (5Y 6/1) sandy clay, dark gray (5Y 4/1) when moist; weak, coarse, angular blocky structure; very hard when dry, firm when moist; pH 7.1; noncalcareous; gradual boundary.

C3g—38 to 44 inches, light-gray (5Y 6/1) gritty sandy clay mottled with light olive gray (5Y 6/2); olive gray (5Y 5/2) mottled with gray (5Y 5/1) when moist; massive; hard when dry; pH 7.1; noncalcareous.

Below a depth of 19 inches, there are many clear grains of feldspar and quartz. The number of these increases with increasing depth. The C1g horizon is slightly mottled with gray and dark gray. In places the material below a depth of 2 feet is stratified, the layers ranging in texture from gravelly loam to gravelly sandy clay and gravelly clay.

AZONAL ORDER

Azonal soils lack a well-developed profile because they are youthful, or because the parent material resists soil-forming processes, or because their relief has prevented development of definite characteristics. The azonal order is represented in the Zuni Mountain Area by the Alluvial soils, the Lithosols, and the Regosols.

ALLUVIAL SOILS

Alluvial soils consist of recent alluvium that is relatively unchanged by environment. Their characteristics are determined largely by the nature of the alluvium and the manner in which it has been sorted and deposited. Climatic conditions, drainage, and vegetation vary widely.

The Alluvial great soil group is represented in the Zuni Mountain Area by the McGaffey, Prewitt, Polich, Tabiona, Tampico, and Trail soils. Many of these soils show evidence of profile development, mainly structural development in the subsurface horizons.

McGaffey Series

The McGaffey series consists of deep and very deep, well-drained, nearly level or gently sloping soils on alluvial fans and valley floors. These soils occur at elevations of 7,500 to 7,800 feet, where the average annual precipitation is 18 to 20 inches and the average annual temperature is about 45° F. They developed in calcareous, reddish alluvium under a cool-temperate, subhumid climate. They are characterized by a thick, loamy A horizon overlying stratified material that has weak structural development. In many places the lower part of the profile is calcareous. The vegetation consists of grass and shrubs. Small stringers of these soils support ponderosa pine.

The McGaffey soils are associated with the Polich and Jekley soils. They are lighter colored than the Polich soils and better drained, and they occupy higher positions on the valley floors. The Jekley soils developed in material weathered from sandstone.

Typical profile of McGaffey loam, in a grassy area north of McGaffey; sec. 28, T. 14 N., R. 16 W., McKinley County:

A1 or Ap—0 to 6 inches, reddish-brown (5YR 4/3) loam, dark reddish brown (5YR 3/3) when moist; weak to moderate, thin, platy structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; few small pores; noncalcareous; pH 7.5; clear boundary.

A12—6 to 18 inches, reddish-brown (5YR 4/3) silt loam, dark reddish brown (5YR 3/3) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist, moderately sticky and moderately plastic when wet; noncalcareous; pH 8.0; gradual boundary.

B2—18 to 28 inches, reddish-brown (5YR 4/3) fine sandy clay loam, dark reddish brown (5YR 3/3) when moist; weak, medium, prismatic structure; very hard when dry, friable when moist, sticky and plastic when wet; thin, patchy clay films; a few large voids; calcareous, with some visible lime; pH 8.2; clear, wavy boundary.

A1b—28 to 34 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) when moist; weak, fine, subangular blocky structure; hard when dry, friable when moist, moderately sticky and moderately plastic when wet; many small and medium pores; noncalcareous; pH 7.7; gradual boundary.

B2b—34 to 51 inches, reddish-brown (5YR 4/3) sandy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, subangular blocky structure; hard when dry, friable when moist, moderately sticky and moderately plastic when wet; very few voids; noncalcareous; pH 7.7; gradual boundary.

B3b—51 to 56 inches +, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/4) when moist; very weak, medium, subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; many large voids; noncalcareous; pH 7.5.

The texture of the surface layer and of the subsoil ranges from loam to medium clay loam. The color is generally uniform to a depth of more than 5 feet. It is typically reddish brown, but the hue ranges from 5YR to 7.5YR. Buried soils are common in areas adjacent to drainageways. In most places there is a high degree of stratification below a depth of 24 inches.

Polich Series

The Polich series consists of deep, level or nearly level, dark-colored, imperfectly drained soils on flood plains and valley floors. These soils occur at elevations of 7,600 to 7,800 feet, where the annual precipitation is 18 to 20 inches and the average annual temperature is about 47° F. They formed in reddish or brownish mixed alluvium. They are characterized by a thick, darkened A1 horizon; a clayey, dark-colored, structured B horizon; and a thick C horizon of silt loam. They are wet for long periods. The vegetation is grass and shrubs. Ponderosa pine does not grow on these soils.

Although the Polich soils are classified as Alluvial soils, they have some characteristics of Humic Gley soils and some characteristics of Chernozems.

The Polich soils are associated with the McGaffey and Jekley soils. They are less well drained than the McGaffey soils, which occupy adjacent alluvial fans and higher parts of the flood plains. The Jekley soils developed in material weathered from sandstone.

Typical profile of Polich loam, in a virgin area of grassland, about 5 miles southeast of McGaffey, near Page; SE¼NE¼ sec. 29, T. 13 N., R. 15 W., McKinley County:

A11—0 to 6 inches, very dark grayish-brown (10YR 3/2) loam, very dark brown (10YR 2/2) when moist; weak, thin, platy structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; some small voids and pores; highly calcareous; pH 8.4; gradual boundary.

A12—6 to 16 inches, very dark grayish-brown (10YR 3/2) heavy loam, very dark brown (10YR 2/3) when moist; moderate, medium, platy structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; organic-matter content high; many fine pores; calcareous; pH 8.4; gradual boundary.

A3—16 to 26 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure breaking to moderate, medium, subangular blocky; hard when dry, friable when moist, moderately plastic and moderately sticky when wet; some brown and dark-brown mottles; many pores; calcareous; pH 8.2; clear boundary.

B2—26 to 33 inches, brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium, prismatic structure breaking to moderate, fine, angular and subangular blocky; very hard when dry, firm when moist, sticky and plastic when wet; calcareous; pH 8.2; gradual boundary.

B3—33 to 42 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, prismatic structure breaking to weak, fine, angular blocky; extremely hard when dry, very firm when moist, sticky and plastic when wet; weakly calcareous; pH 8.1; gradual boundary.

C—42 to 51 inches +, reddish-brown (5YR 5/4) silt loam, reddish brown (5YR 4/4) when moist; massive, breaking to angular blocks; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many large pores; weakly calcareous; pH 8.1.

The color of the A1 horizon ranges from very dark grayish brown to dark reddish brown. In most places the texture of the surface layer is loam or clay loam, but it may be fine sandy loam or silt loam. The texture of the B horizons may be heavy loam, silt loam, or heavy clay loam. Mottling in these horizons and in the substrata ranges up to 10 percent. The mottles are fine to coarse in size and strong brown in color. The soils range from noncalcareous to calcareous. Buried soils are common in the substratum.

Prewitt Series

The Prewitt series consists of reddish, well-drained, calcareous, nearly level to gently sloping soils on alluvial fans. These soils occur at elevations of 6,800 to 7,100 feet, where the annual precipitation is 11 to 15 inches and the average annual temperature is about 48° F. They formed in stratified, moderately fine textured, calcareous alluvium. The parent material was derived from San Andres limestone and from sandstone and calcareous shale of the Chinle formation. They are characterized by an A1–AC–C horizon sequence and a moderately dark color in the A1 horizon. In places a horizon of line accumulation is present. The vegetation consists of blue grama, snakeweed, and a little juniper.

The Prewitt soils are associated with the Laporte and Nathrop soils, which formed in place over limestone residuum. They are finer textured and lie at lower elevations than the Tabiona, McGaffey, and Polich soils. They are less reddish than the Montoya soils and less fine textured.

Typical profile of Prewitt clay loam, in a virgin area; NE¼ sec. 4, T. 11 N., R. 11 W., Valencia County:

A1—0 to 4 inches, reddish-gray (5YR 5/2) clay loam, dark reddish brown (5YR 3/2) when moist; weak, platy structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine pores; calcareous; pH 8.2; abrupt boundary.

AC—4 to 13 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) when moist; weak, fine, granular structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; very few fine pores; calcareous; pH 8.3; clear boundary.

C1—13 to 28 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5 YR 3/4) when moist; weak, medium and coarse, subangular blocky structure; very hard when dry, firm when moist, moderately sticky and moderately plastic when wet; few medium-sized pores; calcareous; pH 8.3; clear, wavy boundary.

C2—28 to 34 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) when moist; weak, coarse, granular structure to massive; hard when dry, firm when moist, sticky and plastic when wet; many medium-sized pores; lime streaks and mycelial lime; strongly calcareous; pH 8.4; clear boundary.

C3—34 to 45 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; many medium-sized pores; strongly calcareous, with visible lime; pH 8.6; abrupt boundary.

C4—45 to 60 inches +, reddish-brown (2.5YR 4/4) sandy clay loam, dark reddish brown (2.5YR 3/4) when moist; very weak, medium, subangular blocky structure; hard when dry, friable when moist, moderately sticky and moderately plastic when wet; few fine pores; calcareous; pH 8.3.

The color of the surface layer ranges from a hue of 2.5YR to a hue of 7.5YR, but reddish brown and red are dominant. Hues of the substratum are dominantly 5YR and 7.5YR, but in some profiles the substratum has a hue of 2.5YR. The substratum is predominantly moderately fine textured, but strata of coarser and finer materials are present in most profiles. In many places the upper part of the substratum has distinct structure.

Tabiona Series

The Tabiona series consists of deep, well-drained, calcareous soils on alluvial fans and valley fill. The slope is 10 to 15 percent. These soils are slightly developed. They occur at an elevation of about 7,500 feet, where the average precipitation is about 14 inches and the average annual temperature is about 48° F. These soils formed in alluvium washed mainly from limestone. The vegetation consists of grasses, shrubs, pinyon pine, and juniper.

The Tabiona soils are less well developed than the Turkeysprings soils and occur on alluvial fans rather than on uplands. They are somewhat redder and better developed than the lower lying Prewitt soils.

Typical profile of Tabiona fine sandy loam, in a grassy virgin area, with some juniper and pinyon pine; SE¼ sec. 8, T. 10 N., R. 11 W., Valencia County:

A1—0 to 5 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) when moist; weak, fine, granular structure; loose when dry, very friable when moist, nonsticky and nonplastic when wet; highly calcareous; pH 8.2; clear boundary.

A3—5 to 10 inches, reddish-brown (5YR 4/3) fine sandy loam, dark reddish brown (5YR 3/3) when moist; weak, fine, granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; highly calcareous; pH 8.4; clear boundary.

B2—10 to 18 inches, reddish-brown (5YR 4/4) loam; dark reddish brown (5YR 3/4) when moist; moderate, fine and very fine, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many small and medium-sized pores; few clay films in voids; highly calcareous; pH 8.4; clear boundary.

Cca—18 to 28 inches, reddish-brown (5YR 5/4) sandy loam, reddish brown (5YR 4/4) when moist; very weak, fine, angular blocky structure; slightly hard when dry, very friable when moist, slightly sticky but nonplastic when wet; very few voids; no clay films; many particles of unweathered minerals; much visible lime; pH 8.3; gradual boundary.

C—28 to 40 inches +, reddish-brown (5YR 5/4) sandy loam, reddish brown (5YR 4/4) when moist; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; very few pores; no visible lime, but calcareous; pH 8.3.

The texture of the surface layer may be sandy loam, fine sandy loam, or loam. The content of limestone fragments ranges from 0 to about 15 percent.

Tampico Series

The Tampico series consists of deep, dark-colored, well-drained soils on flood plains and toe slopes in long, narrow valleys and canyons. These soils are loamy and noncalcareous. They occur at elevations of 7,700 to 8,500 feet, where the annual precipitation is 18 to 22 inches and the average annual temperature is about 45° F. They formed in deep deposits of gritty outwash from granite. The vegetation consists of ponderosa pine, shrubs, and grass.

The Tampico soils are associated with the Zuni soils, which developed in place in material weathered from granite. At higher elevations thin strips of Tampico soils lie on canyon bottoms between the sloping Mirabal and Supervisor soils, which formed in residuum weathered from granite and gneiss.

Typical profile of Tampico loam, in a virgin area under second-growth ponderosa pine, along a streambank about 1 mile south of McGaffey Lookout; sec. 23, T. 13 N., R. 16 W., McKinley County:

O1&O2—½ inch to 0, needles, leaves, and twigs, in various stages of decomposition.

A1—0 to 6 inches, brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) when moist; weak, thin, platy structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; some fine voids; noncalcareous; pH 6.2; clear boundary.

A3—6 to 11 inches, brown (7.5YR 5/2) gravelly loam, dark brown (7.5YR 3/2) when moist; weak to moderate, fine, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine pores; highly micaceous; noncalcareous; pH 6.6; clear boundary.

B1—11 to 17 inches, reddish-brown (5YR 5/3) gravelly loam, reddish brown (5YR 4/3) when moist; weak to moderate, fine, subangular blocky structure; very hard when dry, firm when moist, slightly sticky and slightly plastic when wet; few fine pores; noncalcareous; pH 6.5; clear boundary.

B2—17 to 30 inches, reddish-brown (2.5YR 4/4) gravelly clay loam, dark reddish brown (2.5YR 3/4) when moist; moderate, fine, subangular blocky structure; very hard when dry, firm when moist, moderately sticky and moderately plastic when wet; many small voids and pores; noncalcareous; pH 6.2; gradual boundary.

B3 or C—30 to 50 inches +, reddish-brown (2.5YR 5/4) gravelly loam, reddish brown (2.5YR 4/4) when moist; weak, fine, subangular blocky structure; very hard when dry, firm when moist, slightly sticky and slightly plastic when wet; few fine pores; noncalcareous; pH 6.8.

When dry, the A1 horizon ranges from very dark grayish brown to brown in color. In the subsurface layers the hue ranges from 10YR to 5YR or even 2.5YR. The variations in color follow variations in color of the parent material. Like most alluvial soils, these soils are stratified. They show considerable variation in structural development in the subsurface layers. Cobblestones and larger stones occur on the surface and within the profile in some places.

Trail Series

The Trail series consists of deep, well-drained, reddish soils on narrow valley floors and alluvial fans. These soils are sandy and stratified. They occur at elevations of 7,000 to 7,500 feet, where the annual precipitation is 15 to 18 inches and the average annual temperature is about 47° F. They formed in sedimentary deposits. The vegetation consists of ponderosa pine, Gambel oak, shrubs, and grass.

The Trail soils are associated with the better developed Savoia soils, which formed in similar material on older alluvial fans and terraces. They are also associated with the Bond soils, which developed in place in material weathered from coarse-textured sandstone. In places the Trail soils are associated with the Montoya soils, which formed in finer textured alluvium and show some development in the B horizon.

Typical profile of Trail loamy fine sand, in a grassy virgin area; SW¼ sec. 18, T. 13 N., R. 16 W., McKinley County:

A11—0 to 6 inches, reddish-brown (5YR 4/4) loamy fine sand, dark reddish brown (5YR 3/4) when moist; single grain; loose when dry, very friable when moist, nonsticky and nonplastic when wet weakly calcareous; pH 8.2; clear boundary.

A12—6 to 12 inches, reddish-brown (2.5YR 4/4) loamy fine sand, dark reddish brown (2.5YR 3/4) when moist; very weak, thin, platy structure; slighty hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 8.2; gradual boundary.

C—12 to 30 inches, reddish-brown (2.5YR 5/4) loamy fine sand, reddish brown (2.5YR 4/4) when moist; single grain; loose when dry, very friable when moist, nonsticky and nonplastic when wet; weakly calcareous; pH 8.2; clear, wavy boundary.

CAb—30 to 40 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) when moist; very weak, prismatic structure breaking to coarse, soft blocks; soft when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 8.2; diffuse boundary.

C—40 to 55 inches +, red (2.5YR 5/6) loamy fine sand, red (2.5YR 4/6) when moist; single grain; loose when dry, very friable when moist, nonsticky and nonplastic when wet; weakly calcareous; pH 8.2.

The texture below a depth of 20 to 25 inches varies but is moderately coarse in most places. Buried A1 horizons are common and occur at various depths.

LITHOSOLS

Lithosols are soils having no clearly expressed soil morphology and consisting of a freshly and imperfectly weathered mass of rock fragments. These soils occur mainly on steep slopes. The Lithosol great soil group is represented in the Zuni Mountain Area by the Andrews, Bandera, Kettner, Laporte, Mirabal, and Supervisor soils. The Andrews and Laporte soils formed in material weathered from limestone, and the Bandera soils formed from cinders. Granite and granitic gneiss are the parent rocks of the Mirabal and Supervisor series. The Kettner soils formed in material derived from schist.

Common characteristics of these soils are shallowness, stoniness, medium texture, moderate or steep slopes, a thin A1 horizon with weak, granular structure, and weak to very weak structure below the A1 horizon. In places the Kettner and Supervisor soils are more than 20 inches deep. The A1 horizon of the Supervisor soils generally is thicker than the A1 horizon of the other soils.

Andrews Series

The Andrews series consists of shallow, calcareous, moderately permeable, well-drained soils on smooth, round-topped hills. The slope range is 5 to 20 percent. These soils occur at an elevation of about 8,000 feet, where the annual precipitation is 18 to 20 inches and the average annual temperature is about 44° F. They formed in place in material derived from Madera limestone. The vegetation consists of grass, juniper, pinyon pine, and ponderosa pine.

The Andrews soils are associated with the Wilcoxson and Zuni soils. The Wilcoxson soils formed in material weathered from Madera limestone, but they are deeper and more strongly developed than Andrews soils. The Zuni soils formed in material weathered from granite and are strongly developed. The Andrews soils are somewhat similar to the Kiln soils, but the Kiln soils have a B horizon and are timber covered.

Typical profile of Andrews gravelly loam, under cover of grass, pinyon pine, and juniper; SE¼ sec. 8, T. 11 N., R. 13 W., Valencia County:

A1—0 to 7 inches, dark reddish-brown (5YR 3/3) gravelly loam, dark reddish brown (5YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; about 40 percent gravel; abundant fine roots; strongly calcareous; pH 8.0; gradual, wavy boundary.

C1—7 to 12 inches, reddish-brown (5YR 4/3) gravelly loam, dark reddish brown (5YR 3/3) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; 60 to 70 percent gravel, and some cobblestones; medium roots plentiful; violently calcareous; pH 8.1; clear, wavy boundary.

C2—12 to 19 inches, reddish-brown (2.5YR 5/4) gravelly and cobbly loam, reddish brown (2.5YR 4/4) when moist; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; 60 to 90 percent gravel and cobblestones; becomes progressively stonier with depth; violently calcareous; pH 8.4; gradual boundary.

R—19 inches +, partly weathered and fractured limestone.

The hue of the surface layer may be 7.5YR or 5YR, with brown or reddish brown predominating. The surface layer is very gravelly or cobbly in places. The depth to limestone is commonly 15 to 18 inches, but it may be as little as 12 inches or as much as 21 inches.

Bandera Series

The Bandera series consists of shallow, rapidly permeable, well-drained soils on gently sloping and undulating uplands and on the steep side slopes of cinder cones. Slopes of 5 to 20 percent are common, but some of the side slopes of the cones have a gradient of 35 percent. These soils occur at elevations of 7,800 to 8,000 feet, where the annual precipitation is 16 to 18 inches and the average annual temperature is about 47° F. They formed in ma-

terial derived from volcanic cinders. The vegetation consists chiefly of sparse stands of ponderosa pine and a ground cover of grass.

The Bandera soils are associated with the Gem soils, which formed in material derived from basalt and are strongly developed. They are also associated with the Friana soils, which formed in outwash from basalt.

Typical profile of Bandera gravelly loam, under ponderosa pine and grass; SW¼ sec. 23, R. 12 W., T. 9 N., Valencia County:

A1—0 to 4 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, friable when moist; pH 6.8; 25 percent fine cinder gravel; clear boundary.

AC—4 to 9 inches, brown (10YR 5/3) gravelly loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; pH 7.2; noncalcareous; 35 percent fine cinder gravel; clear boundary.

C1—9 to 16 inches, yellowish-brown (10YR 5/4) gravelly loam, dark yellowish brown (10YR 3/4) when moist; weak, fine to medium, granular structure; pH 7.2; noncalcareous; 35 percent fine cinder gravel; abrupt, wavy boundary.

C2—16 to 30 inches +, very dark gray (N 3/0) cinders, black (N 2/0) when moist; pH 8.4, calcareous; specks of lime on cinders.

In places the cinders are somewhat cemented, and a weak Ca horizon may be present. A perched water table occurs for short periods at the point of contact between the soil and the cinders. The thickness of the solum above the cinders varies, but it is commonly 13 to 18 inches.

Kettner Series

The Kettner series consists of shallow, well-drained, noncalcareous soils on gently undulating uplands. The slope range is 3 to 20 percent. These soils developed over schist. They occur at elevations of 8,100 to 8,300 feet, where the annual precipitation is 18 to 20 inches and the average annual temperature is 44° F. The vegetation is ponderosa pine and grass.

The Kettner soils are associated with the Mirabal and Zuni soils. They lack the strong granitic influence of the Mirabal soils and the coarse fragments in the substratum. They are not so deep as the Zuni soils, and they lack a distinct B2 horizon.

Typical profile of Kettner loam, in an area of cutover ponderosa pine; SW¼ sec. 33, T. 12 N., R. 14 W., Valencia County:

O1&O2—½ inch to 0, needles and leaves, in various stages of decomposition.

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) 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; about 10 percent of horizon is gravel; pH 6.3; clear boundary.

A12—4 to 8 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; pH 6.4; clear boundary.

C—8 to 17 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) when moist; weak, fine, subangular blocky structure; hard to very hard when dry, firm when moist, slightly sticky and slightly plastic when wet; plentiful medium pores; pH 6.8; gradual boundary.

C/R—17 to 22 inches, mixture of yellowish-brown (10YR 5/4) sandy loam and fragments of schist, dark brown (7.5YR 4/4) when moist; massive; hard when dry, firm when moist, nonsticky and nonplastic when wet; pH 7.0; abrupt boundary.

R—22 inches +, schist.

The depth to weathered schist is commonly 15 to 20 inches, but it may be as little as 13 inches in places. Although loam is the dominant texture of the surface layer, the texture is sandy loam or gravelly loam in places. The texture of the substratum is loam or sandy loam. The color ranges from 10YR to 7.5YR in hue. The soil colors are inherited from the parent schist.

Laporte Series

The Laporte series consists of shallow, well-drained, calcareous soils on gently sloping to steep uplands. These soils occur at elevations of 7,000 to 7,500 feet, where the annual precipitation is 14 to 16 inches and the average annual temperature is about 47° F. They formed in material weathered from limestone of the San Andres formation and from mudstone. The vegetation is pinyon pine, juniper, and grass.

The Laporte soils are associated with the Nathrop soils. They are shallower than those soils and are less well developed. The parent limestone is the same as that of the Kiln soils, but the Laporte soils lack a B horizon. The Kiln soils have a weakly developed B horizon and are timber covered.

Typical profile of Laporte stony loam, under a cover of pinyon pine, juniper, and grass; SE¼ sec. 1, R. 12 W., T. 11 N., Valencia County:

A1—0 to 5 inches, dark grayish-brown (10YR 4/2) stony loam, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist; calcareous; pH 8.2; gradual boundary.

C—5 to 12 inches, dark grayish-brown (10YR 4/2) stony loam, dark brown (7.5YR 3/2) when moist; massive, or weak, fine, granular structure; soft when dry, very friable when moist; calcareous; pH 8.2; 35 to 60 percent limestone gravel and stones; gradual boundary.

Cca—12 to 18 inches, grayish-brown (10YR 5/2) very stony loam, dark brown (7.5YR 3/3) when moist; massive, or weak, fine, granular structure; soft when dry, friable when moist; calcareous; pH 8.4; more than 75 percent fragments of limestone; abrupt, wavy boundary.

R—18 inches +, limestone.

This soil is red in areas where the parent mudstone was red. The depth to limestone ranges from about 14 inches to 20 inches. Gravel, stones, and other fragments of limestone and calcareous mudstone cover 50 percent of the surface of many areas.

Mirabal Series

The Mirabal series consists of well-drained soils on low hills, narrow ridgetops, and steep mountain slopes. These soils are shallow over granite or granitic gneiss. They occur at elevations of 7,700 to 9,200 feet, where the annual precipitation is 18 to 24 inches and the average annual temperature is about 43° F. The vegetation consists of ponderosa pine, pinyon pine, shrubs, and grass.

The Mirabal soils are associated with the Supervisor and Zuni soils. Their A1 horizon is about half as thick as that of the Supervisor soils. In most places they are somewhat more stony than the Supervisor soils. The Mirabal soils are shallower than the Zuni soils, and they lack a B horizon.

Typical profile of Mirabal stony loam, in a steep, south-facing area under ponderosa pine, grass, and forbs; SW¼ sec. 21, T. 11 N., R. 12 W., Valencia County:

O1&O2—½ inch to 0, loose mat of pine needles and grass, in various stages of decomposition.

A1—0 to 5 inches, grayish-brown (10YR 5/2) stony loam, very dark grayish brown (10YR 3/2) when moist; weak to moderate, fine, granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 6.0; 25 to 30 percent stones; clear, smooth boundary.

AC—5 to 12 inches, pale-brown (10YR 6/3) stony sandy loam, brown (10YR 4/3) when moist; weak, fine, subangular blocky structure breaking to fine, granular structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 6.4; 45 to 55 percent gravel, cobblestones, and stones; clear, slightly wavy boundary.

C—12 to 18 inches, pale-brown (10YR 6/3) gravelly sandy loam, brown (10YR 4/3) when moist; weak, fine, subangular blocky structure, or massive; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 6.4; about 10 percent more gravel and cobblestones than in the AC horizon; gradual boundary.

R—18 inches +, hard, somewhat shattered and fractured granite; some soil material in fractures.

The depth to bedrock ranges from 15 to 22 inches. The texture of the surface layer may be stony loam, gravelly sandy loam, or stony sandy loam.

Supervisor Series

The Supervisor series consists of shallow to moderately deep, well-drained soils on steep, north-facing slopes. These soils occur at elevations of 8,600 to 9,200 feet, where the annual precipitation is 20 to 25 inches and the average annual temperature is about 42° F. The slope range is 20 to 45 percent, and slopes of more than 30 percent are common. The parent material weathered from granite and granitic gneiss. The vegetation is mainly Douglas-fir, limber pine, ponderosa pine, and grass.

Although Supervisor soils are classified as Lithosols, they have some characteristics of Brown Forest soils.

The Supervisor soils are associated with the Mirabal soils. Generally, they are darker colored, less stony, and deeper than those soils. They have a thicker layer of litter and more organic matter in their surface layer.

Typical profile of Supervisor stony loam, on a north-facing slope, under a cover of Douglas-fir, limber pine, and ponderosa pine; SW¼ sec. 21, T. 11 N., R. 12 W., Valencia County:

O1—2 inches to 0, loose mat of fir and pine needles, in various stages of decomposition; pH 6.2.

A11—0 to 0 inches, dark grayish-brown (10YR 4/2) stony loam, very dark brown (10YR 2/2) when moist; weak to moderate, fine, granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 6.3; 20 percent stones; clear, smooth boundary.

A12—4 to 10 inches, grayish-brown (10YR 5/2) stony gravelly loam, dark brown (10YR 3/3) when moist; moderate, fine, granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 6.4; 25 to 30 percent angular gravel and stones; clear, wavy boundary.

AC—10 to 16 inches, brown (10YR 5/3) gravelly loam, dark brown (10YR 4/3) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 5.8; 30 to 40 percent gravel and stones; gradual boundary.

C—16 to 22 inches, yellowish-brown (10YR 5/4) stony and gravelly sandy loam, dark yellowish brown (10YR 4/4) when moist; massive; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 5.9; 45 to 55 percent gravel and stones; gradual boundary.

R—22 inches +, hard, somewhat shattered granitic rock; some soil material in fractures.

The texture of the surface layer may be sandy loam, gravelly sandy loam, stony loam, or gravelly loam. The depth to shattered and fissured granite is 18 to 22 inches in most places, but it may be as little as 12 or as much as 30 inches. The deeper soils occur in pockets on benches.

REGOSOLS

Regosols consist of deep, unconsolidated material in which few or no clearly expressed soil characteristics have developed. The Regosol great soil group is represented in the Zuni Mountain Area by the Montoya, Thurloni, and Valentine soils. The Montoya and Thurloni soils formed in material weathered from red, clayey shale. The Valentine soils developed in wind-deposited sandy material. The Montoya and Thurloni soils have better horizon expression than the Valentine soils.

Montoya Series

The Montoya series consists of deep, well-drained, level or nearly level soils on flood plains and alluvial fans and in swales. These soils occur at elevations of 6,800 to 7,200 feet, where the annual precipitation is 15 to 18 inches and the average annual temperature is about 47° F. They formed in alluvium washed from shale of the Chinle formation. Grass and shrubs make up most of the vegetation, but at the higher elevations Gambel oak and pinyon pine grow also.

These soils are characterized by a granular A horizon, a prismatic to blocky B2 horizon, and a thick C horizon.

The Montoya soils are associated with McGaffey, Trail, and Concho soils. They are finer textured than the McGaffey and Trail soils, and they have slower permeability. They are redder than the Concho soils.

Typical profile of Montoya clay, in a grassy area; SW¼NE¼ sec. 19, T. 12 N., R. 15 W., Valencia County:

A1—0 to 9 inches, weak-red (2.5YR 4/2) light clay, dusky red (2.5YR 3/2) when moist; strong, fine and medium, granular structure; uppermost 3 inches has strong, very fine, granular structure; hard when dry, firm when moist, sticky and plastic when wet; abundant fine roots; calcareous; pH 8.2; gradual boundary.

B2—9 to 27 inches, weak-red (2.5YR 4/2) clay, dusky red (2.5YR 3/2) when moist; weak, medium, prismatic structure breaking to strong, medium, angular blocky; very hard when dry, very firm when moist, very sticky and very plastic when wet; strongly calcareous; pH 8.2; gradual, wavy boundary.

C—27 to 52 inches +, weak-red (2.5YR 4/2) clay, dusky red (2.5YR 3/2) when moist; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; some slickensides; strongly calcareous; pH 8.2.

The colors of these soils range from 5YR to 10R in hue. In most places the profile is calcareous throughout, but in some places the surface layer is noncalcareous. In places also, the B and C horizons contain fine gravel, and in some the texture of the B horizon is silty clay.

Thurloni Series

The Thurloni series consists of red, clayey, moderately deep or deep, moderately well drained, calcareous soils on gently rolling or moderately steep uplands. These soils occur at elevations of 6,000 to 7,000 feet, where the annual precipitation is 14 to 17 inches and the average annual temperature is about 47° F. They formed in strongly calcareous, red, clayey shale. The vegetation consists of ponderosa pine, pinyon pine, Utah juniper, alligator juniper, Gambel oak, mountain-mahogany, and grass.

These soil are characterized by a thin, dark-colored A1 horizon and a relatively thick cambic horizon that grades to a C or C/R horizon. Fragments of petrified wood are common on the surface and within the solum. In some places fragments of limestone occur in the profile. Fragments and pieces of shale occur on the surface in places, and there are outcrops of shale. This soil is generally calcareous to the surface. The A1 horizon is noncalcareous in places but is not acid.

The Thurloni soils are associated with the Ordnance and Showlow soils. They have been less influenced by sandstone than the Ordnance soils, and their horizonation is less distinct than that of those soils. The Thurloni soils are shallower and more calcareous than the Showlow soils. They are less well developed than those soils.

Typical profile of Thurloni clay, in a virgin area under a cover of pinyon pine, juniper, and ponderosa pine, in Sixmile Canyon, north of McGaffey; SE¼SW¼ sec. 22, T. 14 N., R. 16 W., McKinley County:

O1&O2—1 inch to 0, needles, leaves, and twigs, in various stages of decomposition.

A1—0 to 2 inches, dark reddish-brown (5YR 3/2) clay, dusky red (2.5YR 3/2) when moist; moderate, fine, granular structure; soft when dry, friable when moist, sticky and plastic when wet; weakly calcareous; pH 7.6; clear, smooth boundary.

B1—2 to 6 inches, weak-red (2.5YR 4/2) clay, dusky red (2.5YR 3/2) when moist; moderate, very fine or fine, subangular and angular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous, with visible lime; pH 8.0; clear, smooth boundary.

B2—6 to 11 inches, weak-red (10R 5/3) clay, weak red (10R 4/3) when moist; moderate, medium, prismatic structure breaking to weak, fine and medium, angular blocky; very hard when dry, very firm when moist, very sticky and very plastic when wet; no distinct pores; strongly calcareous; pH 8.2; clear boundary.

B3—11 to 18 inches, weak-red (10R 5/3) silty clay, weak red (10R 4/3) when moist; weak, fine, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; some fine pores; strongly calcareous; pH 8.4; clear boundary.

C/R—18 to 33 inches +, pale-red (10R 6/3), weak-red (10R 5/3), and white (10YR 8/1) shale and silty clay loam, weak red (10R 4/4) and light gray (10YR 7/2) when moist; slightly hard when dry, friable when moist, sticky and plastic when wet; many fine pores; strongly calcareous, with lime in mycelial veins; pH 8.5.

The depth to fractured shale ranges from 20 to 40 inches. The color of the A1 horizon ranges from dark gray to reddish brown to brown. In the layers below the A1 horizon, the degree of redness varies, depending on the color of the parent shale. The texture of the B2 horizon is generally clay, but in places it is silty clay or heavy clay loam.

Valentine Series

The Valentine series consists of deep, somewhat excessively drained, undulating and hummocky soils on the uplands. These soils occur at an elevation of about 8,200 feet, where the annual precipitation is about 18 inches and the average annual temperature is 45° F. The slope is 5 to 15 percent. These soils developed partly from wind-deposited sandy material and partly in material weathered from sandstone. They are characterized by a dark-colored A horizon and a light-brown to strong-brown, sandy C horizon. Nearly all of the sand grains are rounded. The vegetation consists of ponderosa pine, bitterbrush, rabbitbrush, grass, and forbs. Natural regeneration of pine is vigorous.

The Valentine soils are associated with the Sanchez, Kiln, and Osoridge soils. They are deeper, coarser textured, and less stony than those soils. The Sanchez and Osoridge soils formed in place in material weathered from sandstone. The Kiln soils formed in material weathered from limestone.

Typical profile of Valentine loamy fine sand, in an area of cutover ponderosa pine; NW¼ sec. 1, T. 10 N., R. 14 W., Valencia County:

A11—0 to 4 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 3/3) when moist; single grain; loose when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 6.8; clear boundary.

A12—4 to 9 inches, brown (10YR 5/3) loamy fine sand, dark yellowish brown (10YR 4/3) when moist; single grain; loose when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 6.8; clear boundary.

C1—9 to 19 inches, light-brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) when moist; single grain; loose when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 6.6; gradual boundary.

C2—19 to 54 inches, light-brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) when moist; single grain; slightly hard when dry, firm when moist, nonsticky and nonplastic when wet; noncalcareous; pH 7.2; clear, wavy boundary.

R—54 to 63 inches +, strong-brown (7.5YR 5/6) sandstone, strong brown (7.5YR 4/6) when moist; noncalcareous; pH 6.4.

The texture ranges from fine sand to loamy fine sand to fine sandy loam. The thickness of the sandy material over the sandstone bedrock ranges from 40 to 60 inches or more. These soils are generally noncalcareous, but in some places there are calcareous spots, probably resulting from inclusions of lime in the underlying Chinle sandstone.

Chemical and Physical Properties of the Soils

Samples from representative profiles of seven soils were submitted for laboratory analysis. The data obtained are given in table 5. The soils selected developed in material derived from several kinds of parent rock. The Fortwingate and Osoridge soils formed in material derived from sandstone; the Jekley soils formed in material derived partly from sandstone and partly from siltstone; the Kiln and Turkeysprings soils formed in material weathered from limestone; the Thurloni soil developed over shale; and the Zuni soil formed over granite.

The percentage of organic carbon was determined by the potassium dichromate method, based on 77 percent recovery calculated to 100 percent. Total nitrogen was determined by the standard Kjeldahl method. Mechanical analysis was made by the pipette method. Exchangeable cations were determined as follows: calcium by potassium permanganate titration, magnesium as magnesium-ammonium phosphate, and sodium and potassium by flame photometer. Other chemical and physical data were obtained by standard accepted procedures.

The pH values for the several profiles cover a wide range. On the basis of saturated paste, reaction varies from strongly acid (pH 5.2) to moderately alkaline (pH 8.4). The pH values obtained by the saturated paste test show that, with the exception of the subsoil of the Osoridge soil, the soils derived from sandstone range from medium acid to neutral in reaction; the soils derived from limestone are mildly or moderately alkaline; Thurloni clay, the only soil studied that formed in material derived from shale, has a neutral reaction in the surface layer and a mildly alkaline reaction in the subsoil. The Zuni soil, which formed in material weathered from granite, is neutral to mildly or moderately alkaline.

Only two of the soils, Thurloni clay and Turkeysprings clay loam, show a significant rise in reaction with an increased soil-water ratio. In the Thurloni soil, the horizons below 6 inches have pH values of 8.3 to 8.5. In the Turkeysprings soil, the pH of the entire profile is in the range of pH 8.1 to 8.5. This increase in pH value upon dilution is attributed to increased hydrolysis of free calcium carbonate.

Soluble salt content is low; the highest is only 0.13 percent. The low content of soluble salts appears to be normal for these soils. With the exception of the Thurloni and Turkeysprings soils, the soils are essentially noncalcareous.

The content of organic carbon in the samples analyzed ranges from 2.61 to 0.12 percent. In most of the soils the percentage of organic carbon is higher in the surface horizon than in the other horizons, but in the Kiln soil the content of organic carbon is fairly consistent throughout the profile. The content of nitrogen ranges from 0.155 to 0.025 percent. Generally, the content of carbon and nitrogen decreases as depth increases.

The carbon-nitrogen ratio of the surface layer is generally greater than 15 : 1. The Jekley, Kiln, Osoridge, and Thurloni soils have a carbon-nitrogen ratio greater than 10 : 1 throughout the profile. The Zuni soil shows a narrow carbon-nitrogen ratio below a depth of 10 inches.

A carbon-nitrogen ratio greater than 20 : 1 is common in many forest soils. None of the Zuni Mountain Area soils tested, however, have a ratio greater than 18 :1. This fact may be the result of a climatic factor, such as high temperature, which stimulates microbial decomposition of plant residue. In most fresh residue, the carbon-nitrogen ratio is wide. As decomposition progresses and carbon dioxide is liberated, the ratio narrows.

The mechanical analysis data reflect the textural range of the parent materials and the resultant soils. The content of sand in the Fortwingate, Jekley, and Osoridge soils, which formed in material weathered from sandstone, ranges from 16.9 to 55.7 percent. The content of clay ranges from 9.8 to 53.0 percent. Very fine sand makes up more than 60 percent of the total sand fraction in all horizons of these three soils. The Jekley soil has a high content of silt, which reflects the siltstone and fine-grained sandstone parent materials. The clay fraction of the Thurloni soil clearly reflects the influence of the parent shale. The abrupt decrease in clay content below a depth of 18 inches results from the presence of unweathered shale in the substrata. The sand fraction of the Thurloni soil is chiefly fine and very fine. The sand fraction of the Kiln and Turkeysprings soils, which formed in material weathered from limestone, is principally very fine. The even gradation from sand through silt to clay in the Turkeysprings loam helps to explain the mellowness and softness of this soil. The concentration of clay in the 18- to 38-inch layer of the Zuni soil indicates translocation of clay from overlying horizons. This is the only soil analyzed that contains a significant amount of very coarse and coarse sand.

The cation-exchange capacity covers a wide range among the soils tested. It is generally highest in the B2 horizons. The Thurloni soil has a consistently high exchange capacity throughout the profile, and its surface layer has a higher exchange capacity than that of any of the other soils analyzed.

Although most of the soils tested are noncalcareous, the dominant exchangeable cation is calcium. Exchangeable magnesium is second to calcium and is relatively high in the Thurloni and Turkeysprings soils. The percentage of exchangeable sodium and potassium is low in all of the soils. The greatest amount of exchangeable sodium occurs in the B2 horizon of the Fortwingate soil. The greatest amount of exchangeable potassium occurs in the B2 horizon of the Fortwingate soil and in the B1 horizon of the Thurloni soil.

Part III: Soil Use and Management

Most of the Zuni Mountain Area was heavily logged and excessively grazed in the past. Many millions of board feet of timber were harvested, and no provision was made for a residual stand. Heavy grazing, dating back to the early 1800's, depleted the ground cover, and the loss of ground cover resulted in erosion, lowering of the water table, and a decline in productivity. Gullies formed in many logging roads and skid trails that were improperly located.

In 1944, through a land-exchange program, most of this Area was placed under the management of the Forest Service. The Forest Service initiated a program of multiple-use management on the Federally owned lands, the objectives of which are to increase the production of timber and forage, control erosion, increase the sustained yield of water, protect wildlife, and permit the development of recreational facilities. Rehabilitation of the vegetation is of prime importance in this program. Planting, reseeding, grazing control, fire prevention, and selective logging are among the practices that have been applied to improve the timber stands and to give the range vegetation and browse plants a chance to recover.

This part of the soil survey emphasizes the information that is needed in planning the use and management of wild lands. In it the soils of the Area are grouped first according to geographic association (the soil management areas) and then according to suitability for specified uses.

TABLE 5.—*Chemical and physical*[1]

[Dashed lines indicate that values were considered not representative of the natura

Soil type	Horizon	Depth from surface	Reaction		Soluble salts	$CaCO_3$ (lime)
			Saturated paste	1:5 soil-water suspension		
		Inches	*pH*	*pH*	*Percent*	*Percent*
Fortwingate loam (pit sample 18).	A1	0–6	6. 9	6. 9	0. 02	0. 1
	A21	6–9	6. 8	6. 9	. 02	. 1
	A22–A3	9–11	6. 4	6. 9	. 02	. 1
	B1	11–13	6. 2	6. 6	. 07	. 1
	B2	13–32	6. 7	7. 1	. 11	. 2
Jekley silt loam (pit sample 1).	A1	0–5	5. 9	6. 1	. 02	. 2
	B1	5–8	5. 9	6. 0	. 02	0
	B2	8–14	6. 2	6. 2	. 05	0
	C	14–17	6. 1	6. 5	. 02	0
Kiln loam (pit sample 6).	A11	0–2	7. 5	7. 5	. 02	. 3
	A12	2–5	7. 5	7. 5	. 02	. 4
	B2	5–11	7. 5	7. 8	. 02	. 4
Osoridge fine sandy loam (pit sample 17).	A1	0–2	6. 9	6. 5	. 02	. 3
	A2	2–4	6. 7	6. 1	. 02	. 2
	B1	4–8	6. 0	6. 4	. 10	. 1
	B21	8–12	5. 3	6. 0	. 10	0
	B22	12–17	5. 2	5. 8	. 10	. 1
Thurloni clay (pit sample 13).	A1	0–2	7. 2	7. 5	. 12	. 9
	B1	2–6	7. 0	7. 4	. 13	2. 6
	B2	6–13	7. 5	8. 3	. 13	4. 4
	B3	13–18	7. 7	8. 4	. 12	4. 2
	C	18–33	7. 7	8. 5	. 11	3. 5
Turkeysprings clay loam (pit sample 15).	A11	0–3	7. 7	8. 2	. 08	17. 0
	A12	3–7	7. 7	8. 1	. 10	14. 6
	B1	7–10	7. 8	8. 1	. 10	13. 1
	B2	10–17	7. 8	8. 3	. 11	11. 9
	B3ca	17–33	7. 9	8. 3	. 10	12. 1
	C	33–54	8. 1	8. 5	. 08	27. 4
Zuni sandy loam (pit sample ZM1).	A11	0–2	6. 7	6. 8	. 02	0
	A12	2–5	6. 8	6. 6	. 02	0
	A21	5–8	6. 8	6. 8	. 02	0
	A22	8–10	6. 9	6. 7	. 02	0
	A3	10–13	6. 8	6. 7	. 02	0
	B1	13–18	6. 5	6. 5	. 02	0
	B2	18–38	6. 9	7. 0	. 02	0
	B3	38–45	7. 7	7. 7	. 02	0
	C	45+	7. 4	7. 7	. 10	0

Soil Management Areas

Soils occur in characteristic positions on the landscape and in characteristic geographic patterns. By grouping soils that normally are associated geographically, we get a generalized map that is useful in planning the management of large areas. The soils of the Zuni Mountain Area have been placed in 10 such geographic groups. In this report these groups are called soil management areas.

Each soil management area has a distinct pattern of soils, and in each area the soils of one or two series are dominant. Soils within a given area may differ markedly from each other. The pattern of soils is not exactly uniform in each part of a management area, but the same soils are present in somewhat the same arrangement.

Soil management areas cannot be used effectively in intensive planning or in planning management of small areas, but they are useful in planning for broad uses, such as growing timber, managing range for grazing, or improving the watershed.

The 10 soil management areas in the Zuni Mountain Area are shown on the colored map at the back of this report. In table 6, the major characteristics of each of the areas are summarized. The soil management areas are described in the following pages. For more detailed information about the soils, see the detailed soil map and the section "Descriptions of the Soils."

characteristics of representative soils

soil, or they were based on numerical results too low for meaningful interpretation]

Organic matter			Mechanical analysis			Cation-exchange capacity	Exchangeable cations			
Organic carbon	Nitrogen	C/N ratio	Sand (2.0–0.05 mm.)	Silt (0.05–0.002 mm.)	Clay (less than 0.002 mm.)		Ca	Mg	Na	K
Percent	*Percent*		*Percent*	*Percent*	*Percent*	*Meq. per 100 gm. of soil*	*Meq. per 100 gm. of soil*	*Meq. per 100 gm. of soil*	*Meq. per 100 gm. of soil*	*Meq. per 100 gm. of soil*
1. 59	0. 093	17. 0	54. 9	35. 3	9. 8	----------	----------	1. 8	0. 1	0. 6
. 54	. 044	12. 3	42. 6	41. 3	16. 1	----------	----------	2. 3	. 2	. 5
. 41	. 053	7. 7	40. 1	41. 8	18. 1	----------	----------	3. 2	. 2	. 6
. 41	. 049	8. 4	38. 5	40. 3	21. 2	----------	----------	5. 2	. 4	. 8
. 44	. 052	8. 5	36. 8	23. 6	39. 6	----------	----------	9. 8	1. 2	1. 2
1. 65	. 093	17. 7	26. 9	55. 5	17. 5	----------	----------	1. 8	. 3	. 3
. 98	. 077	12. 7	23. 0	60. 0	16. 0	9. 9	7. 9	1. 9	. 4	. 3
. 83	. 055	14. 1	23. 6	53. 2	23. 2	10. 5	7. 7	2. 8	. 4	. 3
. 82	. 059	13. 9	16. 9	45. 4	37. 7	16. 5	10. 1	5. 0	. 6	. 7
1. 28	. 081	15. 8	57. 9	29. 1	13. 0	----------	----------	1. 2	. 1	. 2
1. 24	. 085	14. 5	48. 8	35. 8	15. 4	----------	----------	3. 0	. 1	. 4
1. 12	. 087	12. 8	48. 8	29. 8	21. 4	----------	----------	5. 8	. 1	. 2
2. 17	. 140	15. 5	55. 7	32. 8	11. 5	----------	----------	2. 7	. 4	. 3
1. 18	. 078	15. 1	55. 3	32. 3	12. 4	----------	----------	2. 4	. 3	. 3
1. 07	. 076	14. 1	38. 7	14. 2	44. 2	----------	----------	8. 5	. 4	. 4
. 68	. 055	12. 4	32. 8	14. 2	53. 0	41. 5	18. 2	11. 8	. 4	. 5
. 65	. 050	13. 0	37. 3	9. 7	53. 0	----------	----------	10. 2	. 5	. 5
2. 61	. 155	16. 8	17. 2	23. 7	59. 1	----------	----------	14. 4	. 4	1. 0
1. 71	. 099	17. 2	24. 3	25. 5	50. 2	----------	----------	4. 0	. 4	1. 2
. 65	. 048	13. 5	25. 4	31. 4	43. 2	----------	----------	4. 4	. 4	. 9
. 46	. 034	13. 5	24. 9	27. 3	47. 8	----------	----------	5. 6	. 4	. 8
. 29	. 027	10. 7	35. 6	38. 6	25. 8	----------	----------	4. 7	. 4	. 6
1. 38	. 113	12. 2	36. 3	35. 3	28. 4	----------	----------	2. 5	. 4	. 6
1. 41	. 111	12. 7	33. 0	35. 6	31. 4	----------	----------	2. 7	. 5	. 6
1. 35	. 113	11. 9	31. 5	41. 0	27. 5	----------	----------	2. 3	. 4	. 5
. 89	. 073	12. 2	31. 2	29. 6	39. 2	----------	----------	3. 7	. 5	. 5
. 58	. 060	9. 7	24. 4	37. 0	38. 6	----------	----------	4. 1	. 5	. 5
. 30	. 040	7. 5	22. 8	45. 2	32. 0	----------	----------	6. 3	. 4	. 3
1. 76	. 099	17. 7	71. 8	18. 6	9. 6	10. 9	7. 0	1. 1	. 1	. 1
. 71	. 059	12. 0	65. 3	23. 7	11. 0	7. 8	5. 5	1. 1	. 2	. 1
. 43	. 033	13. 0	64. 2	26. 5	9. 3	6. 3	4. 7	1. 7	. 2	. 1
. 36	. 043	8. 3	61. 3	27. 7	11. 0	6. 2	4. 1	1. 4	. 2	. 1
. 38	. 068	5. 6	56. 9	28. 0	15. 1	8. 2	5. 5	1. 5	. 3	. 1
. 41	. 081	5. 1	47. 6	32. 5	19. 9	12. 4	9. 0	1. 7	. 3	. 2
. 39	. 054	7. 3	37. 2	29. 2	33. 6	25. 0	15. 0	5. 3	. 7	. 4
. 17	. 025	----------	45. 7	26. 3	28. 0	21. 6	14. 0	4. 7	. 6	. 3
. 12	. 028	----------	60. 1	17. 5	22. 4	16. 8	12. 8	3. 0	. 7	. 2

1. Osoridge-Kiln area

Shallow, rocky soils on uplands

Shallow, stony and rocky, highly erodible soils of low to medium water-holding capacity are dominant in this soil management area. Almost all of the area is underlain by sandstone or limestone. Outcrops of sandstone are prominent and extensive. Stones are common, both on and below the surface. The depth to bedrock ranges from only a few inches to 20 inches. Ledges and rimrock are extensive in some parts of the area. The relief is gently sloping to steep and rough (fig. 26), and the entire area is strongly dissected by numerous drainageways. The pattern of soils is complex because of the intricate mixture of underlying rock.

Almost all of area 1 is within the ponderosa pine zone. The vegetation consists of an overstory of residual ponderosa pine and scattered thickets of pine. Gambel oak trees and brush occur throughout the area, and some pinyon and juniper at the lower elevations. Browse plants, such as mountain-mahogany, bitterbrush, and cliffrose, are present. The grass cover consists of Arizona fescue, mountain muhly, and blue grama.

An estimated 50 percent of soil management area 1 consists of Osoridge and Kiln soils; 14 percent consists of Jekley stony loam, 10 to 30 percent slopes, and Jekley rocky complex, 30 to 40 percent slopes; and 8 percent consists of Sanchez and Bond soils. Miscellaneous land

Figure 26.—View of the Osoridge-Kiln and the McGaffey-Tampico-Polich soil management areas. The steep slopes in the background are part of the Osoridge-Kiln area, and the gentle slopes in the foreground and center are part of the McGaffey-Tampico-Polich area.

types account for 28 percent. Altogether, this group of soils makes up 43.3 percent of the survey Area.

In general, soil fertility is only moderate, and production of timber and of range herbage is low or moderate. Jekley stony loam, 10 to 30 percent slopes, and Kiln rocky complex, 3 to 20 percent slopes, are medium for timber production. The Osoridge, Sanchez, and Bond soils are poor or fair for the production of ponderosa pine and range herbage. Ponderosa pine grows slowly on the Osoridge, Sanchez, and Bond soils, and the trees are poorly formed and short stemmed. Most of area 1 has been heavily logged and cut over, and natural regeneration of ponderosa pine is poor. Past grazing has reduced the amount of forage available, and recovery of the vegetation is slow. Some of the area is only lightly grazed now because of lack of water.

The soils of this management area have low water-storage capacity, but they produce a great amount of surface runoff. A large part of the inflow to Bluewater, Nutria, and Ramah Reservoirs is runoff from this area.

Lightly vegetated areas are severely eroded. Runoff causes gullying in roads and trails, and many old logging roads are now nearly impassable because of stones, boulders, and bedrock.

The engineering properties are only fair at best. The shallow, extremely stony soils provide hardly enough embankment material even for construction of stock tanks.

This area is of high value as a watershed. There is a need to maintain and improve the quality and density of the vegetation, so as to reduce the erosion hazard. Economic returns from reseeding the range or from planting trees are unlikely under the present level of management, but such practices would enhance the value of the area as a watershed.

2. *Thurloni-Showlow area*

Moderately deep and shallow, clayey soils on uplands

Unstable, shaly, moderately deep and shallow, alkaline, strongly calcareous soils are dominant in this soil management area. The slopes are moderately steep and steep, and erosion has carved out many small and large drainageways. The soils were derived from shale and thin-bedded sandstone of the Chinle formation. In places they are very stony or rocky, and there is much exposed shale and sandstone. The depth to bedrock ranges from 12 to 36 inches.

The soils of this area support a thick and vigorous growth of pinyon pine and juniper. Some ponderosa pine and oak brush grow at the higher elevations, but regeneration of ponderosa pine generally is poor and in some areas is entirely ineffective. The principal grasses are blue grama, ring muhly, squirreltail, and three-awn.

The Thurloni and Showlow soils make up 47 percent of soil management area 2; Badland, a land type, accounts for 43 percent; and Ordnance soils for the remaining 10 percent. Altogether, this group of soils makes up about 5 percent of the survey Area. The complex soil pattern results from the uneven distribution of shale and sandstone within the main geologic formation.

Lightly vegetated areas and steep areas are severely eroded. Large areas have only a thin remnant of surface soil, and in many places the clayey, calcareous subsoil is exposed. Many old roads and trails are so seriously cut and eroded that they are now deep gullies with vertical walls.

Ponderosa pine grows in the higher parts of this area, but the trees are stunted and of poor quality. Generally, the soils are poorly suited to ponderosa pine and moderately well suited to range herbage, but Thurloni clay, 5 to 20 percent slopes, has a high potential for the production of herbage.

The water-storage capacity is low, and there is little potential for sustained yield. During intense storms or rapid snowmelt, surface yield is high but the water is heavily laden with sediment.

In engineering properties these soils are poor. They are unsuitable for use in earthen structures, because they contain large amounts of highly dispersed materials. Roads and trails require a great deal of maintenance and repair.

Management should be such as to cause minimum disturbance of the vegetative cover.

3. *Laporte-Nathrop area*

Shallow, stony, calcareous soils on uplands

Shallow, stony and rocky, calcareous soils are predominant in this soil management area. Included are the steep cliffs, escarpments, and talus slopes of Zuni Canyon. The slope range is from moderate to very steep. The depth of the soils ranges from 12 to 36 inches and is commonly about 15 inches. Much of the surface is covered with limestone fragments and stones, and outcrops of limestone are common.

Area 3 is in the northeastern part of the survey Area and lies chiefly within the pinyon-juniper zone. Thick stands of pinyon pine and juniper are present. Small open spots have a good cover of grass, chiefly blue grama and three-awn. Ponderosa pine is scarce, and the trees are of poor quality.

The Laporte and Nathrop soils make up 69 percent of soil management area 3; Rock outcrop, cliffs, occupies 30 percent; and Tabiona soils 1 percent. Altogether, this group of soils makes up about 4 percent of the survey Area. The soil pattern is simple and uniform.

TABLE 6.—*Summary of major characteristics of soil management areas*

Management area	Percent of survey Area	Component soils		Parent rock	Soil pattern	Relief	Type of vegetation
		Names of series and land types	Percent of management area				
1. Osoridge-Kiln	43. 3	Osoridge Kiln Jekley Sanchez Bond Rock outcrop, gently sloping; Rock land; and Rock outcrop, cliffs.	29 21 14 7 1 28	Sandstone and limestone.	Complex	Gently sloping to steep and rough.	Ponderosa pine.
2. Thurloni-Showlow.	5	Thurloni Showlow Ordnance Badland	37 10 10 43	Shale, sandstone, and conglomerate.	Complex	Moderately steep and steep.	Pinyon-juniper-ponderosa pine.
3. Laporte-Nathrop	4	Laporte Nathrop Tabiona Rock outcrop, cliffs.	66 3 1 30	Limestone and sandstone.	Simple, uniform.	Moderately steep and steep; steep escarpments.	Pinyon-juniper.
4. Zuni-Mirabal	12. 9	Zuni Mirabal Kettner Wilcoxson Andrews	26 61 3 9 1	Granite, gneiss, schist, and some limestone.	Simple, uniform.	Gently sloping, undulating, and rolling to steep and rough.	Ponderosa pine.
5. Fortwingate-Jekley.	13	Fortwingate Jekley Savoia Turkeysprings Valentine	25 50 16 6 3	Sandstone, siltstone, and limestone.	Simple, uniform.	Gently sloping and moderately sloping, long dip slopes.	Ponderosa pine.
6. McGaffey-Tampico-Polich.	5. 8	McGaffey Tampico Polich	54 25 21	Sandstone, shale, limestone, and granite.	Simple, uniform.	Very gently sloping and smooth.	Ponderosa pine.
7. Mirabal-Supervisor.	5. 4	Mirabal Supervisor Larry Tampico	69 29 1 1	Granite, gneiss, and schist.	Simple, uniform.	Steep; rough	Ponderosa pine and mixed conifers.
8. Bandera-Gem	5. 1	Bandera Gem Friana Lava flows and Lava rock land.	30 44 3 23	Basalt and cinders.	Simple, uniform.	Gently sloping, undulating, and rolling.	Pinyon-juniper-ponderosa pine.
9. Concho-Prewitt	3. 5	Concho Prewitt Montoya	38 59 3	Shale, sandstone, and limestone.	Simple, uniform.	Gently sloping and smooth.	Grass-pinyon-juniper-ponderosa pine.
10. Trail-Savoia	2	Trail Savoia	55 45	Sandstone and limestone.	Simple, uniform.	Gently sloping and moderately sloping; smooth.	Ponderosa pine.

The erosion hazard is high. Many small and large erosion channels have formed in the Laporte soils, and many old roads and trails are so eroded that bedrock is exposed and boulders are on the surface.

Ponderosa pine grows only in the higher parts of this management area, and production is poor. Generally, the climate is not suitable for pine. The potential for production of range herbage is medium, but the thick stands of juniper create strong competition for grass and other forage plants.

The water-storage capacity is limited, and the capacity for sustained yield of water is very low. Surface runoff often is rapid.

The engineering properties of the soils are only fair at best. The shallow Laporte soils offer few sites for stock tanks or reservoirs. In most parts of this area, excavation necessitates removal of large quantities of hard rock.

Production of herbage is the best use for the soils of area 3. The less sloping areas of the Laporte soils can be reseeded to grass, and grass could be established in places where juniper now grows. Since this area is at a relatively low elevation, it is used as winter range by big game. Browse species could be planted to increase the supply of feed.

4. *Zuni-Mirabal area*

Shallow to deep soils on uplands, underlain by granite

The predominant soils of this soil management area have a surface layer of sandy loam or loam and a finer textured subsoil. An estimated 87 percent of the area consists of the Zuni and Mirabal soils, and 13 percent consists of Kettner, Wilcoxson, and Andrews soils. Altogether, this group of soils constitutes 12.9 percent of the survey Area. The soil pattern is simple compared with that of area 2 (Thurloni-Showlow).

Granite, gneiss, and schist underlie most of the soils, but limestone underlies the Wilcoxson and Andrews soils. The Zuni, Kettner, and Wilcoxson soils are gently sloping and undulating, and the Mirabal and Andrews soils are moderately sloping. Rock outcrops are common on the Mirabal and Andrews soils but are less prevalent on the Zuni, Kettner, and Wilcoxson soils. The Mirabal and Andrews soils are 10 to 20 inches deep, and the Zuni, Kettner, and Wilcoxson soils 36 to 48 inches. Most of the area is strongly dissected with small drainageways.

A large part of area 4 has been heavily logged or cut over; consequently, the overstory now consists chiefly of second-growth ponderosa pine of uneven age. There is some oak brush, and the ground cover consists mostly of Arizona fescue, mountain muhly, blue grama, and squirreltail.

The soils of this area are fertile and productive. All are well suited to ponderosa pine. Natural regeneration of pine is good, and thickets of young pine are common. The potential for production of range herbage is medium to high. Many small openings in the pine forest have a good cover of grass. The rate of water intake is moderate, and most of the soils are deep enough to have a medium capacity for storage of water. The sustained yield of water is high, particularly that from the soils that overlie granite.

The erosion hazard is high where the slopes are strongest and moderate where the slopes are more gentle.

Most of the soils of this area have good engineering properties and are suitable for use in the construction of water-retaining structures and other earthen structures. Roads and trails require no more than ordinary maintenance. Some of the best of the main roads in the mountains are in this management area.

Most of area 4 can be managed for the production of both timber and range herbage. The erosion hazard must be taken into account, and the capacity for water yield ought to be protected.

5. *Fortwingate-Jekley area*

Moderately deep and deep soils on uplands, underlain by sandstone

Stable, fertile, highly productive soils that have high or medium water-storage capacity are predominant in this area. Most of the area has long, uniform, gentle or moderate slopes. Level and nearly level areas are common. Sandstone underlies most of the area. The soils are not stony, and outcrops are rare. The depth to bedrock ranges from 24 to more than 60 inches.

The overstory consists primarily of good stands of ponderosa pine, including dense thickets of young trees. There is some oak brush, and the dominant grasses are Arizona fescue, junegrass, mountain muhly, and squirreltail.

Fortwingate loam, 2 to 8 percent slopes, and Jekley silt loam, 3 to 7 percent slopes, constitute 75 percent of soil management area 5. The rest consists of Savoia, Turkeysprings, and Valentine soils. Altogether, this group of soils makes up 13 percent of the survey Area. The soil pattern is simple in comparison with the patterns of area 1 (Osoridge-Kiln) and area 2 (Thurloni-Showlow).

The erosion hazard is low to moderate; little surface soil has been lost, and gullying has been negligible. The small number of drainageways indicates that water generally has passed through the soil rather than running off the surface.

The soils of area 5, particularly Jekley silt loam, 3 to 7 percent slopes, and the Savoia soils, are well suited to timber. The regeneration potential is high, and dense (dog hair) thickets are common. The potential for production of herbage is high or moderate. Desirable grasses, such as Arizona fescue and mountain muhly, are predominant.

Infiltration is rapid, and the water-storage capacity is good. The capacity for sustained yield of water to springs and streams is good.

These soils are excellent for road or dam construction. They are easy to work and to handle and are stable in fills and embankments. Unsurfaced roads require only minimum maintenance. Except in the Jekley soil, very little rock is likely to be encountered in road cuts as much as 5 feet in depth.

The soils of area 5 can be used for the production of both timber and herbage. Management should be directed toward improvement of productivity.

6. *McGaffey-Tampico-Polich area*

Deep soils in upland valleys

Deep, fertile, highly productive soils are predominant in this soil management area. The slopes are gentle, and level and nearly level areas are common. The soils are not

stony or rocky. Soil-moisture storage and plant-supplying capacities are high.

Most of the acreage has a cover of native grasses. Good forage species, such as Arizona fescue and mountain muhly, are predominant. Wheatgrass has been introduced in places. Yellow sweetclover grows well, and rabbitbrush is abundant in many places. A large part of area 6 has been cleared of timber, but some good ponderosa pine remains on stringers of the McGaffey and Tampico soils (fig. 27).

Figure 27.—**Grass and ponderosa pine on McGaffey loam. The slope range is 1 to 3 percent.**

McGaffey soils constitute 54 percent of this soil management area, and Polich and Tampico soils 46 percent. Altogether, this group of soils makes up about 5.8 percent of the survey Area. The soil pattern is simple and uniform.

Both the McGaffey and the Tampico soils are well suited to ponderosa pine. Because they have a seasonal high water table, the Polich soils probably have never supported much pine. The McGaffey soils and the Polich soils are well suited to range herbage.

The capacity for water storage and the capacity for sustained yield of water are high. In periods of normal precipitation, small seeps and springs are numerous.

The hazard of erosion is moderate or low. The Tampico soils erode more readily than either the McGaffey or the Polich soils. Gullying may do some damage. Most of the existing gullies appear to have developed as a result of erosion along old roads and trails.

A considerable part of the acreage of the McGaffey and Polich soils has been dryfarmed, but only a small acreage is still cultivated. Since much of the acreage has been cleared, the situation is ideal for the establishment of pastures. Through advanced methods of reforestation, the McGaffey and Tampico soils could be returned to timber production. Management should be directed toward protection and conservation of these valuable soils.

7. *Mirabal-Supervisor area*

Shallow and moderately deep, steep soils underlain by granite

Shallow and moderately deep, gravelly and stony, highly erodible soils on steep slopes high in the mountains are dominant in this soil management area (fig. 28). Granite and gneiss underlie all the soils of this area, and outcrops of granite and gneiss are prominent on the south-facing slopes. The relief is steep and rough, and slopes of 30 percent or more are common.

Most of area 7 is near Mt. Sedgwick and is at elevations of 8,500 to 9,100 feet.

The Mirabal soils, which are on south-facing slopes and narrow ridgetops, constitute 69 percent of the acreage; the Supervisor soils, which are on north-facing slopes, constitute 29 percent; and the Larry and Tampico soils make up the rest. Altogether, this group of soils makes up 5.4 percent of the survey Area. The soils are strongly contrasting because of differences in exposure, but the soil pattern is simple and uniform.

The slope is generally between 20 and 45 percent, but the narrow ridgetops have slopes of 5 to 15 percent. In the steep Mirabal soils, the depth to bedrock is between 15 and 22 inches; in the Mirabal soils on ridgetops, it is between 10 and 12 inches; and in the Supervisor soils, it is commonly between 20 and 30 inches. Outcrops are more common on the Mirabal soils than on the Supervisor soils.

On the Mirabal soils, the overstory consists chiefly of open-grown ponderosa pine, and the understory of Arizona fescue, mountain muhly, and other grasses. On the Supervisor soils, the overstory includes Douglas-fir and limber pine as well as ponderosa pine, and the understory includes bromegrass. Kentucky bluegrass grows well on the stringers of Larry and Tampico soils, which are valley fill soils.

Both the Mirabal soils and the Supervisor soils are productive, the Supervisor soils the more so. This area is one of the best water-producing areas in the mountains. The rate of water intake is rapid throughout the area, but the water storage capacity is only medium, because the soils are not deep enough to provide much reservoir space. Nevertheless, the capacity for sustained yield of water is good, because the characteristics of the soils are favorable and because the amount of precipitation is greater than in any other part of the survey Area.

The Supervisor soils and the steep Mirabal soils are well suited to timber; the Mirabal soils on ridgetops are less well suited. The Supervisor and Mirabal soils are poor or fair for production of range herbage, but the Larry and Tampico soils are good.

The erosion hazard is severe, partly because of soil characteristics inherited from the granitic parent material and partly because of the slope.

The engineering properties are good. The soils are easy to work and to handle and are stable in roadbeds. Because of the differences in depth to bedrock, careful on-site investigation is necessary. All structures, roads, and trails need carefully designed drainage systems, because of the erosion hazard.

Control of erosion should be a major consideration in planning the management of the soils of area 7. At present the vegetation provides protection against erosion. Minimum disturbance of the vegetation is important, and measures should be taken to compensate for any necessary disturbance.

Figure 28.—**Typical landscape in soil management area 7 (Mirabal-Supervisor), near Mt. Sedgwick.**

8. *Bandera-Gem area*

Shallow and moderately deep soils on uplands, underlain by basalt and cinders

Shallow and moderately deep, dark-colored, gravelly and stony soils derived from volcanic material are predominant in this soil management area. These soils have gently undulating and rolling slopes of 5 to 10 percent, except for some areas on the sides of cinder cones that have slopes of 25 percent or more. The amount of stone and gravel ranges from 10 to as much as 50 percent. Cobblestones, stones, and outcrops of basalt are common on the surface. Generally, the subsoil consists of clay or clay loam. Drainageways are numerous, and many of them have basalt floors.

The overstory vegetation consists of open-grown ponderosa pine, Gambel oak, and some pinyon and juniper. The understory consists of Arizona fescue, blue grama, and much rabbitbrush. Mountain-mahogany, cliffrose, and other desirable browse plants grow on Lava rock land.

An estimated 44 percent of this soil management area consists of the Gem soils, 30 percent of the Bandera soils, and 3 percent of the Friana soils. The rest consists of Lava flows and Lava rock land. Altogether, this group of soils makes up 5.1 percent of the survey Area. The soil pattern is simple and fairly uniform.

Although the soils of this area are fertile, they are not highly productive of ponderosa pine. The fine-textured subsoil appears to have an adverse effect, and the rocks and stones reduce the space in which roots can grow. The soils are well suited to range herbage and support good stands of grass.

The capacity to store water is low or medium, because the soils are shallow and rocky. The capacity for sustained water yield is low.

The erosion hazard is low or medium. The soils are well aggregated and stable and predominantly gently sloping.

The engineering properties are only fair. The silty and clayey soils do not compact well and are difficult to handle and to work. The cinders underlying the Bandera soils are used for road surfacing.

The soils of this area can be managed for the production of both timber and herbage, and the area is a good habitat for big game.

9. *Concho-Prewitt area*

Deep, calcareous soils on bottom lands

The predominant soils in this soil management area are deep, calcareous, moderately fine textured, and highly stratified. They are mainly gently sloping (1 to 3 percent) but include some colluvial slopes of as much as 10 percent. All of these soils are forming in alluvium derived partly from shale. There are very few stones and rocks in the profile and no rock outcrops. Deep gullies with vertical walls are common.

The vegetation consists of a scattering of ponderosa pine, some juniper, blue grama, western wheatgrass, rabbitbrush, Russian-thistle, and sunflower.

The Concho soils make up about 38 percent of area 9, the Prewitt soils 59 percent, and the Montoya soils 3 percent. Altogether, this group of soils constitutes about 3.5 percent of the survey Area. The soil pattern is simple and uniform.

These soils are well suited to production of range herbage, but the better forage species have been depleted by heavy grazing. Neither the physical characteristics of the soils nor the amount of precipitation are favorable for ponderosa pine.

The erosion hazard is high, largely as a result of the shale in the parent material but partly because of the high degree of stratification.

Although the soils are deep, the water-storage capacity is only medium. Infiltration and permeability are slow, and the deep gullies drain moisture from the subsoil.

The engineering properties are poor, largely because of the shale in the parent material. Gullies will form in roads and trails that are not properly located and cross drained. Special construction and design measures are necessary to insure the stability and permanence of dams, dikes, and other earthen structures. Production of range herbage is the best use for the soils of area 9. Revegetation, fertilization, and gully plugging would increase the amount of usable herbage produced. Any plan for use of these soils must take into account the high erosion hazard.

10. Trail-Savoia area

Deep, sandy soils on alluvial fans

Deep, sandy soils that formed in valley fill are predominant in this soil management area. The slopes are mostly gentle (2 to 5 percent), but some slopes of 20 percent are included.

Area 10 is in the southwestern part of the survey Area. Trail loamy fine sand and Trail loamy fine sand, hummocky, make up 55 percent of the acreage; Savoia fine sandy loam, 2 to 5 percent slopes, and Savoia fine sandy loam, 5 to 20 percent slopes, make up 45 percent. Altogether, this group of soils constitutes only 2 percent of the survey Area.

Trail loamy fine sand and the Savoia soils support ponderosa pine, Gambel oak, juniper, and a good ground cover of blue grama. These soils are well suited to both ponderosa pine and herbage. The better stands of pine are on the Savoia soils. The pine trees are thrifty and well formed. Good stands of grass grow in open areas on the Savoia soils.

Trail loamy fine sand, hummocky, is an unproductive soil that appears to have been affected by wind. It has only a sparse cover of vegetation, and it has little or no potential for the production of timber.

In the Savoia soils and in Trail loamy fine sand, the water-storage capacity is high; in Trail loamy fine sand, hummocky, it is low.

All the soils of this area take in water readily but are nevertheless susceptible to gully erosion. Trail loamy fine sand, hummocky, is susceptible to wind erosion also, and is a potential producer of sediment.

Except for Trail loamy fine sand, hummocky, the soils of area 10 can be managed for the production of both timber and herbage. Management should be planned to maintain productivity.

Forest Management

Ponderosa pine is the principal timber species in the forests of the Zuni Mountain Area, but there are limited quantities of Douglas-fir, limber pine, and white fir. Most of the timber of commercial size has been logged. The second growth is not yet ready to be harvested, but it will be a valuable source of timber in the future. Pinyon and juniper have commercial value as fenceposts, mine props, stulls, and firewood. Pinyon trees make good Christmas trees. Pulpwood could be harvested from these forests also if a demand for it arose.

Climate, topography, and soil characteristics affect the growth of trees. Ponderosa pine grows mainly in areas that receive 18 or more inches of precipitation annually. The stands on undulating and gently to moderately sloping soils are better than those on steep soils. The deeper, more fertile, better developed soils support better stands than the less fertile, less well developed, shallow, rocky soils. Parts of the Zuni Mountain Area are below the elevation at which the moisture supply is adequate for ponderosa pine.

Good forest management must include protection against fire, insects, and disease; thinning and pruning to improve the quality of the stands; and reforestation to insure continued yields and to maintain the watershed.

Under Forest Service management, fire protection is provided through a system of lookouts and fire patrolmen and through practices that reduce the fire hazard. Protection against insects and disease is provided through proper silvicultural practices and through direct control.

Pruning, precommercial thinning, and commercial cutting improve the quality of the timber and increase productivity.

Reforestation is achieved through natural regeneration, planting, and seeding. Most of the pine-producing soils in the Area are fair mediums for natural regeneration, and several are excellent. The soils that appear to offer optimum conditions for growth of seedlings are the following: Jekley silt loam, 3 to 7 percent slopes; Fortwingate loam, 2 to 8 percent slopes; Zuni sandy loam, 2 to 10 percent slopes; Savoia fine sandy loam, 2 to 5 percent slopes; and Kiln rocky complex, 3 to 20 percent slopes. Of these, the Jekley, Fortwingate, and Zuni soils are the best.

Competition from other vegetation does not seriously interfere with the regeneration and survival of pine seedlings, but locally there is some competition from Gambel oak. It is most apparent on the Wilcoxson, Andrews, Ordnance, and Kiln soils.

Losses through windthrow are not significant. Moderate damage has been observed on alluvial soils in the vicinity of Mt. Sedgwick. Such damage apparently occurs only when the soils are wet and the wind is very strong.

Roads, landings, and skid trails need to be protected against erosion. Cross ditching, seeding to grass, scattering of slash, and construction of water bars are among the effective erosion-control practices that can be applied.

Management of forests may be hampered because of soil characteristics and topographic features that restrict the use of equipment commonly used in harvesting timber. Only a moderate problem of equipment limitation exists in this Area. For a short period after the frost leaves the soil in spring, and occasionally after summer rainfall,

the soils are too wet and soft to support such equipment. The steep slopes also cause some restriction.

A well-managed forest provides indirect benefits, aside from the timber it produces. The network of surface roots binds the soil and helps to control erosion. The protective layer of forest litter breaks the impact of rainfall and thereby prevents damage to the soil structure. In addition, the litter absorbs water, and the tree roots keep the soil porous.

Timber suitability groups

In table 7 the soils of the Area are grouped according to their relative suitability for the production of timber. Since ponderosa pine is the chief timber species, site index values for this species were used as the basis of the groupings. "Site index" as used here refers to the average height of the dominant and codominant trees at the age of 100 years. Height and age measurements were obtained for trees on selected soils in the Zuni Mountain Area, then the site indexes were computed, using the site index curves for ponderosa pine developed by Meyer (*4*). The site index values ranged from 32 to 78.

The groupings shown in table 7 are relative and are applicable only to this survey Area. The groups are numbered in decreasing order of productivity; the soils of group 1 are the most productive, and those of group 5 the least. About half of the survey Area is fair or better for the production of timber.

Range Management

The nature and quantity of herbage produced in any area depends on elevation, climate, and topography, and on the fertility, water-supplying capacity, and other characteristics of the soils. Most of the range herbage in the Zuni Mountain Area falls in three types of vegetation: the pine forest type, the pinyon-juniper woodland type, and the grassland type. Of these, the pine forest type is the most extensive. The three types differ significantly in elevation, climate, topography, and soils.

The soils most productive of herbage are those on bottom lands and the deeper and more fertile of those on uplands. Shallow, poorly developed, rocky, and sloping soils are likely to be droughty and consequently poor for production of herbage. Also poor are eroded soils, which are likely to be droughty and low in fertility, and soils that are inherently low in fertility.

Herbage productivity groups

The soils of the Zuni Mountain Area have been placed in five groups, according to their relative potential for the production of range herbage. Table 8 shows these five groups, the combined extent of the soils in each group, and the types of vegetation. It also gives estimates of productivity, both potential and average. Since most of the soils of the Area have been overgrazed, average production at present represents production when the range is in poor or fair condition. The estimates are based on measurements, over a period of several seasons, of clippings from small exclosures on selected soils and on the inherent fertility of the soils as evidenced in greenhouse tests (*3*). Productivity will change as the results of research and experience are applied and management is improved.

The soils in groups 1, 2, and 3 make up about 245,400 acres, nearly 60 percent of the Area. They produce medium or high yields of herbage, and under improved management they are capable of even better yields. The McGaffey, Polich, Concho, Thurloni, and Savoia soils, because of their inherent characteristics, location, and topography, are the ones most likely to be benefited by revegetation, control of noxious plants, fencing into small, easily managed pastures or units, water spreading, and fertilization. Large-scale use of fertilizer should be undertaken only after fertilizer requirements have been established through field trials.

Group 4 includes most of the steep, rocky, and stony areas. Revegetation and control of noxious plants would be costly and extremely difficult. Most areas lack suitable sites for construction of stock tanks or water catchment areas; consequently, effective distribution of livestock is hindered.

The land types in group 5 are poorly suited to production of herbage. On most such areas, plants grow only in pockets where water accumulates and some soil has formed. Many are excessively sloping, and the ledges and escarpments are barriers to the movement of livestock.

Management practices

Range-improvement practices applicable in the Zuni Mountain Area include the following:

Deferment of grazing; that is, excluding all livestock from an area of range for a time during the growing season.

Control of brush and noxious plants. The moisture that these would use is then available to the useful range plants.

Revegetation with native or improved grasses and shrubs. Besides increasing the yield of herbage, this practice helps to control erosion and conserve moisture.

Building stock tanks and developing springs and wells, so as to make enough water available to livestock, and locating these so as to help keep the stock distributed over the range.

Salting to attract stock to areas that have no water and consequently might be underutilized.

Fencing to divide the range into effective management units.

Grazing allotments

Grazing allotments on national forest lands are administered under a permit system. Each permit holder is granted permission to graze a designated number of livestock on a specified grazing allotment. The Zuni Mountain Area is divided into 23 grazing allotments, which range in size from 3,774 to 68,112 acres. Some of the allotments are divided into management units to facilitate control of grazing. There is no correlation between the allotments and the vegetation zones, the herbage productivity groups, or the soil management areas. Capacity to support livestock differs from one allotment to another and between parts of a single allotment.

Watershed Management

Water is an important product of the Zuni Mountain Area; consequently, management of the forest watersheds is directed toward maintaining streamflow and increasing the yield of usable water. Most of the water comes from

TABLE 7.—*Timber suitability groups*

[The land types that are not suitable for timber are not listed in this table]

Map symbol	Group and soils	Site index for ponderosa pine	Accessibility	Erosion hazard	Extent	
					Acres	Percent of survey Area
	Group 1	70 or more	Easy	Moderate to high.	18, 750	4. 5
Ma	McGaffey loam.					
Tc	Tampico loam.					
Td	Tampico loam, dark variant.					
	Group 2	60 to 69	Easy to difficult.	Moderate to high.	57, 830	13. 9
Je	Jekley silt loam, 3 to 7 percent slopes.					
Mm	Mirabal stony loam, 15 to 45 percent slopes.					
Sb	Savoia fine sandy loam, 2 to 5 percent slopes.					
Sf	Savoia fine sandy loam, 5 to 20 percent slopes.					
Su	Supervisor stony loam, 20 to 45 percent slopes.					
Wc	Wilcoxson loam, 3 to 5 percent slopes.					
	Group 3	50 to 59	Easy to moderate.	Moderate	133, 280	32. 1
Co	Concho clay loam, 3 to 10 percent slopes.					
Fo	Fortwingate loam, 2 to 8 percent slopes.					
Gm	Gem stony loam, 2 to 7 percent slopes.					
Jk	Jekley stony loam, 10 to 30 percent slopes.					
Ke	Kettner loam, 3 to 10 percent slopes.					
Kr	Kiln rocky complex, 3 to 20 percent slopes.					
Kx	Kiln rocky complex, 20 to 40 percent slopes.					
Mb	Mirabal stony loam, 5 to 15 percent slopes.					
Tm	Trail loamy fine sand.					
Tu	Turkeysprings clay loam, 2 to 10 percent slopes.					
Va	Valentine loamy fine sand, 5 to 15 percent slopes.					
Wn	Wilcoxson clay loam, 3 to 15 percent slopes.					
Zd	Zuni sandy loam, 2 to 10 percent slopes.					
Zm	Zuni-Mirabal stony loams, 10 to 30 percent slopes.					
	Group 4	40 to 49	Moderate to difficult.	High	104, 420	25. 1
Ag	Andrews gravelly loam, 5 to 20 percent slopes.					
Bd	Bandera gravelly loam, 5 to 15 percent slopes.					
Bg	Bandera gravelly loam, 15 to 35 percent slopes.					
Bo	Bond sandy loam, 5 to 15 percent slopes.					
Ca	Cabezon rocky complex, 2 to 10 percent slopes.					
Jr	Jekley rocky complex, 30 to 40 percent slopes.					
Kn	Kettner stony loam, 10 to 20 percent slopes.					
Mn	Mirabal stony loam, low rainfall, 5 to 20 percent slopes.					
Od	Ordnance loam.					
Or	Osoridge rocky complex, 5 to 20 percent slopes.					
Ox	Osoridge rocky complex, 20 to 40 percent slopes.					
Sa	Sanchez stony complex, 10 to 20 percent slopes.					
Sh	Showlow loam, 0 to 5 percent slopes.					
Sm	Showlow clay loam, 5 to 15 percent slopes.					
Tk	Thurloni clay, black variant, 3 to 10 percent slopes.					
	Group 5	39 or less	Easy to moderate.	High	37, 560	9
Cc	Concho clay loam, 1 to 3 percent slopes.					
Fr	Friana silt loam.					
La	Laporte stony loam, 3 to 10 percent slopes.					
Lp	Laporte stony loam, 20 to 40 percent slopes.					
Lr	Larry silty clay loam.					
Mo	Montoya clay.					
Na	Nathrop loam, 0 to 5 percent slopes.					
Po	Polich loam.					
Pr	Prewitt clay loam.					
Ta	Tabiona fine sandy loam, 10 to 15 percent slopes.					
Th	Thurloni clay, 5 to 20 percent slopes.					
Tn	Trail loamy fine sand, hummocky.					

TABLE 8.—*Range herbage productivity groups*

Map symbol	Group and soils	Extent		Description	Vegetation		Estimated productivity (native herbage)	
		Acres	Percent of survey Area		Type	Typical plants	Good condition	Fair to poor condition
							Lb. per acre	*Lb. per acre*
	Group 1	24, 700	6. 0	Deep, fertile soils on bottom lands, flood plains, alluvial fans, and mountain meadow lands. Moisture-supplying capacity is high. Content of rock and stone is generally less than 5 percent.	Grassland and meadow.	Blue grama, bluestem, ring muhly, needle-and-thread, squirreltail, Carex, mutton bluegrass, Arizona fescue.	1,500 or more.	500 to 700.
Cc	Concho clay loam, 1 to 3 percent slopes.							
Co	Concho clay loam, 3 to 10 percent slopes.							
Lr	Larry silty clay loam (2 to 5 percent slopes).							
Ma	McGaffey loam (1 to 3 percent slopes).							
Po	Polich loam (0 to 2 percent slopes).							
	Group 2	31, 370	7. 5	Moderately deep and deep soils on uplands, fans, and terraces. Rate of water intake and rate of permeability generally are moderate. The subsoil holds moisture in the root zone. Capacity to supply moisture to plants is high. Natural fertility is good.	Grassland; pine forest; pinyon-juniper woodland.	Ponderosa pine, pinyon, juniper, Gambel oak, Arizona fescue, mountain muhly, needle-and-thread, mutton bluegrass, spike muhly, blue grama, junegrass, pine dropseed.	1,100 to 1,500.	350 to 500.
Fr	Friana silt loam (1 to 3 percent slopes).							
Gm	Gem stony loam, 2 to 7 percent slopes.							
Ke	Kettner loam, 3 to 10 percent slopes.							
Na	Nathrop loam, 0 to 5 percent slopes.							
Sb	Savoia fine sandy loam, 2 to 5 percent slopes.							
Sf	Savoia fine sandy loam, 5 to 20 percent slopes.							
Sh	Showlow loam, 0 to 5 percent slopes.							
Th	Thurloni clay, 5 to 20 percent slopes.							
Wc	Wilcoxson loam, 3 to 5 percent slopes.							
Wn	Wilcoxson clay loam, 3 to 15 percent slopes.							
	Group 3	189, 330	45. 5	Deep, moderately deep, and shallow soils. Many are droughty. Content of stone and rock may be as much as 40 percent. Natural fertility is fair to good.	Pine forest; grassland; pinyon-juniper woodland.	Ponderosa pine, pinyon, juniper, Gambel oak, Apache-plume, cliffrose, Oregon grape, mountain-mahogany, Arizona fescue, mountain muhly, blue grama, junegrass, squirreltail, sand dropseed, pine dropseed.	700 to 1,100.	250 to 350.
Ag	Andrews gravelly loam, 5 to 20 percent slopes.							
Bd	Bandera gravelly loam, 5 to 15 percent slopes.							
Ca	Cabezon rocky complex, 2 to 10 percent slopes.							
Cb	Clayey alluvial land (0 to 2 percent slopes).							
Fo	Fortwingate loam, 2 to 8 percent slopes.							
Je	Jekley silt loam, 3 to 7 percent slopes.							
Kn	Kettner stony loam, 10 to 20 percent slopes.							
Kr	Kiln rocky complex, 3 to 20 percent slopes.							
Mm	Mirabal stony loam, 15 to 45 percent slopes.							
Mn	Mirabal stony loam, low rainfall, 5 to 20 percent slopes.							

Mo	Montoya clay (0 to 3 percent slopes).							
Od	Ordnance loam (5 to 15 percent slopes).							
Pr	Prewitt clay loam (0 to 5 percent slopes).							
Sa	Sanchez stony complex, 10 to 20 percent slopes.							
Sm	Showlow clay loam, 5 to 15 percent slopes.							
Su	Supervisor stony loam, 20 to 45 percent slopes.							
Ta	Tabiona fine sandy loam, 10 to 15 percent slopes.							
Tk	Thurloni clay, black variant, 3 to 10 percent slopes.							
Tm	Trail loamy fine sand (1 to 3 percent slopes).							
Tu	Turkeysprings clay loam, 2 to 10 percent slopes.							
Va	Valentine loamy fine sand, 5 to 15 percent slopes.							
Zd	Zuni sandy loam, 2 to 10 percent slopes.							
Zm	Zuni-Mirabal stony loams, 10 to 30 percent slopes.							
	Group 4	108, 320	26. 1	Moderately deep and shallow, very rocky and stony soils on uplands. Moisture-storage capacity and moisture-supplying capacity are low. Rock outcrops are common.	Grassland; pinyon-juniper woodland; pine forest.	Ponderosa pine, pinyon, juniper, Gambel oak, blue grama, squirreltail, Arizona fescue, mountain muhly, pine dropseed, bluestem, mountain-mahogany, cliffrose, Oregon grape.	400 to 700	150 to 250.
Bg	Bandera gravelly loam, 15 to 35 percent slopes.							
Bo	Bond sandy loam, 5 to 15 percent slopes.							
Jk	Jekley stony loam, 10 to 30 percent slopes.							
Jr	Jekley rocky complex, 30 to 40 percent slopes.							
Kx	Kiln rocky complex, 20 to 40 percent slopes.							
La	Laporte stony loam, 3 to 10 percent slopes.							
Lp	Laporte stony loam, 20 to 40 percent slopes.							
Mb	Mirabal stony loam, 5 to 15 percent slopes.							
Or	Osoridge rocky complex, 5 to 20 percent slopes.							
Ox	Osoridge rocky complex, 20 to 40 percent slopes.							
Tc	Tampico loam (2 to 10 percent slopes).							
Td	Tampico loam, dark variant (1 to 3 percent slopes).							
Tn	Trail loamy fine sand, hummocky (1 to 3 percent slopes).							
	Group 5	62, 960	15. 2	Weathered rock, exposed bedrock, and lava flows. Small areas of shallow, undifferentiated soils.	Pine forest; pinyon-juniper woodland.	Ponderosa pine, pinyon, juniper, Gambel oak, cliffrose, mountain-mahogany, blue grama, Arizona fescue, mountain muhly, squirreltail.	100 to 250	40 to 150.
Ba	Badland.							
Ls	Lava flows.							
Lv	Lava rock land.							
Rk	Rock land (5 to 50 percent slopes).							
Ro	Rock outcrop, gently sloping.							
Rp	Rock outcrop, cliffs.							

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the watersheds as surface runoff following snowmelt or heavy summer storms. Some, but not much, comes as flow of several months duration in creeks and canyons.

The effectiveness of a watershed is influenced by topography, geology, vegetation, climate, and soils. In table 9, the infiltration rate, permeability rate, water-storage space, and runoff potential of each of the soils of the Zuni Mountain Area are rated. A knowledge of these hydrologic properties of the soils is essential in judging the probable value of an area as a watershed.

In the Zuni Mountain Area, surface runoff is the chief source of water. Only two soils—Mirabal stony loam, 15 to 45 percent slopes, and Supervisor stony loam, 20 to 45 percent slopes—have a high capacity for sustained yield of water. These soils have only medium storage capacities, but they are underlain by broken rock, which provides additional storage space and allows passage of water to adjacent streams. Bluewater Creek depends largely on the sustained yield of water from these two soils.

In general, deep soils on bottom lands and on gently to moderately sloping uplands are high in water-storage capacity. Shallow soils have limited space for water storage, and many shallow soils are also steep and have a high runoff potential. Examples are the Mirabal, Kiln, and Laporte soils. In some shallow soils, such as those of the Bond, Kiln, and Osoridge series, the water-storage capacity is limited by rocks and stones in the profile, and in the Bond and Osoridge soils a clayey subsoil restricts percolation and limits the storage space. These soils, however, produce large amounts of runoff, and consequently the Osoridge-Kiln soil management area is of major importance as a water-producing area.

The Showlow and Thurloni soils, which formed in material derived from shale, have medium or low storage capacity. These soils have an unstable surface layer and a slowly permeable subsoil, which impede infiltration and permeability and thus restrict the capacity for yield of water.

The miscellaneous land types are low in water-storage capacity, but some of them produce large amounts of runoff.

Hydrologic soil groups.—Table 9 shows the hydrologic group for each of the soils in the Zuni Mountain Area. These groupings are based on intake of water at the end of long-duration storms, after prior wetting and opportunity for swelling, without consideration of slope or the effect of vegetation. Criteria for the groupings were established by hydrologists of the Soil Conservation Service, the Forest Service, and other agencies.

There are four hydrologic groups:

Group A consists of soils that have a high infiltration rate even when thoroughly wetted, chiefly deep, well-drained to excessively drained sand, gravel, or both. These soils have a high rate of water transmission and a low runoff potential.

Group B consists of soils that have a moderate infiltration rate when thoroughly wetted and that are chiefly moderately deep to deep, moderately well drained to well drained, and moderately fine textured to moderately coarse textured. These soils have a moderate rate of water transmission.

Group C consists of soils that have a slow rate of infiltration when thoroughly wetted, chiefly soils that have a layer that impedes downward movement of water and soils that are moderately fine textured to fine textured. These soils have a slow rate of transmission.

Group D consists of soils that have a very slow rate of infiltration when thoroughly wetted, chiefly clay soils with a high swelling potential, soils with a permanently high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious materials. These soils have a very slow rate of water transmission.

The hydrologic grouping is an indication of runoff potential, but to estimate runoff it is necessary to take into account precipitation, slope, effect of vegetative cover, and other factors, as well as the hydrologic group. When an estimate of runoff is needed for use in planning management of a particular area, a hydrologist should be consulted.

Erodibility and Erosion Hazard

To manage land effectively, it is necessary to know the susceptibility of the soils to erosion. Table 9 gives the erodibility classification and an estimate of the erosion hazard for each of the soils in the Area. The erodibility classification is a rating of the relative resistance of the soils to surface erosion by water. The erodibility classification does not take into account the factors of climate, vegetation, slope, and volume and velocity of runoff. It depends upon—

1. The stability and size of the soil aggregates.
2. The ease with which the aggregates can be detached and transported by moving water.
3. The permeability of the soil, or the ease with which the soil becomes saturated.
4. The presence of rock or other restricting material near the surface.
5. The water-storage capacity of the soil.
6. The percentage of the surface that is protected by coarse fragments that check splash erosion and reduce the velocity of surface flow.

In the Zuni Mountain Area, many of the soils that are inherently erodible formed in material weathered from granite and shale. The Mirabal, Supervisor, and Zuni soils are highly erodible soils that formed from granite, and the Showlow, Ordnance, and Thurloni soils are highly erodible soils that formed from shale. The soils that formed in material derived from the shale are particularly unstable and strongly dispersed. The Concho, Montoya, and Prewitt soils, which formed in material derived from alluvium that was strongly influenced by shale, erode easily and have little resistance to gully formation. Also highly erodible are the Tampico soils, which formed from granitic alluvium.

The erosion hazard depends partly on erodibility and partly on climate, slope, and other environmental factors. It is an indication of the relative susceptibility of the soils to accelerated erosion if the vegetation is disturbed or destroyed as a result of fire, clear cutting of timber, overgrazing, trampling by livestock, or other causes. The estimates in table 9 are based on conditions in the Zuni Mountain Area and take into account the amount and intensity of rainfall in that region.

For nearly half of the soils in the Area, the erosion hazard is high, for 40 percent it is moderate, and for 10 percent it is low.

Wildlife Management

All parts of the ponderosa pine forest are good summer range for deer, elk, and turkey. The trees provide adequate protection for escape and concealment, and the areas of browse supply feed. Deer appear to concentrate in the Osoridge-Kiln soil management area and in areas of Fortwingate, Jekley, and Savoia soils. Both deer and turkey thrive in the Zuni-Mirabal soil management area east of Sawyer.

Introduction of additional browse species in the pine forest would benefit the deer herds. Plantings on the Ordnance, Thurloni, Kiln, Turkeysprings, Showlow, and Sanchez soils should be successful. Seeding mixtures used in revegetation of disturbed areas should include browse species. If Gambel oak is not interfering with the production of ponderosa pine, it should be left to provide sprouts and mast for deer and other wildlife.

In winter, deer and other big game concentrate in the Thurloni-Showlow and Laporte-Nathrop soil management areas, where the vegetation is mostly pinyon-juniper type. The thick stands of pinyon and juniper provide excellent areas of escape and concealment, but browse plants are scarce and introduction of browse species is needed. The Laporte, Nathrop, and Thurloni soils would produce good stands of palatable browse. When new browse species are planted, the existing stands of usable shrubs should be protected. Seeding mixtures might include burnet clover and other forbs.

The Bandera-Gem soil management area and Sixmile Canyon, which is part of the Concho-Prewitt soil management area, also are winter habitats for big game.

In many parts of the Area, particularly in the Osoridge-Kiln and Laporte-Nathrop soil management areas, it is necessary to provide watering places for game. Since most of the soils in these two areas are shallow and rocky, there are few sites suitable for the construction of earthen tanks. Thus, specially designed structures are needed, such as "trick tanks"—storage tanks that receive water diverted from precipitation catchment aprons—and pipelines leading from wells and springs to drinking troughs.

Early in spring, deer and turkeys need green feed, which they find in the form of grass and forbs growing on soils in the McGaffey-Tampico-Polich, the Fortwingate-Jekley, and the Concho-Prewitt soil management areas.

The management of the soils as wildlife habitats is further discussed in the section "Management Groups."

Development of Recreation Sites

The Zuni Mountain Area is easily accessible and offers many opportunities for outdoor recreation. Over 30,000 visits are made to the Area each year by sightseers, picnickers, campers, hunters, hikers, horseback riders, and others in search of recreation. McGaffey Lake, which is fished heavily during all parts of the season, is a major attraction of the McGaffey Recreation Area. The Ojo Redondo picnic ground is in the vicinity of Mt. Sedgwick, in the eastern part of the survey Area.

In this section, the soils of the Area are placed in groups on the basis of characteristics significant in the design and development of recreational facilities. The criteria are similar to those used in the National Forest Recreation Survey (7). The main characteristics considered are fertility or productivity, stability, depth, permeability, stoniness, and slope. Subgroups indicate significant differences in slope.

The groupings are not intended as recommendations as to location of recreational developments but as guides to the nature of the soil and the terrain and their suitability for recreational activities.

Except for Clayey alluvial land, the miscellaneous land types are not included in the recreation site groups, because they are unsuitable for recreational development. Steep slopes and exposures of ledge rock would make construction costly and difficult.

GROUP 1 FOR RECREATION SITES

This group consists of deep and moderately deep, stable, well-drained, permeable, productive soils. Two subgroups have been established.

The soils in subgroup 1–a have few natural limitations and present few construction difficulties. These soils are—

Friana silt loam (1 to 3 percent slopes).
Gem stony loam, 2 to 7 percent slopes.
Jekley silt loam, 3 to 7 percent slopes.
McGaffey loam (1 to 3 percent slopes).
Savoia fine sandy loam, 2 to 5 percent slopes.

Development of sites on the one soil that makes up subgroup 1–b requires consideration of the stronger slope. This soil is—

Savoia fine sandy loam, 5 to 20 percent slopes.

GROUP 2 FOR RECREATION SITES

This group consists of deep and moderately deep, relatively stable soils of medium to high productivity. The soils are—

Concho clay loam, 1 to 3 percent slopes.
Concho clay loam, 3 to 10 percent slopes.
Fortwingate loam, 2 to 8 percent slopes.
Kettner loam, 3 to 10 percent slopes.
Nathrop loam, 0 to 5 percent slopes.
Turkeysprings clay loam, 2 to 10 percent slopes.
Wilcoxson loam, 3 to 5 percent slopes.
Wilcoxson clay loam, 3 to 15 percent slopes.
Zuni sandy loam, 2 to 10 percent slopes.

In most of these soils, cuts 1 to 2 feet deep expose the clayey subsoil. The terrain presents no problems.

GROUP 3 FOR RECREATION SITES

This group consists of shallow, moderately deep and deep soils that generally are unstable and easily eroded. Three subgroups have been established.

The soils of subgroup 3–a present no problems of terrain, but they generally have undesirable soil characteristics. Unless they are protected during and after construction, severe erosion will take place. The Montoya, Ordnance, Prewitt, and Thurloni soils are dispersed and consequently are poor for foundations. The Trail and Valentine soils are sandy and are easily eroded by both wind and water. The Larry and Polich soils have a seasonal high water table and are subject to overflow. The Tampico soils are

TABLE 9.—*Hydrologic factors, erodibility classification, and erosion hazard*

[Dashed lines indicate that no rating was assigned]

Map symbol	Soil	Infiltration [1]	Permeability [1] of least pervious layer	Space for water storage [2]	Runoff potential (water yield) [3]	Hydrologic group [4]	Erodibility [5]	Erosion hazard [6]
Ag	Andrews gravelly loam, 5 to 20 percent slopes	Moderate	Slow	Low	Medium	C	Moderate	Moderate.
Ba	Badland							
Bd	Bandera gravelly loam, 5 to 15 percent slopes	Rapid	Moderate	Low	Low	A	Moderate	Low.
Bg	Bandera gravelly loam, 15 to 35 percent slopes	Rapid	Moderate	Low	Low	A	Moderate	High.
Bo	Bond sandy loam, 5 to 15 percent slopes	Rapid	Slow	Medium	High	C	Moderate	High.
Ca	Cabezon rocky complex, 2 to 10 percent slopes	Moderate	Slow	Low	Medium	D	Moderate	Low.
Cb	Clayey alluvial land (0 to 2 percent slopes)	Moderate	Slow	Medium	Low	C	Moderate	Moderate.
Cc	Concho clay loam, 1 to 3 percent slopes	Moderate	Slow	High	Low	D	Moderate	Moderate.
Co	Concho clay loam, 3 to 10 percent slopes	Moderate	Slow	High	Low	D	Moderate	Moderate.
Fo	Fortwingate loam, 2 to 8 percent slopes	Rapid	Slow	High	Low	C	High	Moderate.
Fr	Friana silt loam (1 to 3 percent slopes)	Moderate	Slow	High	Medium	C	High	Moderate.
Gm	Gem stony loam, 2 to 7 percent slopes	Moderate	Slow to very slow.	Medium	Medium	C	Moderate	Low.
Je	Jekley silt loam, 3 to 7 percent slopes	Rapid	Slow	Low to medium.	Low	C	High	Low.
Jk	Jekley stony loam, 10 to 30 percent slopes	Rapid	Slow	Low	Medium	C	High	High.
Jr	Jekley rocky complex, 30 to 40 percent slopes	Moderate	Slow	Low	High	C	High	High.
Ke	Kettner loam, 3 to 10 percent slopes	Moderately rapid.	Moderate	Medium to low.	Low	B	High	Moderate.
Kn	Kettner stony loam, 10 to 20 percent slopes	Moderate	Moderate	Low	High	D	High	High.
Kr	Kiln rocky complex, 3 to 20 percent slopes	Moderate	Moderate	Low	Medium	D	Moderate	Moderate.
Kx	Kiln rocky complex, 20 to 40 percent slopes	Moderate	Moderate	Low	High	D	Moderate	High.
La	Laporte stony loam, 3 to 10 percent slopes	Moderate	Moderate	Low	Medium	B	Moderate	High.
Lp	Laporte stony loam, 20 to 40 percent slopes	Moderate	Moderate	Low	Medium	B	Moderate	High.
Lr	Larry silty clay loam (2 to 5 percent slopes)	Moderate	Slow	High	Medium	D	Low	Low.
Ls	Lava flows							
Lv	Lava rock land							
Ma	McGaffey loam (1 to 3 percent slopes)	Rapid	Moderate	High	Medium	B	Moderate	Moderate.
Mb	Mirabal stony loam, 5 to 15 percent slopes	Rapid	Moderate to rapid.	Low	Medium	A	High	Moderate.
Mm	Mirabal stony loam, 15 to 45 percent slopes	Rapid	Moderate to rapid.	Medium	Low	B	High	High.
Mn	Mirabal stony loam, low rainfall, 5 to 20 percent slopes.	Rapid	Moderate to rapid.	Low	High	D	High	High.
Mo	Montoya clay (0 to 3 percent slopes)	Moderate	Slow to very slow.	Medium	Low	D	High	High.
Na	Nathrop loam, 0 to 5 percent slopes	Moderate	Moderate	Low to medium.	Low	C	Moderate	Moderate.
Od	Ordnance loam (5 to 15 percent slopes)	Slow	Slow	Low	Medium	D	High	High.
Or	Osoridge rocky complex, 5 to 20 percent slopes	Rapid	Slow	Low	High	D	High	High.
Ox	Osoridge rocky complex, 20 to 40 percent slopes	Rapid	Slow	Low	High	D	High	High.
Po	Polich loam (0 to 2 percent slopes)	Moderate	Slow	High	Medium	C	High	Moderate.
Pr	Prewitt clay loam (0 to 5 percent slopes)	Moderate	Slow to very slow.	Medium	Medium	D	High	High.
Rk	Rock land (5 to 50 percent slopes)							
Ro	Rock outcrop, gently sloping							
Rp	Rock outcrop, cliffs							
Sa	Sanchez stony complex, 10 to 20 percent slopes	Moderate	Moderate to slow.	Low	Medium	D	High	High.

Sb	Savoia fine sandy loam, 2 to 5 percent slopes	Moderate	Moderate	High	Low	B	Moderate	Moderate.
Sf	Savoia fine sandy loam, 5 to 20 percent slopes	Moderate	Moderate	High	Low	B	Moderate	High.
Sh	Showlow loam, 0 to 5 percent slopes	Moderate to slow.	Slow	Medium	Medium	D	Moderate	Moderate.
Sm	Showlow clay loam, 5 to 15 percent slopes	Moderate to rapid.	Slow to very slow.	Low to medium.	Medium	D	Moderate	High.
Su	Supervisor stony loam, 20 to 45 percent slopes	Rapid	Moderate to rapid.	Medium	Low	B	High	High.
Ta	Tabiona fine sandy loam, 10 to 15 percent slopes	Moderate	Moderate	Medium	Medium	B	High	Moderate.
Tc	Tampico loam (2 to 10 percent slopes)	Rapid	Moderate	High	Medium	A	High	Moderate.
Td	Tampico loam, dark variant (1 to 3 percent slopes).	Rapid	Moderate	High	Medium	B	High	High.
Th	Thurloni clay, 5 to 20 percent slopes	Moderate	Slow	Medium	Medium	D	High	High.
Tk	Thurloni clay, black variant, 3 to 10 percent slopes.	Moderate	Slow	Medium	Medium	D	High	High.
Tm	Trail loamy fine sand (1 to 3 percent slopes)	Rapid	Rapid	High	Low	A	High	High.
Tn	Trail loamy fine sand, hummocky (1 to 3 percent slopes).	Rapid	Rapid	High	Low	A	High	High.
Tu	Turkeysprings clay loam, 2 to 10 percent slopes.	Rapid	Moderate	High	Low	B	High	Moderate.
Va	Valentine loamy fine sand, 5 to 15 percent slopes.	Very rapid	Rapid	Medium	Low	A	Moderate	High.
Wc	Wilcoxson loam, 3 to 5 percent slopes	Moderate	Slow	Medium	Medium	D	Moderate	Moderate.
Wn	Wilcoxson clay loam, 3 to 15 percent slopes	Moderate	Slow	Medium	Low	D	High	Moderate.
Zd	Zuni sandy loam, 2 to 10 percent slopes	Moderate	Slow	High	Medium	D	High	Moderate.
Zm	Zuni-Mirabal stony loams, 10 to 30 percent slopes.	Rapid	Moderate to slow.	Medium	Medium	B	High	High.

[1] Very rapid=more than 10 inches per hour; rapid=5 to 10 inches per hour; moderate=0.8 inch to 5 inches per hour; slow=0.05 to 0.8 inch per hour; very slow=less than 0.05 inch per hour.

[2] High=more than 18 inches; medium=6 to 18 inches; low=less than 6 inches.

[3] Classification takes into consideration the nature of the soil, the vegetation, the slope, and the climate.

[4] Hydrologic grouping does not take into consideration the slope, vegetation, or climate.

[5] Stability or instability of soils when subjected to surface erosion by water; the least stable soils are rated "high" and the most stable are rated "low."

[6] Susceptibility of the soil to accelerated erosion when either the soil or the vegetation has been disturbed.

unstable and are susceptible to gullying. The soils in subgroup 3–a are—

Clayey alluvial land (0 to 2 percent slopes).
Larry silty clay loam (2 to 5 percent slopes).
Montoya clay (0 to 3 percent slopes).
Ordnance loam (5 to 15 percent slopes).
Polich loam (0 to 2 percent slopes).
Prewitt clay loam (0 to 5 percent slopes).
Showlow loam, 0 to 5 percent slopes.
Tabiona fine sandy loam, 10 to 15 percent slopes.
Tampico loam (2 to 10 percent slopes).
Tampico loam, dark variant (1 to 3 percent slopes).
Thurloni clay, black variant, 3 to 10 percent slopes.
Trail loamy fine sand (1 to 3 percent slopes).
Trail loamy fine sand, hummocky (1 to 3 percent slopes).
Valentine loamy fine sand, 5 to 15 percent slopes.

All of the soils in subgroup 3-b are likely to erode if the protective vegetation is disturbed or destroyed. The Bond and Mirabal soils are shallow and generally contain a considerable quantity of coarse fragments. Generally, an excavation deeper than a foot and a half necessitates removal of hard rock. The Thurloni and Showlow soils are dispersed and have elastic subsoils. The soils assigned to subgroup 3-b are—

Bond sandy loam, 5 to 15 percent slopes.
Mirabal stony loam, 5 to 15 percent slopes.
Mirabal stony loam, low rainfall, 5 to 20 percent slopes.
Showlow clay loam, 5 to 15 percent slopes.
Thurloni clay, 5 to 20 percent slopes.
Zuni-Mirabal stony loams, 10 to 30 percent slopes.

The soils assigned to subgroup 3-c are steep and unstable. Disturbed areas erode easily, and the slope makes construction costly. These soils are—

Mirabal stony loam, 15 to 45 percent slopes.
Supervisor stony loam, 20 to 45 percent slopes.

GROUP 4 FOR RECREATION SITES

This group consists of shallow, stony, and rocky soils that are low to medium in productivity. Three subgroups have been established.

The soils of subgroup 4–a are poorly suited to recreational development because they are shallow, stony, and rocky. Establishing vegetation in disturbed areas is difficult. These soils are—

Cabezon rocky complex, 2 to 10 percent slopes.
Laporte stony loam, 3 to 10 percent slopes.

The soils of subgroup 4-b are shallow over bedrock. The bedrock is generally hard enough to require costly excavation, and rock outcrops interfere with grading. The slope creates a high erosion hazard for lightly vegetated areas. The soils assigned to subgroup 4-b are—

Andrews gravelly loam, 5 to 20 percent slopes.
Bandera gravelly loam, 5 to 15 percent slopes.
Jekley stony loam, 10 to 30 percent slopes.
Kettner stony loam, 10 to 20 percent slopes.
Kiln rocky complex, 3 to 20 percent slopes.
Osoridge rocky complex, 5 to 20 percent slopes.
Sanchez stony complex, 10 to 20 percent slopes.

The soils of subgroup 4–c are the least suitable in the Area for recreation sites. They are shallow and rocky and are highly susceptible to accelerated erosion if disturbed. These soils are—

Bandera gravelly loam, 15 to 35 percent slopes.
Jekley rocky complex, 30 to 40 percent slopes.
Kiln rocky complex, 20 to 40 percent slopes.
Laporte stony loam, 20 to 40 percent slopes.
Osoridge rocky complex, 20 to 40 percent slopes.

Soils in Engineering

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, facilities for water storage, erosion-control structures, drainage systems, and sewage-disposal systems. The properties most important to engineers are permeability to water, shear strength, compaction characteristics, drainage, shrink-swell characteristics, grain size, plasticity, and reaction (pH). Also important are topography, depth to the water table, and depth to bedrock.

The engineering practices of most significance in the Zuni Mountain Area are those that help to control runoff and erosion, improve the water-storage capacity, and permit the development of recreational facilities. Except for grazing, there is little agriculture in the Area, and industrial development is unlikely. The information in this report can be used to—

1. Aid in the selection of road or airport locations and in planning detailed investigations of the soils at the intended locations.
2. Determine the suitability of soil units for cross-country movement of vehicles and construction equipment.
3. Aid in the selection and development of recreational, residential, and administrative sites.
4. Locate soils suitable for fill or foundation material for earthen structures, such as stock tanks and dams.
5. Make estimates of runoff and erosion characteristics for use in designing drainage systems and in planning dams and other structures for water and soil conservation.

With the use of the soil map for identification, the engineering interpretations reported here can be useful for many purposes. It should be emphasized that they may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and excavations deeper than the depth of the layers here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Engineering properties, interpretations, and test data

Table 10 provides a brief description of each of the soils of the survey Area and a summary of the soil properties significant in engineering. For some soils, the statements concerning permeability, reaction, dispersion, and shrink-swell potential are generalizations based on laboratory data, and for the others they are estimates.

The rates of permeability are for soils that are not compacted. The ratings for dispersion indicate the degree of slaking and the rapidity with which the soil structure breaks down. An easily dispersed soil is unstable and lacks binding power. Construction with such materials requires more than normal precaution. The ratings for shrink-swell potential indicate the volume changes to be expected with changes in content of moisture.

Table 11 shows the relative suitability of the soils of the Area for the engineering practices most commonly needed

in the management of wild land. These interpretations are based on the estimates given in table 10, on test data, and on field experience.

Table 12 gives engineering test data for soil samples from selected profiles in the survey Area. The tests were made in the laboratories of the Bureau of Public Roads and of the New Mexico State Highway Department. The mechanical analysis was made by combined sieve and hydrometer methods. The tests for liquid limit and plastic limit measure the effect of water on the consistence of the soil material. As the moisture content is increased, the material changes from a semisolid to a plastic state. As the moisture content is increased further, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the soil passes from a plastic to a liquid state. 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 in a plastic condition.

Engineering and agricultural classification of the soils

Two systems of classifying soils for engineering purposes are in general use. One was developed by the American Association of State Highway Officials (AASHO), and the other, called the Unified system, by the U.S. Army Corps of Engineers. The bases for the engineering classifications differ from the basis for the textural classification used by the Department of Agriculture.

The AASHO system (*1*) is based on field performance of soils in highways. In this system soil materials are classified into seven groups, designated A–1 through A–7. The best materials for engineering purposes (gravelly soils of high bearing capacity) are classified as A–1, and the poorest (clayey soils having low strength when wet) are classified as A–7. Within each group, the relative engineering value of the soils is indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest. Most highway engineers classify soils in accordance with the AASHO system.

The Unified system (*8*) is based on identification of soils according to texture and plasticity and on performance as engineering construction material. In this system, soils are placed in 15 groups, each identified by a letter symbol. The symbols SC and SM represent sand mixed with fines (clay and silt); CL and ML represent clay and silt that have a low liquid limit; CH and MH represent clay and silt that have a high liquid limit; and GP and GM represent gravel and mixtures of gravel and sand. Soils that have characteristics that place them in a border zone between two major classes are given borderline classifications, such as ML–CL.

The U.S. Department of Agriculture system of classifying soils according to texture is primarily for agricultural use, but it is useful in engineering also.

Estimated classifications of all soils in the Zuni Mountain Area according to all three of these systems are given in table 10. Laboratory-determined engineering classifications for selected soils of the Area are given in table 12, beginning on page 80.

Management Groups

Individual soils differ widely in use suitability and in management needs. To simplify the discussion of management, the 57 soils and land types in the Zuni Mountain Area have been arranged in 10 management groups. Each group is composed of soils that are about the same in use suitability and in management needs. Suggestions that apply to geographic associations of soils are given in the section "Soil Management Areas."

The management suggestions given in this section are based on the known characteristics and qualities of the soils and on observations of soil behavior, either in research trials or in normal use.

MANAGEMENT GROUP 1

The soils in this management group are good for herbage and very poor to good for timber. The group consists of—

McGaffey loam (1 to 3 percent slopes).
Polich loam (0 to 2 percent slopes).

These soils are deep, fertile, and friable, and they have a good supply of moisture for plants most of the time. They are nearly free of gravel and stones. The erosion hazard generally is medium, but the hazard of gullying and of development of head cuts is severe. Deep gullies with vertical walls are common. Considerable streambank erosion is caused by runoff from the surrounding uplands.

The management requirements of these soils are simple, compared with those of the other management groups. Controlling erosion is largely a matter of reducing runoff from the uplands. Building storage dams in some of the smaller channels to impound and spread water helps to build up the water table. Caving of streambanks and deepening of channels can be controlled to some extent by building dams and by planting trees and shrubs on the bottom and sides of the washes.

The vegetation in many areas probably would recover if grazing were limited. Some areas have been reseeded successfully. Much of the acreage has been cleared and could be converted to pasture.

Under more intensive management, these soils would produce more herbage than they now do. Through advanced methods of reforestation, much of the McGaffey soil could be put into timber production.

MANAGEMENT GROUP 2

The soils in this management group are fair or good for herbage and range from unsuitable to very good for timber. The group consists of—

Tampico loam (2 to 10 percent slopes).
Tampico loam, dark variant (1 to 3 percent slopes).
Trail loamy fine sand (1 to 3 percent slopes).
Trail loamy fine sand, hummocky (1 to 3 percent slopes).
Valentine loamy fine sand, 5 to 15 percent slopes.

These are deep, coarse-textured and medium-textured soils that are highly erodible and highly susceptible to gullying and head cutting. Trail loamy fine sand is seriously gullied, and many of the gullies are 20 feet deep. The Valentine soils and the hummocky Trail soil are susceptible to wind erosion.

Maintenance and improvement of the vegetation is a major management requirement of these erodible soils. Except for Trail loamy fine sand, hummocky, the soils

TABLE 10.—*Brief descriptions of the soils and*

Map symbol	Soil name	Description	Depth from surface
			Inches
Ag	Andrews gravelly loam, 5 to 20 percent slopes.	Gravelly loam over gravelly clay loam, 20 to 24 inches thick over limestone.	0 to 7 7 to 23
Ba	Badland.	Shale and sandstone outcrops; pockets and remnants of clay. No estimates of properties given, because nature of area precludes proper appraisal.	
Bd	Bandera gravelly loam, 5 to 15 percent slopes.	Gravelly loam, 16 to 18 inches thick; underlain by volcanic cinders.	0 to 16
Bg	Bandera gravelly loam, 15 to 35 percent slopes.	Gravelly loam, about 12 inches thick; underlain by volcanic cinders.	0 to 12
Bo	Bond sandy loam, 5 to 15 percent slopes.	Sandy loam over clay that grades to sandy clay loam; underlain by sandstone at a depth of 2 feet.	0 to 4 4 to 12 12 to 17
Ca	Cabezon rocky complex, 2 to 10 percent slopes.	Basalt outcrop intermingled with shallow stony loam over clay; underlain by basalt, generally at a depth less than 2 feet.	0 to 6 6 to 18
Cb	Clayey alluvial land (0 to 2 percent slopes).	Stratified clay loam, silty clay, and clay; water table at a depth of 40 to 50 inches; depth to bedrock generally more than 5 feet.	0 to 12 12 to 30
Cc	Concho clay loam, 1 to 3 percent slopes.	Clay loam over clay; depth to bedrock more than 10 feet.	0 to 3 3 to 14 14 to 46+
Co	Concho clay loam, 3 to 10 percent slopes.	Clay loam over clay that grades to silty clay; underlain by sandy clay loam; on valley bottom lands; depth to bedrock more than 10 feet.	0 to 15 15 to 24 24 to 42 42+
Fo	Fortwingate loam, 2 to 8 percent slopes.	Loam or fine sandy loam, about 10 inches thick, over sandy clay loam that grades to sandy clay; underlain by sandstone at a depth of 4 to 5 feet.	0 to 8 8 to 20 20 to 38 38 to 48
Fr	Friana silt loam (1 to 3 percent slopes).	Silt loam over silty clay that grades to clay; on alluvial fans; depth to bedrock 4 to 5 feet.	0 to 6 6 to 18 18 to 34 34 to 44+
Gm	Gem stony loam, 2 to 7 percent slopes.	Stony loam over sandy clay loam that grades to clay; underlain by basalt, generally at a depth of more than 3 feet.	0 to 3 3 to 13 13 to 38
Je	Jekley silt loam, 3 to 7 percent slopes.	Silt loam over silty clay loam over clay loam, grading to laminated sandstone; bedrock at a depth of 2 feet or more.	0 to 3 3 to 12 12 to 24
Jk	Jekley stony loam, 10 to 30 percent slopes.	Stony loam over light clay; laminated sandstone at a depth of about 13 inches.	0 to 5 5 to 13
Jr	Jekley rocky complex, 30 to 40 percent slopes.	Mixture of shallow soil material and ledge rock; bedrock at a depth of 1 to 2 feet. No estimates of properties given, because nature of area precludes proper appraisal.	
Ke	Kettner loam, 3 to 10 percent slopes.	Loam and gravelly sandy loam; underlain by schist at a depth of 22 inches; bedrock at a depth of 1 to 1½ feet where slope is more than 10 percent.	0 to 12 12 to 17 17 to 22
Kn	Kettner stony loam, 10 to 20 percent slopes.		
Kr	Kiln rocky complex, 3 to 20 percent slopes.	Shallow stony loam over clay; underlain by limestone at a depth of about 10 inches; steeper phase is more rocky.	0 to 5 5 to 10
Kx	Kiln rocky complex, 20 to 40 percent slopes.		
La	Laporte stony loam, 3 to 10 percent slopes.	Shallow stony loam over very stony loam; underlain by limestone at a depth of 1 to 2 feet.	0 to 12 12 to 18
Lp	Laporte stony loam, 20 to 40 percent slopes.		

See footnotes at end of table.

their estimated physical and chemical properties

Classification			Permeability	Reaction	Dispersion	Shrink-swell potential
USDA texture	Unified [1]	AASHO [2]				
			Inches per hour	*pH*		
Gravelly loam	ML	A-4 or A-6	0.5 to 2.5	7.8 to 8.2	Moderate	Moderate.
Gravelly clay loam	CL-ML	A-4 or A-6	0.05 to 0.5	8.0 to 8.6	Moderate	High.
Gravelly loam	ML	A-4	0.5 to 2.5	7.0 to 8.0	High to moderate.	Moderate to low.
Gravelly loam	ML	A-4	0.5 to 2.5	6.7 to 7.8	High to moderate.	Moderate to low.
Sandy loam	SM	A-4	2.5 to 7.5	6.8 to 7.4	High	Low.
Clay	CL-CH	A-7	0.05 to 0.5	6.8 to 7.4	Low	High.
Gravelly sandy clay loam	CL	A-6	0.05 to 0.5	6.8 to 7.4	High	Low.
Stony loam	ML	A-4	0.5 to 2.5	6.0 to 6.8	Moderate	Moderate.
Clay	CH	A-6	0.05 to 0.5	6.2 to 7.4	Low	High.
Clay loam	ML-CL	A-4 or A-6	0.05 to 2.5	7.5 to 8.2	Low	Moderate.
Silty clay	CL-CH	A-6 or A-7	0.05	8.0 to 8.5	Moderate	High.
Clay loam	ML	A-4 or A-6	0.5 to 2.5	7.6 to 8.6	Moderate	Moderate.
Clay loam	CL-ML	A-6 or A-7	0.05 to 0.5	7.6 to 8.6	High	High.
Clay	CL	A-7	0.05	7.6 to 8.6	High	High.
Clay loam	CL	A-7	0.05	7.2 to 7.8	High	High.
Clay	CL-CH	A-7	0.05	7.8 to 8.4	High	High.
Silty clay	CL	A-7	0.05	8.0 to 8.6	High	High.
Sandy clay loam	SC	A-6 or A-7	0.5 to 2.5	7.8 to 8.6	High	High.
Loam	SM	A-4	2.5 to 7.5	6.0 to 6.6	Low	Low.
Sandy clay loam	SC	A-6	0.5 to 2.5	6.0 to 6.8	Moderate	High.
Sandy clay	SC	A-6	0.05 to 0.5	6.2 to 7.0	High	High.
Sandy clay loam	SC	A-6	0.05 to 0.5	7.0 to 7.8	Moderate	Moderate.
Silt loam	ML-CL	A-6 or A-7	0.05 to 0.5	6.2 to 7.0	High	Moderate.
Silty clay	CL	A-7	0.05	6.6 to 7.4	Low	High.
Clay	CL	A-7	0.05	6.8 to 7.6	Moderate	High.
Clay loam	CL-ML	A-6 or A-7	0.05 to 0.5	7.0 to 7.8	Low	High.
Stony loam	ML	A-4 or A-6	0.5 to 2.5	6.0 to 6.5	Moderate	Moderate.
Sandy clay loam	CL	A-6	0.05 to 0.5	6.4 to 7.0	Low	High.
Clay	CL-CH	A-7	0.05	6.8 to 8.4	Low	High.
Silt loam	ML	A-4	0.5 to 2.5	6.2 to 7.2	Low	Moderate.
Silty clay loam	CL-ML	A-6 or A-7	0.05 to 0.5	6.0 to 7.2	Low	Moderate.
Clay loam	CL-ML	A-6 or A-7	0.05 to 2.5	6.2 to 7.6	Low	Moderate.
Stony loam	SM-SC	A-4	0.5 to 2.5	6.8 to 7.0	Low	Low.
Light clay	CL	A-6	0.05	6.6 to 7.0	Low	High.
Loam	SC	A-4	2.5 to 7.5	6.0 to 7.0	Low	Low.
Loam	ML	A-4 or A-6	0.5 to 2.5	6.6 to 7.2	Low	Low.
Gravelly sandy loam	SM	A-4	2.5 to 7.5	6.8 to 7.4	Low	Low.
Stony loam	ML	A-4 or A-6	0.5 to 2.5	7.2 to 7.8	Low	Low.
Clay or clay loam	ML-CL	A-4 or A-6	0.5 to 2.5	7.4 to 8.4	Low	Moderate.
Stony loam	ML	A-4	0.5 to 2.5	8.0 to 8.6	Low	Low.
Very stony loam	ML	A-4	0.5 to 2.5	8.0 to 8.6	Low	Low.

TABLE 10.—*Brief descriptions of the soils and their*

Map symbol	Soil name	Description	Depth from surface
			Inches
Lr	Larry silty clay loam (2 to 5 percent slopes).	Silty clay loam over heavy clay that grades to silty clay underlain by gravelly clay loam; on meadow lands.	0 to 6 6 to 19 19 to 23 23 to 44+
Ls	Lava flows.	Recent lava flows; rough broken surface. No estimates of properties given, because nature of area precludes proper appraisal.	
Lv	Lava rock land.	Mixture of lava flows and pockets and basins of soil. No estimates of properties given, because nature of area precludes proper appraisal.	
Ma	McGaffey loam (1 to 3 percent slopes).	Loam over silt loam that grades to sandy clay loam to clay; bedrock at a depth of more than 10 feet; on alluvial fans and flood plains.	0 to 6 6 to 18 18 to 51 51 to 56
Mb	Mirabal stony loam, 5 to 15 percent slopes.	Stony loam and stony sandy loam; underlain by granite and gneiss at a depth of 1 to 2 feet; Mb on ridgetops and very shallow.	0 to 5 5 to 18
Mm	Mirabal stony loam, 15 to 45 percent slopes.		
Mn	Mirabal stony loam, low rainfall, 5 to 20 percent slopes.	Stony loam and stony sandy loam underlain by granite and gneiss at a depth of 1 to 2 feet.	0 to 5 5 to 18
Mo	Montoya clay (0 to 3 percent slopes).	Clay, silty clay, and gravelly clay on flood plains and in basins; bedrock at a depth of 5 feet or more.	0 to 3 3 to 40 40 to 62
Na	Nathrop loam, 0 to 5 percent slopes.	Loam over clay loam; underlain by limestone at a depth of 16 inches or more.	0 to 5 5 to 16
Od	Ordnance loam (5 to 15 percent slopes).	Loam and gravelly loam over clay underlain by mixture of clay, sandstone, and shale; bedrock at a depth of 2 to 4 feet.	0 to 4 4 to 8 8 to 30 30 to 36
Or	Osoridge rocky complex, 5 to 20 percent slopes.	Shallow stony sandy loam over clay; sandstone at a depth of 1 to 2 feet; much outcropping rock.	0 to 5 5 to 9 9 to 18
Ox	Osoridge rocky complex, 20 to 40 percent slopes.		
Po	Polich loam (0 to 2 percent slopes).	Loam over silt loam to sandy clay loam underlain by clay; bedrock at a depth of more than 5 feet; on bottom lands; seasonal water table.	0 to 6 6 to 18 18 to 51 51 to 56+
Pr	Prewitt clay loam (0 to 5 percent slopes).	Stratified clay loam over silty clay loam underlain by clay; bedrock at a depth of more than 5 feet; on alluvial fans and flats.	0 to 4 4 to 9 9 to 13 13 to 33 33 to 50+
Rk	Rock land.	Mixture of rock outcrop and shallow to deep soils; bedrock generally at a depth of less than 1 foot. No estimates of properties given, because nature of area precludes proper appraisal.	
Ro	Rock outcrop, gently sloping.	Bare rock. No estimates of properties given, because nature of area precludes proper appraisal.	
Rp	Rock outcrop, cliffs.	Rock outcrop on escarpments and steep walls of canyons. No estimates of properties given, because nature of area precludes proper appraisal.	
Sa	Sanchez stony complex, 10 to 20 percent slopes.	Mixture of shallow stony sandy loams, stony clay loams, and sandstone outcrop; bedrock at a depth of 1 to 2 feet.	0 to 2 2 to 17

See footnotes at end of table.

estimated physical and chemical properties—Continued

Classification			Permeability	Reaction	Dispersion	Shrink-swell potential
USDA texture	Unified [1]	AASHO [2]				
			Inches per hour	*pH*		
Silty clay loam	CL–ML	A–6 or A–7	0. 05 to 0. 5	6. 4 to 7. 4	Low	Moderate.
Clay	CH	A–7	0. 05	6. 2 to 7. 4	High	High.
Silty clay	CL–CH	A–7	0. 05	6. 6 to 7. 4	High	High.
Gravelly clay loam	CL–ML	A–6 or A–7	0. 05 to 0. 5	6. 6 to 7. 8	Moderate	High.
Loam	ML	A–4	0. 5 to 2. 5	7. 2 to 7. 8	Low	Low.
Silt loam	ML	A–4 or A–6	0. 5 to 2. 5	7. 4 to 8. 4	Moderate	Moderate.
Sandy clay loam	SC	A–6	0. 5 to 2. 5	7. 8 to 8. 6	Moderate	Moderate.
Clay	CL	A–6	0. 05 to 0. 5	7. 8 to 8. 6	Moderate	High.
Stony loam	SM	A–4	2. 5 to 7. 5	5. 8 to 6. 4	Low	Low.
Stony loam and stony sandy loam	SM	A–4	2. 5 to 7. 5	6. 0 to 6. 8	Low	Low.
Stony loam	SM	A–4	2. 5 to 7. 5	5. 8 to 6. 4	Low	Low.
Stony loam and stony sandy loam	SM	A–4	2. 5 to 7. 5	6. 0 to 6. 8	Low	Low.
Clay	CH	A–7	0. 05	7. 8 to 8. 6	High	High.
Clay	CH	A–7	0. 05	7. 8 to 8. 8	High	High.
Silty clay	CH	A–7	0. 05	7. 8 to 8. 8	Moderate	High.
Loam	ML	A–6	0. 5 to 2. 5	7. 4 to 8. 2	Moderate	Low.
Clay loam	ML–CL	A–6 or A–7	0. 05 to 0. 5	7. 4 to 8. 6	Moderate	Moderate.
Loam and gravelly loam	ML	A–6	0. 5 to 2. 5	6. 2 to 6. 6	High	Moderate.
Sandy clay loam	ML	A–6	0. 05 to 0. 5	6. 2 to 6. 8	High	High.
Clay	CL–CH	A–6 or A–7	0. 05	6. 2 to 8. 2	High	High.
Shaly clay	CL–CH	A–6 or A–7	0. 05	7. 8 to 8. 6	High	High.
Stony sandy loam	SC	A–4	2. 5 to 7. 5	6. 0 to 6. 6	Low	Low.
Stony light clay	ML	A–6	0. 5 to 2. 5	5. 8 to 6. 4	High	High.
Heavy clay	CH	A–7	0. 05	5. 8 to 6. 6	High	High.
Loam	ML	A–4	0. 5 to 2. 5	7. 2 to 7. 8	Low	Moderate.
Silt loam	ML	A–4 or A–6	0. 5 to 2. 5	7. 6 to 8. 4	Moderate	Moderate.
Sandy clay loam	SC	A–6	0. 05 to 0. 5	7. 6 to 8. 6	Moderate	Moderate.
Clay	CL	A–7	0. 05	7. 6 to 8. 6	Moderate	High.
Clay loam	CL–ML	A–6 or A–7	0. 05 to 0. 5	7. 6 to 8. 6	High	High.
Silty clay loam	CL–ML	A–6 or A–7	0. 05 to 0. 5	7. 6 to 8. 6	High	High.
Heavy clay loam	CL–CH	A–7	0. 05 to 0. 5	7. 6 to 8. 6	High	High.
Silty clay	CH	A–7	0. 05	7. 4 to 8. 8	High	High.
Clay	CH	A–7	0. 05	7. 4 to 8. 8	High	High.
Stony sandy loam	SM	A–4	2. 5 to 7. 5	6. 2 to 7. 0	High	Low.
Sandy clay loam or clay loam	SC–CL	A–6 or A–7	0. 5 to 2. 5	6. 6 to 7. 4	Moderate	Moderate.

TABLE 10.—*Brief descriptions of the soils and their*

Map symbol	Soil name	Description	Depth from surface
			Inches
Sb	Savoia fine sandy loam, 2 to 5 percent slopes.	Fine sandy loam over sandy clay loam that grades to sandy loam; depth to bedrock more than 4 feet; on terraces and fans.	0 to 6
Sf	Savoia fine sandy loam, 5 to 20 percent slopes.		6 to 24
			24 to 42
Sh	Showlow loam, 0 to 5 percent slopes.	Loam over clay that grades to silty clay loam, depth to bedrock generally more than 4 feet; on alluvial fans and terraces.	0 to 2
			2 to 28
			28 to 52
Sm	Showlow clay loam, 5 to 15 percent slopes.	Clay loam, underlain by shale, generally at a depth more than 4 feet.	0 to 6
			6 to 35
			35 to 56
Su	Supervisor stony loam, 20 to 45 percent slopes.	Stony loam over gravelly loam; underlain by granite and gneiss, generally at a depth less than 2 feet.	0 to 5
			5 to 12
			12 to 19
Ta	Tabiona fine sandy loam, 10 to 15 percent slopes.	Fine sandy loam over loam; on colluvial slopes and in areas of alluvial deposits.	0 to 18
			18 to 28
Tc	Tampico loam (2 to 10 percent slopes).	Loam over gravelly loam that grades to gravelly clay loam; underlain by granite alluvium; depth to bedrock generally more than 4 feet.	0 to 6
Td	Tampico loam, dark variant (1 to 3 percent slopes).		6 to 17
			17 to 30
			30+
Th	Thurloni clay, 5 to 20 percent slopes.	Clay over shale; depth to bedrock 2 to 3 feet.	0 to 6
Tk	Thurloni clay, black variant, 3 to 10 percent slopes.		6 to 33
			33+
Tm	Trail loamy fine sand (1 to 3 percent slopes).	Loamy fine sand over loamy sand; on alluvial fans; depth to bedrock more than 10 feet.	0 to 12
Tn	Trail loamy fine sand, hummocky (1 to 3 percent slopes).		12 to 55+
Tu	Turkeysprings clay loam, 2 to 10 percent slopes.	Clay loam and light clay; underlain by limestone at a depth of 4 to 5 feet.	0 to 7
			7 to 10
			10 to 54
Va	Valentine loamy fine sand, 5 to 15 percent slopes.	Stratified, wind-deposited loamy fine sand and fine sand; underlain by sandstone at a depth of 4 feet or more.	0 to 40
Wc	Wilcoxson loam, 3 to 5 percent slopes.	Loam or sandy loam over clay loam that grades to clay; underlain by limestone at a depth of 4 to 5 feet.	0 to 8
			8 to 14
			14 to 28
			28 to 40+
Wn	Wilcoxson clay loam, 3 to 15 percent slopes.	Clay loam over silty clay loam that grades to clay; underlain by limestone at a depth of 4 to 5 feet.	0 to 3
			3 to 7
			7 to 44
Zd	Zuni sandy loam, 2 to 10 percent slopes.	Sandy loam over loam or clay that grades to gravelly clay loam; underlain by granite at a depth of 3 to 4 feet.	0 to 10
			10 to 20
			20 to 40
			40 to 48
Zm	Zuni-Mirabal stony loams, 10 to 30 percent slopes.	Zuni: See description of Zuni sandy loam, 2 to 10 percent slopes (Zd). Mirabal: See description of Mirabal stony loam, 15 to 45 percent slopes (Mm).	

[1] For an explanation of the Unified system, see "The Unified Soil Classification System" (*8*).

estimated physical and chemical properties—Continued

Classification			Permeability	Reaction	Dispersion	Shrink-swell potential
USDA texture	Unified [1]	AASHO [2]				
			Inches per hour	*pH*		
Fine sandy loam	SM	A–4	2. 5 to 7. 5	6. 2 to 7. 0	Low	Low.
Sandy clay loam	SC	A–4	0. 5 to 2. 5	6. 6 to 7. 4	Low	Moderate.
Sandy loam	SM	A–4	2. 5 to 7. 5	7. 0 to 8. 4	Low	Low.
Loam	ML	A–4	0. 5 to 2. 5	6. 5 to 7. 0	Moderate	Moderate.
Clay	CH	A–7	0. 05	6. 6 to 7. 5	High	High.
Silty clay loam	CL–ML	A–6 or A–7	0. 05 to 0. 5	7. 0 to 8. 0	High	High.
Clay loam	CL–ML	A–6	0. 05 to 0. 5	6. 4 to 7. 4	High	Moderate.
Clay loam and clay	CL	A–6	0. 05	6. 6 to 7. 4	High	High.
Clay	CH	A–7	0. 05	7. 0 to 8. 0	High	High.
Stony loam	ML	A–4	0. 5 to 2. 5	5. 4 to 6. 4	Low	Low.
Gravelly loam	ML	A–4	0. 5 to 2. 5	5. 4 to 6. 4	Low	Low.
Stony gravelly loam	SM	A–4	2. 5 to 7. 5	5. 6 to 6. 6	Low	Low.
Fine sandy loam and loam	SM–ML	A–4	0. 5 to 2. 5	7. 8 to 8. 6	High	Low.
Sandy loam	SM	A–4	2. 5 to 7. 5	8. 0 to 8. 7	Low	Low.
Loam	SM	A–4	0. 5 to 2. 5	5. 8 to 6. 4	Low	Low.
Gravelly loam	SM	A–4	0. 5 to 2. 5	6. 4 to 7. 2	Low	Low.
Gravelly clay loam	ML	A–4 or A–6	0. 5 to 2. 5	6. 6 to 7. 4	Low	Low.
Very gravelly loam	SM–ML	A–4	0. 5 to 2. 5	6. 6 to 7. 4	Low	Low.
Light clay	CL	A–7	0. 05 to 0. 5	7. 4 to 8. 6	High	High.
Clay	CL–CH	A–7	0. 05	8. 0 to 8. 8	High	High.
Shale	CH	A–7	0. 05	8. 0 to 8. 8	High	High.
Loamy fine sand	SM	A–2	2. 5 to 7. 5	7. 8 to 8. 4	Low	Low.
Loamy sand	SM	A–2	7. 5+	7. 8 to 8. 6	Low	Low.
Clay loam	ML	A–6	0. 5 to 2. 5	7. 6 to 8. 4	Low	Low.
Clay loam	CL–ML	A–6 or A–7	0. 5 to 2. 5	7. 6 to 8. 4	Low	Moderate.
Light clay	CL	A–6 or A–7	0. 05 to 0. 5	7. 6 to 8. 4	Low	Moderate.
Loamy fine sand and fine sand	SP–SM	A–2 or A–3	7. 5+	6. 2 to 7. 2	Low	Low.
Loam or sandy loam	SM	A–4	0. 5 to 2. 5	6. 4 to 7. 0	Low	Low.
Clay loam	ML	A–6	0. 05 to 0. 5	6. 6 to 7. 6	Low	Moderate.
Clay	CL–CH	A–7	0. 05	7. 0 to 8. 4	Moderate	High.
Clay loam and gravelly loam	ML	A–6	0. 05 to 0. 5	8. 0 to 8. 8	Moderate	Moderate.
Clay loam	CL–ML	A–6 or A–7	0. 05 to 0. 5	6. 8 to 7. 4	Low	Moderate.
Silty clay loam	CL–ML	A–6 or A–7	0. 05 to 0. 5	6. 8 to 7. 4	Low	Moderate.
Clay	CL	A–7	0. 05	6. 8 to 8. 4	Low	High.
Sandy loam	SM	A–4	2.5 to 7.5	6.0 to 7.0	Low	Low.
Sandy loam or loam	ML	A–4 or A–6	0.5 to 2.5	6.2 to 7.2	Low	Moderate.
Clay	CL	A–6	0.05	6.2 to 7.2	Low	High.
Gravelly clay loam	CL–ML	A–6	0.05 to 0.5	6.2 to 7.2	Low	Moderate.

[2] For an explanation of the AASHO system, see AASHO Designation: 145–49 (*1*).

TABLE 11.—*Engineering*

Soil series and map symbol	Suitability for use as—		Suitability as a source of—		
	Subgrade	Subbase	Topsoil	Sand and gravel for subgrade	Rock
Andrews (Ag)	Fair	Poor	Poor; gravelly	Unsuitable	Good for limestone
Badland (Ba)	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable
Bandera (Bd, Bg)	Fair	Poor	Poor	Poor; good source of cinders.	Poor
Bond (Bo)	Fair	Fair to poor	Poor	Unsuitable	Good for sandstone
Cabezon (Ca)	Fair	Poor	Good	Unsuitable	Good for basalt
Clayey alluvial land (Cb)	Poor	Poor	Good	Unsuitable	Unsuitable
Concho (Cc, Co)	Fair to poor	Poor	Good	Unsuitable	Unsuitable
Fortwingate (Fo)	Fair	Fair to poor	Good	Unsuitable	Fair for sandstone
Friana (Fr)	Fair	Poor	Good	Unsuitable	Unsuitable
Gem (Gm)	Fair	Poor	Good	Unsuitable	Fair for basalt
Jekley (Je, Jk, Jr)	Good to fair	Fair to poor	Good (Je); poor (Jk, Jr).	Unsuitable	Fair for fine-grained sandstone.
Kettner (Ke, Kn)	Good	Fair	Poor	Unsuitable	Fair to good for schist.
Kiln (Kr, Kx)	Poor to fair	Poor	Poor; too rocky	Unsuitable	Good for limestone
Laporte (La, Lp)	Good to fair	Fair to poor	Poor; too stony	Unsuitable	Good for limestone
Larry (Lr)	Poor	Poor	Good	Unsuitable	Unsuitable
Lava flows (Ls)	Poor	Unsuitable	Unsuitable	Unsuitable	Good for basalt
Lava rock land (Lv)	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Good for basalt
McGaffey (Ma)	Fair	Poor	Good	Unsuitable	Unsuitable
Mirabal (Mb, Mm, Mn, Zm)	Good	Fair to poor	Fair (Mb, Mm, Mn); poor (Zm).	Unsuitable	Good for granite
Montoya (Mo)	Poor	Poor	Poor	Unsuitable	Unsuitable
Nathrop (Na)	Fair	Fair to poor	Fair	Unsuitable	Good for limestone
Ordnance (Od)	Fair to poor	Poor	Poor	Unsuitable	Poor
Osoridge (Or, Ox)	Fair	Poor	Poor	Unsuitable	Good for sandstone
Polich (Po)	Fair	Poor	Good	Unsuitable	Unsuitable
Prewitt (Pr)	Fair to poor	Poor	Fair to poor	Unsuitable	Unsuitable
Rock land (Rk)	Poor	Unsuitable	Unsuitable	Unsuitable	Good for sandstone
Rock outcrop, gently sloping (Ro).	Poor	Unsuitable	Unsuitable	Unsuitable	Good for sandstone and granite.
Rock outcrop, cliffs (Rp)	Poor	Unsuitable	Unsuitable	Unsuitable	Good for sandstone and limestone.
Sanchez (Sa)	Good to fair	Fair to poor	Poor	Unsuitable	Fair
Savoia (Sb, Sf)	Good to fair	Fair	Good	Fair	Unsuitable
Showlow (Sh, Sm)	Fair to poor	Poor	Fair	Unsuitable	Poor; shale
Supervisor (Su)	Good	Fair	Good	Unsuitable	Good; granite
Tabiona (Ta)	Good to fair	Fair to poor	Fair	Unsuitable	Unsuitable

interpretations

Suitability for—					
Stock tanks and reservoirs		Terraces and diversions	Water spreading	Range pitting and chiseling	Waterways
Embankment	Reservoir area				
Fair to poor	Poor; too shallow	Poor; too shallow	Unsuitable	Unsuitable	Poor.
Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable.
Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable.
Fair	Poor; shallow and rocky.	Poor	Unsuitable	Unsuitable	Unsuitable.
Fair	Poor; too shallow	Fair, but soil is shallow.	Poor; too stony	Poor; too rocky for equipment to be used.	Poor.
Fair	Good	Good	Good	Good	Good, but should be vegetated.
Good	Good	Good	Good	Good	Good.
Good; compacts easily.	Good	Good	Good	Good	Good.
Fair	Good	Good	Good	Good	Good, but protection against erosion needed.
Fair	Good	Good	Good; gentle slopes	Good	Good; erosion hazard low.
Fair to poor; not much soil material.	Fair to poor (Je, Jk); unsuitable (Jr); shallow.	Good, but poor on steep slopes.	Fair (Je, Jk); unsuitable (Jr); shallow.	Poor (Je, Jk); unsuitable (Jr); too shallow.	Fair to unsuitable.
Fair to good; compacts well.	Poor; too shallow; rapidly permeable.	Good	Fair	Fair	Fair; protection against erosion needed.
Poor; not much soil material.	Unsuitable; too shallow to limestone.	Unsuitable	Unsuitable	Unsuitable	Unsuitable.
Poor; not much soil material.	Poor; shallow; limestone is fissured.	Poor; too stony	Unsuitable	Unsuitable	Fair to unsuitable, depending on slope.
Poor; too clayey	Good	Good	Good, but subsoil is slowly permeable.	Good	Good.
Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable.
Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable.
Good	Good, but stratified	Good	Good	Good	Good, but will headcut.
Fair (Zm); poor, must be compacted (Mb, Mm, Mn).	Poor because too shallow (Zm); unsuitable (Mb, Mm, Mn).	Fair to poor; shallow and steep.	Fair (Zm); unsuitable (Mb, Mm, Mn).	Fair (Zm); unsuitable (Mb, Mm, Mn).	Fair (Zm); unsuitable (Mb, Mm, Mn).
Poor; hard to compact.	Good; slow permeability.	Good	Good	Good, but slow permeability.	Good, but erodes easily.
Fair to good	Poor; shallow	Fair to good	Fair to good	Fair to good	Fair, but erodes easily.
Poor; material dispersed.	Fair; shallow	Poor; unstable	Poor; dispersed	Fair, but unstable	Poor; erodes easily.
Poor; too shallow and rocky.	Unsuitable; too shallow and rocky.	Unsuitable	Unsuitable	Unsuitable	Unsuitable.
Good	Good	Good	Good	Good	Good, but should be vegetated.
Poor; hard to compact.	Good; slow permeability.	Good	Good	Good, but slow permeability.	Good, but erodes easily.
Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable.
Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable.
Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable.
Poor	Poor; too shallow	Poor; too shallow	Unsuitable; erodes easily.	Unsuitable	Unsuitable.
Good	Good to fair	Good	Good	Good	Good, but should be vegetated.
Poor; disperses; may pipe and slough.	Good to fair	Poor; unstable	Poor; erodes easily	Fair, but unstable	Poor; erodes easily.
Good, but should be compacted.	Unsuitable	Fair; shallow; steep.	Unsuitable	Unsuitable	Unsuitable.
Good	Good	Good	Good	Good	Fair.

TABLE 11.—*Engineering*

Soil series and map symbol	Suitability for use as—		Suitability as a source of—		
	Subgrade	Subbase	Topsoil	Sand and gravel for subgrade	Rock
Tampico (Tc, Td)	Good to fair	Fair to poor	Fair, but low in fertility.	Fair	Unsuitable
Thurloni (Th, Tk)	Fair to poor	Poor	Poor	Unsuitable	Unsuitable
Trail (Tm, Tn)	Good	Fair	Fair to poor; too sandy.	Good	Unsuitable
Turkeysprings (Tu)	Fair	Poor	Good	Unsuitable	Unsuitable
Valentine (Va)	Good	Good to fair	Poor; too sandy	Good	Unsuitable
Wilcoxson (Wc, Wn)	Fair	Poor	Good	Unsuitable	Unsuitable
Zuni (Zd, Zm)	Good to fair	Fair to poor	Fair (Zd); poor (Zm).	Unsuitable	Poor for granite (Zd); good for granite (Zm).

have good capacity to supply moisture to plants, are capable of producing a good cover of vegetation, and are suitable for sustained use. The two Tampico soils have good capacity for sustained yield of water. The Tampico soils and the Valentine soil are the best in the group for ponderosa pine.

In some places the native cover is so depleted that most of the desirable grasses have been eliminated. Trail loamy fine sand offers the best chance of success in reseeding. On Trail loamy fine sand, hummocky, and Valentine loamy fine sand, 5 to 15 percent slopes, the risk of failure in reseeding is high. For these two soils, regulation of grazing is the best way to improve the vegetative cover, because seeding failure leaves them unprotected against erosion.

The soils of this group have only limited possibilities as wildlife habitats and as recreational areas. Indiscriminate cross-country vehicular travel should be avoided, because many of the gullies seem to have formed in old roads and trails.

MANAGEMENT GROUP 3

The soils in this management group are good to excellent for herbage, poor or very poor for timber, and high to low in capacity for sustained yield of water. The group consists of—

Clayey alluvial land (0 to 2 percent slopes).
Concho clay loam, 1 to 3 percent slopes.
Concho clay loam, 3 to 10 percent slopes.
Friana silt loam (1 to 3 percent slopes).
Larry silty clay loam (2 to 5 percent slopes).
Montoya clay (0 to 3 percent slopes).
Prewitt clay loam (0 to 5 percent slopes).

These are deep and moderately deep, fertile soils that are free of outcrops and nearly free of stones and gravel. They are moderately to highly erodible, and deep gullies are common.

The soils of this group should be managed mainly for forage yield, and any plan for their use must take into account the hazard of erosion. Overgrazing has depleted the better forage plants. The native species recover if grazing is limited, and the Concho soils have been seeded to wheatgrass with good results. Seeded areas need to be protected from grazing until the new vegetation is established. Seedbed preparation and seeding should be timed to take advantage of seasonal rainfall.

Most areas of these soils are outside the zone where precipitation is adequate for pine, and the characteristics of the soils are not conducive to the growth of pine. Although there are isolated trees, it is doubtful that much pine ever grew on any of these soils.

Herbage production could be increased through more intensive management practices, including gully plugging, water spreading, and fertilization. Much of the moisture in the subsoil drains off through the existing gullies.

The possibilities for use as wildlife habitats or for development of recreational areas are slight.

MANAGEMENT GROUP 4

The soils in this management group are fair to good for timber and poor to good for herbage. They have medium to high capacity for sustained yield of water. The group consists of—

Mirabal stony loam, 5 to 15 percent slopes.
Mirabal stony loam, 15 to 45 percent slopes.
Supervisor stony loam, 20 to 45 percent slopes.
Zuni-Mirabal stony loams, 10 to 30 percent slopes.

These soils are shallow to moderately deep. Their surface layer is gritty or gravelly, and they are open and porous throughout. Infiltration and permeability are moderate to rapid. Stones and other fragments are numerous within the profile, and outcrops are common.

Most areas are dissected by numerous drainageways. Small active gullies are common, and most of the drainageways are unstable.

The soils of this group should be managed for production of timber, herbage, and water. They are timber covered, and natural regeneration of pine is fairly rapid. Reproduction thickets of ponderosa pine are common, and in most areas new seedlings have a good chance of surviving. The yield of water to springs and streams is substantial.

interpretations—Continued

Suitability for—					
Stock tanks and reservoirs		Terraces and diversions	Water spreading	Range pitting and chiseling	Waterways
Embankment	Reservoir area				
Good; compacts well.	Fair; subsoil stratified.	Good	Good, but erodes easily.	Good	Poor; erodes easily.
Poor; plastic clay; hard to work.	Good	Poor; unstable	Poor; steep and erodible.	Poor; unstable	Poor; erodes easily.
Fair if compacted	Poor; too sandy	Good	Fair to poor	Poor; not needed	Poor; erodes easily.
Good; easy to compact and work.	Good	Good	Good	Good	Good, but should be vegetated.
Poor; too rapidly permeable.	Poor	Poor	Poor	Poor	Poor.
Good	Good	Good	Good	Good	Good.
Good (Zd); fair (Zm).	Good (Zd); poor because too shallow (Zm).	Good (Zd); fair (Zm).	Good (Zd); fair (Zm).	Good (Zd); fair (Zm).	Good, but should be vegetated (Zd); fair (Zm).

Careful management is needed, because of the erosion hazard. Minimum disturbance of the vegetation is particularly important, because the vegetation provides protection against erosion. Any disturbance of the soils should be compensated for by protective measures. The Mirabal and Supervisor soils, because of their slope, require special logging procedures.

Cool temperatures in summer, verdant vegetation, and interesting scenery make these areas attractive as recreation sites.

MANAGEMENT GROUP 5

The soils in this management group are good to very good for both timber and herbage. The group consists of—

Fortwingate loam, 2 to 8 percent slopes.
Gem stony loam, 2 to 7 percent slopes.
Jekley silt loam, 3 to 7 percent slopes.
Kettner loam, 3 to 10 percent slopes.
Savoia fine sandy loam, 2 to 5 percent slopes.
Savoia fine sandy loam, 5 to 20 percent slopes.
Turkeysprings clay loam, 2 to 10 percent slopes.
Wilcoxson loam, 3 to 5 percent slopes.
Wilcoxson clay loam, 3 to 15 percent slopes.
Zuni sandy loam, 2 to 10 percent slopes.

The fertility of these soils is high. Infiltration is rapid or moderate, permeability ranges from moderate to slow, and surface runoff is slow. The capacity to supply moisture to plants is high. The erosion hazard ranges from low to medium.

All of the soils in this group should be managed for production of timber and herbage. They occur in the areas in which most of the original timber cuttings were made. Now they support vigorous young stands of ponderosa pine and good stands of grass and other herbage. The capacity for natural recovery of the vegetation is good, and the response to management is good. Natural regeneration of pine is rapid, especially on the Jekley, Fortwingate, and Zuni soils.

The capacity for sustained water yield is generally moderate but ranges from low for the Gem soils to high for the Fortwingate and Savoia soils. Except for the Kettner soil, the water-storage capacity is moderate to high.

Most areas of these soils provide a good environment for wildlife. Browse is abundant, except on the Zuni soil. The Fortwingate, Turkeysprings, and Wilcoxson soils support brush, cliffrose, and other shrubs in abundance. Trees provide concealment for deer and other wildlife.

These soils include good sites for recreational facilities.

MANAGEMENT GROUP 6

The soils in this management group are very poor to poor for timber and poor to good for herbage. Their capacity for sustained yield of water is low. The group consists of—

Badland.
Ordnance loam (5 to 15 percent slopes).
Showlow clay loam, 5 to 15 percent slopes.
Thurloni clay, 5 to 20 percent slopes.
Thurloni clay, black variant, 3 to 10 percent slopes.

These are highly erodible soils. Infiltration is moderate, but percolation of water is restricted by a clayey subsoil. Outcrops of shale and sandstone are common.

Runoff is rapid, and large amounts of sediment are produced. Pedestaling of grasses and shrubs is evidence of loss of surface soil.

The soils of this group should be managed for production of herbage. They are well suited to controlled grazing. The lesser slopes could be seeded to grasses and shrubs, and some areas could be converted from pinyon and juniper to grass. Because of the erosion hazard, both seeding and conversion should be timed to take advantage of the seasonal rainfall.

Ponderosa pine does not grow well on any of these soils, and it does not grow at all on Thurloni clay, 5 to 20 percent slopes. Some has grown on the Ordnance and Showlow soils, but it does not regenerate naturally on those soils, and reforestation would be difficult and probably unprofitable.

These soils provide a good environment for wildlife. Deer use the lower lying areas of the Thurloni soils as winter range.

TABLE 12.—*Engineering*

[Tests performed by the Bureau of Public Roads and the New Mexico State Highway Department in accordance with standard procedures of Public

Soil name and location of sample	Parent material	New Mexico report No.	Depth from surface	Horizon	Mechanical analysis [1]				
					Fragments of more than 3 in. diameter discarded in field sampling (estimated)	Percentage passing sieve [2]—			
						3-in.	2-in.	1½-in.	1-in.
			Inches		*Percent*				
Savoia fine sandy loam, 2 to 5 percent slopes.									
NW¼SW¼ sec. 23, T. 13 N., R. 17 W., McKinley County. (Modal profile.)	Sandstone (Mesaverde formation).	S34369	8–22	B2					
		S34370	22–49	B3					
		S34371	49–64+	C					
NE¼SE¼ sec. 14, T. 13 N., R. 17 W., McKinley County. (Shallower than modal.)	Sandstone (Mesaverde formation).	58–24485	7–15	B2					
		58–24486	15–20	B3					
		58–24487	20–28+	C					
NW¼ sec. 23, T. 13 N., R. 17 W., McKinley County. (Shallower than modal.)	Sandstone (Mesaverde formation).	58–24488	6–9	B2					
		58–24489	9–13	B3					
		58–24490	13–22+	C					
Fortwingate loam, 2 to 8 percent slopes.									
NE¼ sec. 11, T. 11 N., R. 15 W., Valencia County. (Modal profile.)	Glorieta sandstone.	S34372	0–6	A1					
		S34373	11–20	B21					
		S34374	27–38	B3		[5] 86	78	76	74
SW¼ sec. 17, T. 13 N., R. 16 W., McKinley County. (Shallower than modal.)	Glorieta sandstone.	58–24494	3–6	A2					
		58–24495	6–14	B1					
		58–24496	14–26	B21					
NW¼ sec. 20, T. 13 N., R. 16 W., McKinley County. (Shallower than modal and rocky.)	Glorieta sandstone.	58–24491	5–11	A3					
		58–24492	11–19	B1					
		58–24493	19–26	B2					
Jekley silt loam, 3 to 7 percent slopes.									
SW¼SW¼ sec. 2, T. 12 N., R. 15 W., Valencia County. (Deeper than modal.)	Abo sandstone.	58–24480	0–3	A11 and A12.					
		58–24481	6–12	B2					
		58–24482	19–24	C2					
SW¼ sec. 13, T. 12 N., R. 15 W., Valencia County. (Channery in B2 horizon.)	Abo sandstone.	58–24478	3–9	A12			100		96
		58, 24479	9–16	B2			100		95
Ordnance loam (5 to 15 percent slopes).									
SW¼ sec. 20, T. 14 N., R. 16 W., McKinley County. (Modal profile.)	Sandstone and shale (Chinle formation).	S34798	8–13	B21					
		S34799	13–19	B22					
		S34800	19–30	B3					
NW¼ sec. 29, T. 14 N., R. 16 W., McKinley County. (Modal profile.)	Sandstone and shale (Chinle formation).	S34801	11–17	B22					
		S34802	17–27	B3					
		S34803	27–33+	C					
Thurloni clay, 5 to 20 percent slopes.									
SE¼SW¼ sec. 22, T. 14 N., R. 16 W., McKinley County. (Modal profile.)	Sandstone and shale (Chinle formation).	S34804	6–13	B2					
		S34805	13–18	B3					
		S34806	18–33	C					
Turkeysprings clay loam, 2 to 10 percent slopes.									
NE¼SW¼NE¼ sec. 29, T. 14 N., R. 16 W., McKinley County. (Modal profile.)	Limestone or mudstone (San Andres member of Chupadera formation).	S34807	10–17	B2					
		S34808	17–33	B3ca					
		S34809	33–54	C					

See footnotes at end of table.

test data

of the American Association of State Highway Officials (AASHO). Samples with report number prefixed by "S" were tested by the Bureau Roads]

Mechanical analysis [1]—Continued											Liquid limit	Plasticity index	Classification	
Percentage passing sieve [2]—Continued							Percentage smaller than [2]—							
¾-in.	⅜-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO	Unified [3]
------	------	------	------	100	90	43	39	36	31	28	29	12	A-6(2)-----	SC.
------	------	------	------	100	92	44	40	35	30	26	28	11	A-6(2)-----	SC.
------	------	------	------	100	88	44	40	36	29	24	29	12	A-6(2)-----	SC.
------	------	------	100	97	------	43	------	------	------	21	28	10	A-4(2)-----	SC.
------	------	------	100	95	------	30	------	------	------	16	[4]	[4]	A-2-4(0)---	SM.
------	------	------	100	98	------	38	------	------	------	18	26	7	A-4(1)-----	SM-SC.
------	------	------	------	100	------	36	------	------	------	22	27	8	A-4(0)-----	SC.
------	------	------	100	70	------	27	------	------	------	16	[4]	[4]	A-2-4(0)---	SM.
------	------	------	100	98	------	15	------	------	------	10	[4]	[4]	A-2-4(0)---	SM.
------	------	------	100	99	90	39	31	17	11	9	[4]	[4]	A-4(1)-----	SM.
------	------	------	100	99	89	44	40	36	33	31	34	18	A-6(4)-----	SC.
71	69	68	65	64	58	32	28	24	21	20	31	15	A-6(2)-----	SC.
------	------	------	100	97	------	69	------	------	------	22	27	9	A-4(7)-----	CL.
------	------	------	100	98	------	77	------	------	------	26	35	13	A-6(9)-----	ML-CL.
------	------	------	100	99	------	74	------	------	------	30	38	15	A-6(10 ----	ML-CL.
------	------	------	------	100	------	65	------	------	------	13	[4]	[4]	A-4(6)-----	ML.
------	------	------	100	99	------	72	------	------	------	19	[4]	[4]	A-4(7)-----	ML.
------	------	------	100	99	------	74	------	------	------	22	28	8	A-4(8)-----	CL.
------	------	------	------	100	------	99	------	------	------	24	[4]	[4]	A-4(8)-----	ML.
------	------	------	------	------	------	100	------	------	------	39	36	15	A-6(10)----	CL.
------	------	------	------	100	------	99	------	------	------	39	37	16	A-6(10)----	CL.
93	80	69	59	54	------	49	------	------	------	13	[4]	[4]	A-4(3)-----	SM.
93	85	73	63	55	------	52	------	------	------	12	[4]	[4]	A-4(3)-----	ML.
------	------	------	100	98	96	74	64	48	37	31	30	13	A-6(9)-----	CL.
------	------	------	100	99	98	77	69	57	51	47	48	25	A-7-6(16)--	CL.
------	------	------	------	100	99	77	66	53	46	44	47	24	A-7-6(15)--	CL.
------	------	------	------	100	99	84	73	57	50	47	50	28	A-7-6(17)--	CL.
------	------	------	100	99	98	88	83	74	65	54	51	28	A-7-6(17)--	CH.
------	------	------	100	99	97	88	86	83	73	60	53	32	A-7-6(19)--	CH.
------	------	------	100	98	93	77	74	68	57	46	54	28	A-7-6(18)--	CH.
------	------	------	100	97	92	78	75	68	58	51	56	28	A-7-6(18)--	MH-CH.
------	------	------	100	97	93	69	64	51	40	31	56	16	A-6(9)-----	CL.
------	------	------	100	99	99	86	76	57	46	41	47	22	A-7-6(14)--	CL.
100	99	98	97	95	94	86	78	57	45	40	44	21	A-7-6(13)--	CL.
100	99	97	95	92	90	83	77	56	38	29	34	15	A-6(10)----	CL.

TABLE 12.—*Engineering*

Soil name and location of sample	Parent material	New Mexico report No.	Depth from surface	Horizon	Mechanical analysis [1]				
					Fragments of more than 3 in. diameter discarded in field sampling (estimated)	Percentage passing sieve [2]—			
						3-in.	2-in.	1½-in.	1-in.
			Inches		*Percent*				
Zuni sandy loam, 2 to 10 percent slopes.									
NW¼SE¼ sec. 5, T. 11 N., R. 14 W., Valencia County. (Modal profile.)	Granite	S34375	6–10	A2					
		S34376	10–20	A3		[5] 79	76	76	75
		S34377	20–40	B2				100	99
SW¼ sec. 32, T. 12 N., R. 14 W., Valencia County. (Shallower than modal and lacks A3 horizon.)	Granite	58–24475	4–7	A2		100	76		67
		58–24476	7–13	B1			100		89
		58–24477	13–19	B2					
SE¼ sec. 11, T. 13 N., R. 16 W., McKinley County. (Shallower than modal and lacks A2 and A3 horizons.)	Granite	58–24483	2–5	A12					
		58–24484	9–16	B2					
Wilcoxson clay loam, 3 to 15 percent slopes.									
NE¼NE¼ sec. 5, T. 12 N., R. 15 W., Valencia County. (Modal profile.)	Granite	S34810	8–14	B1					
		S34811	14–30	B2					
		S34812	35–50	C12					
Osoridge (sandy loam, 5 to 20 percent slopes).									
SE¼NW¼ sec. 11, T. 11 N., R. 15 W., Valencia County. (Modal profile.)	Glorieta sandstone	S34813	5–9	B1	30	[6]			
		S34814	9–13	B21	30	[6]		70	68
		S34815	13–18	B22	30	[6]			
SE¼SW¼ sec. 12, T. 11 N., R. 15 W., Valencia County. (Modal profile.)	Glorieta sandstone	S34816	4–8	B1	30	[6]			
		S34817	8–12	B21	30	[6]			
		S34819	12–17	B22	30	[6]			

[1] Mechanical analysis according to AASHO Designation: T 88–57 (*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for use in naming textural classes for soils.

None of these soils has possibilities for development of recreational facilities. All of them are unstable and will compact and slick over if used for camping or picnicking.

Badland needs to be protected against any use except carefully controlled grazing. It is highly erodible and will become more so if much of the vegetation is removed.

MANAGEMENT GROUP 7

The soils in this management group are very poor to fair for timber, and most of them are fair to good for herbage. The group consists of—

Andrews gravelly loam, 5 to 20 percent slopes.
Bandera gravelly loam, 5 to 15 percent slopes.
Bond sandy loam, 5 to 15 percent slopes.
Cabezon rocky complex, 2 to 10 percent slopes.
Jekley stony loam, 10 to 30 percent slopes.
Kettner stony loam, 10 to 20 percent slopes.
Kiln rocky complex, 3 to 20 percent slopes.
Laporte stony loam, 3 to 10 percent slopes.
Mirabal stony loam, low rainfall, 5 to 20 percent slopes.
Osoridge rocky complex, 5 to 20 percent slopes.

These are shallow, stony and gravelly soils that have low capacity for sustained water yield. They are friable and permeable. Outcrops of limestone, basalt, and sandstone are common. Angular fragments of limestone, of various sizes, cover much of the surface of the Andrews, Laporte, and Kiln soils; slabs of sandstone cover much of the Osoridge complex; and stones and outcrops of sandstone are common in the Bond soil.

Water-storage capacity is limited because the soils are shallow. The Bandera soils are underlain by cinders, and the Andrews, Kiln, and Laporte soils by cracked and fissured limestone. Much of the water that infiltrates these soils drains into the underlying material.

The Cabezon, Jekley, Kettner, and Kiln soils are fair for ponderosa pine. They could be reforested, but because they are shallow, rocky, and stony, reforestation by direct seeding or by conventional methods of transplanting is not feasible. The rest of the soils in the group are poor for pine.

test data—Continued

Mechanical analysis [1]—Continued											Liquid limit	Plasticity index	Classification	
Percentage passing sieve [2]—Continued							Percentage smaller than [2]—							
¾-in.	⅜-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO	Unified [3]
100	99	98	96	88	85	67	54	31	18	14	22	2	A–4(6)	ML.
75	74	73	70	64	62	46	38	32	13	10	21	3	A–4(5)	ML.
99	98	97	95	93	92	81	74	64	56	55	69	42	A–7–6(20)	CH.
65	63	62	56	42	-------	30	-------	-------	-------		16	[4]	[4]	A–2–4(0)	SM.
89	86	82	72	49	-------	30	-------	-------	-------		17	[4]	[4]	A–2–4(0)	SM.
------	-------	-------	100	78	-------	60	-------	-------	-------		36	45	19	A–7–6(10)	ML–CL.
------	-------	-------	100	65	-------	49	-------	-------	-------		39	57	24	A–7–5(9)	SM.
------	-------	-------	100	65	-------	48	-------	-------	-------		24	33	10	A–4(3)	SM–SC.
------	-------	-------	100	98	97	78	66	42	33	30	39	18	A–6(11)	CL.
------	100	99	96	92	91	73	63	49	41	39	51	27	A–7–6(16)	CH.
100	99	95	83	68	64	53	51	47	38	36	68	34	A–7–5(13)	MH–CH.
70	69	69	69	69	65	52	50	43	39	37	65	35	A–7–5(20)	MH–CH.
67	66	66	66	66	62	49	47	42	39	37	69	40	A–7–6(18)	CH.
------	70	69	69	68	63	50	48	43	39	38	74	44	A–7–5(19)	CH.
------	-------	-------	-------	70	64	48	46	38	34	33	54	32	A–7–6(17)	CH.
------	-------	-------	-------	70	65	50	49	41	39	36	69	45	A–7–6(19)	CH.
------	-------	-------	-------	70	64	47	46	41	39	39	76	51	A–7–6(18)	CH.

[2] Based on total material. Laboratory test data corrected for amount discarded in field sampling.
[3] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points of A-line are to be given borderline classification. Examples of borderline classifications obtained by this use are SM–SC, ML–CL, and MH–CH.
[4] Nonplastic.
[5] Material larger than 3 inches received in laboratory.
[6] Coarse fragments in laboratory samples disintegrated in sample preparation.

The more nearly level areas of these soils can be revegetated with suitable grasses. The seed has to be broadcast, and success depends on a high rate of germination and the ability of seedlings to survive under rather unfavorable conditions. The possibilities of protective devices, such as contour furrows, terraces, and small check dams, are limited because the soils are shallow and rocky.

Many areas of these soils provide a suitable environment for wildlife. Browse is abundant on the Andrews and Kiln soils. On the Laporte soils, juniper competes with the browse plants, and suitable browse plants should be planted in natural openings or cleared spots.

MANAGEMENT GROUP 8

The soils in this management group are very poor to poor for both timber and herbage and have low capacity for sustained yield of water. The group consists of—

Bandera gravelly loam, 15 to 35 percent slopes.
Jekley rocky complex, 30 to 40 percent slopes.
Kiln rocky complex, 20 to 40 percent slopes.
Laporte stony loam, 20 to 40 percent slopes.
Osoridge rocky complex, 20 to 40 percent slopes.
Rock land (5 to 50 percent slopes).
Sanchez stony complex, 10 to 20 percent slopes.

The soils of this group are characterized by low to moderate fertility, low productivity, and low moisture-holding and moisture-supplying capacity. Runoff is heavy, and the erosion hazard is high. The depth to bedrock ranges from only a few inches to 20 inches. Outcrops are numerous. Stones and cobblestones cover much of the surface, and there is much stone in the shallow profiles. Canyons and other deep drainageways are common, and many areas are difficult to cross on horseback or on foot.

The soils of this group are valuable mainly as a source of water. The capacity for sustained yield is low, but the surface yield is high.

Although all of these soils except the Laporte soil are almost entirely within the ponderosa pine forest, they are

not suited to pine. Most of the acreage has been cut over. Regeneration of pine and recovery of other vegetation are slow, and reforestation would not be profitable.

Only a small amount of forage is produced, and the movement of livestock is restricted by ledges, outcrops, and steep slopes. Revegetation of the range is not likely to be profitable.

The environment is favorable for wildlife. Areas of concealment and avenues of escape are plentiful. Sources of water for deer and turkey need to be developed in places where browse is available.

Although economic returns from revegetation and reforestation are unlikely, a vegetative cover should be established and maintained for control of erosion.

MANAGEMENT GROUP 9

The soils in this management group are good for herbage but very poor for timber. The group consists of—

Nathrop loam, 0 to 5 percent slopes.
Showlow loam, 0 to 5 percent slopes.
Tabiona fine sandy loam, 10 to 15 percent slopes.

These are shallow and deep soils that are nearly free of surface stones and cobblestones. Even though they all receive runoff from the surrounding slopes, only the Tabiona soil is gullied.

These soils should be managed mainly for the production of herbage. Heavy grazing or other use has depleted the desirable forage plants, and the gullies in the Tabiona soil appear to have had an adverse effect on vegetation. The native plants grow well if only lightly grazed, but natural increase of the plant cover is slow. Improvement of the kind and amount of herbage requires revegetation. Seedbed preparation and seeding must be timed to take advantage of seasonal precipitation. Except for the gullies in the Tabiona soil, there are no obstacles to the use of ordinary machinery.

The environment for wildlife can be improved by planting shrubs.

MANAGEMENT GROUP 10

This management group is composed of land types that have only limited productivity for timber or herbage. The capacity for sustained yield of water is low. The group consists of—

Lava flows.
Lava rock land.
Rock outcrop, gently sloping.
Rock outcrop, cliffs.

Although these rough, rocky areas produce some vegetation, they are of limited use for grazing, and their capacity for the production of timber is very low. Rock outcrop, cliffs, yields some surface water after heavy rains.

All of these land types have scenic or esthetic value. They provide areas of concealment for wildlife. Some are barriers to cross-country travel. Lava flows and Lava rock land can be crossed only on foot, and such travel is dangerous on account of the jagged surface and the many cracks and fissures in the lava.

Lava flows and Lava rock land support fair amounts of browse. That along the edges of the areas is accessible, and deer make use of it.

Capability Groups of Soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.

In the capability system, all kinds of soils are grouped at three levels, the capability class, subclass, and unit.

Class I.—Soils have few limitations that restrict their use.
Class II.—Soils have some limitations that reduce the choice of plants or require moderate conservation practices.
Class III.—Soils have severe limitations that reduce the choice of plants, or require special conservation practices, or both.
Class IV.—Soils have very severe limitations that restrict the choice of plants, require very careful management, or both.
Class V.—Soils subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.
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 food and cover.
Class VII.—Soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.
Class VIII.—Soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

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 response to management. Capability units are generally designated by adding an arabic numeral to the subclass symbol, for example, IIe–1. Most of the soils in the Zuni Mountain Area, however, are not suitable for cultivation and therefore have not been placed in capability units. They have been placed in capability classes and subclasses, as shown in the list that follows:

Soil name	*Capability class and subclass*
Andrews gravelly loam, 5 to 20 percent slopes	VIIs
Badland	VIIe–VIIIs
Bandera gravelly loam, 5 to 15 percent slopes	VIs
Bandera gravelly loam, 15 to 35 percent slopes	VIIe
Bond sandy loam, 5 to 15 percent slopes	VIe
Cabezon rocky complex, 2 to 10 percent slopes	VIs
Clayey alluvial land	VIe
Concho clay loam, 1 to 3 percent slopes	VIe
Concho clay loam, 3 to 10 percent slopes	VIe
Fortwingate loam, 2 to 8 percent slopes	VIe
Friana silt loam	VIe
Gem stony loam, 2 to 7 percent slopes	VIe
Jekley silt loam, 3 to 7 percent slopes	VIe

Soil name	Capability class and subclass
Jekley stony loam, 10 to 30 percent slopes	VIs
Jekley rocky complex, 30 to 40 percent slopes	VIIe
Kettner loam, 3 to 10 percent slopes	VIe
Kettner stony loam, 10 to 20 percent slopes	VIs
Kiln rocky complex, 3 to 20 percent slopes	VIIs
Kiln rocky complex, 20 to 40 percent slopes	VIIe
Laporte stony loam, 3 to 10 percent slopes	VIs
Laporte stony loam, 20 to 40 percent slopes	VIIe
Larry silty clay loam	Vw
Lava flows	VIII
Lava rock land	VIIs–VIIIs
McGaffey loam	IVc
Mirabal stony loam, 5 to 15 percent slopes	VIs
Mirabal stony loam, 15 to 45 percent slopes	VIIe
Mirabal stony loam, low rainfall, 5 to 20 percent slopes	VIs
Montoya clay	VIe
Nathrop loam, 0 to 5 percent slopes	VIe
Ordnance loam	VIe
Osoridge rocky complex, 5 to 20 percent slopes	VIIs
Osoridge rocky complex, 20 to 40 percent slopes	VIIe
Polich loam	IVc
Prewitt clay loam	VIe
Rock land	VIIs–VIIIs
Rock outcrop, gently sloping	VIIIs
Rock outcrop, cliffs	VIIs–VIIIs
Sanchez stony complex, 10 to 20 percent slopes	VIIs
Savoia fine sandy loam, 2 to 5 percent slopes	VIe
Savoia fine sandy loam, 5 to 20 percent slopes	VIe
Showlow loam, 0 to 5 percent slopes	VIe
Showlow clay loam, 5 to 15 percent slopes	VIe
Supervisor stony loam, 20 to 45 percent slopes	VIIe
Tabiona fine sandy loam, 10 to 15 percent slopes	VIe
Tampico loam	VIe
Tampico loam, dark variant	VIe
Thurloni clay, 5 to 20 percent slopes	VIe
Thurloni clay, black variant, 3 to 10 percent slopes	VIe
Trail loamy fine sand	VIe
Trail loamy fine sand, hummocky	VIIe
Turkeysprings clay loam, 2 to 10 percent slopes	VIe
Valentine loamy fine sand, 5 to 15 percent slopes	VIe
Wilcoxson loam, 3 to 5 percent slopes	VIe
Wilcoxson clay loam, 3 to 15 percent slopes	VIe
Zuni sandy loam, 2 to 10 percent slopes	VIe
Zuni-Mirabal stony loams, 10 to 30 percent slopes	VIe–VIs

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Aspect. The direction toward which a slope faces. Synonym: Exposure.

Buried soil. A developed soil, once exposed but now overlain by a more recently formed soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

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. In engineering, as used in this report, soil particles smaller than 0.005 millimeter.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash, and deposited at the base of steep slopes.

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; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle to moderate 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; tends to stretch somewhat and pull apart, rather than pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Eolian. Wind deposited.

Erosion, soil. The wearing away or removal of soil material by wind, running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide compounds in adequate amounts and in proper balance for the growth of specified plants, when other growth factors, such as light, moisture, temperature, and the physical condition (or tilth) of the soil, are favorable.

Forest. Land bearing a stand of trees of any age or stature, including seedlings of species that attain a minimum average height of 6 feet at maturity; or land from which such a stand has been removed but which is not now restocking and which has not been put to other use. Forest on farms is called "farm woodland" or "farm forest."

Gravel. Rounded pebbles or angular fragments of rock as much as 3 inches in diameter. The content of gravel is not used in determining the textural class of the soil, but, if the soil is as much as 20 percent gravel, the word "gravelly" is added as a prefix to the textural soil name. In engineering, a coarse-grained soil, more than 50 percent of which is retained on a No. 4 screen.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

Internal soil drainage. The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers, and by the level of the water table, either permanent or perched. Relative terms for expressing internal drainage are none, very slow, slow, medium, rapid, and very rapid.

Landscape. All the characteristics that distinguish a certain kind of area on the earth's surface and give it a distinguishing pattern, in contrast to other kinds of areas. Any one kind of soil is said to have a characteristic natural landscape, and under different uses it has one or more characteristic cultural landscapes.

Leaching, soil. The removal of soluble materials from soils or other material by percolating water.

Loam. Soil consisting of about equal proportions of sand, silt, and clay.

Morphology. The makeup of the soil, including the texture, structure, consistence, color, and other physical, mineralogical, and biological properties of the various horizons of the soil profile.

Natural drainage. Refers to moisture conditions that existed during the development of the soil, 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. The following relative terms are used to describe natural drainage: *excessive, somewhat excessive, good, moderately good, imperfect* or *somewhat poor, poor,* and *very poor.*

Noncalcareous. As used in this report, a soil that does not contain enough free lime to effervesce (fizz) with dilute hydrochloric acid.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Nitrogen, phosphorus, calcium, potassium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil, and carbon, hydrogen, and oxygen obtained largely from the air and water, are plant nutrients.

Parent material. The horizon of weathered rock or partly weathered soil material from which a soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Pedestaling. The removal of soil around clumps of grass or other vegetation by water erosion so that the vegetation is left on small pedestals or stools.

Permeability. The quality of a soil horizon that enables water or air to move through it.

Phase, soil. A subdivision of a soil type, most commonly based on variations in such external characteristics as relief, stoniness, accelerated erosion, or some other characteristic that affects management.

Productivity, soil. The present capability of a soil for producing a specified plant or sequence of plants under a specified system of management.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction. The degree of acidity or alkalinity of the soil mass, expressed in words and pH values. A soil that tests to pH 7.0 is precisely neutral in reaction, because it is neither acid nor alkaline. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Revegetation. The reestablishment or improvement of a plant cover, either naturally or through reseeding or transplanting.

Sand. As a soil separate, individual rock or mineral fragments ranging from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz, but they may be of any mineral composition. As a textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

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 textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slash. Debris left after logging, pruning, thinning, or brush cutting; also, debris left by wind or fire.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief over periods of time.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. 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 (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer lying beneath the solum, or true soil.

Surface layer (surface soil). Technically, the A horizon; commonly, the part of the soil ordinarily moved by plowing.

Sustained water yield. The amount of water that the soil and underlying material will store and release slowly through springs and seeps to maintain a sustained flow in streams; in contrast with flood yields and surface runoff following storms or rapid snowmelt.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. (See also clay, sand, and silt.) The basic textural classes, in order of increasing proportions of fine particles, are as follows: sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Water spreading. Diverting runoff from a gully or watercourse onto gently sloping, absorptive land, to conserve waste water, to reduce flood peaks, or to replenish ground water supplies.

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