SOIL SURVEY OF

Taylor River Area, Colorado

(Northeastern Part of Gunnison County)

United States Department of Agriculture
Forest Service and Soil Conservation Service
In cooperation with
Colorado Agricultural Experiment Station

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

Major fieldwork for this soil survey was completed in the period 1958–63. Soil names and descriptions were approved in 1968. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1963. This survey was made cooperatively by the Forest Service, the Soil Conservation Service, and the Colorado Agricultural Experiment Station. It is part of the technical assistance furnished to the Gunnison Soil Conservaion District.

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

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of the Taylor River Area contains information that can be applied in project or multiple use planning; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for timber production, grazing, wildlife, recreation, or other uses.

Locating Soils

All the soils of the Taylor River Area are shown on the detailed map at the back of this survey. 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 identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

Each soil and land type in the survey area, and the page on which it is described, is listed in the "Index to Mapping Units" following the contents. Following that is the "Summary of Tables," which lists all of the tables in the survey. General information about the Area is presented in Part I, "The Landscape." The soil series and mapping units are described in Part II, "The Soils." Use and management of the soils for timber, range, water, recreation, wildlife, and engineering are discussed in Part III, "Soil Use and Management." "Erosion and Landslides" and "Fire" are also discussed in Part III. Tables showing the suitability and potentials of the different soils for various uses are referred to under the discussion of each resource.

Individual colored maps showing the relative suitability, limitations, or potential uses of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be placed 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.

Engineers will find, under "Engineering," tables that give engineering descriptions 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 are formed and how they are classified in the section "Genesis, Morphology, and Classification of Soils."

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

Newcomers in the Taylor River Area may be especially interested in the section "Soil Associations," where broad patterns of soils are described. They may also be interested in the section "The Landscape," which gives additional information about the Area.

Cover: Landscape of the Taylor River Area. The glaciated valley in the background is Rock outcrop and Rock slides; the timbered mountains are mainly in an area of Schofield-Peeler soils.

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SOIL SURVEY OF TAYLOR RIVER AREA, COLORADO

(NORTHEASTERN PART OF GUNNISON COUNTY)

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

Part I: The Landscape

THE TAYLOR RIVER AREA is in Gunnison County, Colorado, 98 miles southwest of Denver and 80 miles west of Colorado Springs (fig. 1). Taylor Park is in about the center of the Area. The Continental Divide, to the east, forms the boundary between the Taylor River Area and Chaffee County. The Elk Mountains, to the north, separate the Area from Pitkin County. The Area covers 566,093 acres and lies entirely within the Gunnison National Forest. Approximately 34,000 acres of the survey area is privately owned, and the remainder is primarily Federal land.

The Area is made up of hills covered by sagebrush and grass along its western and southern boundaries, areas of lodgepole pine and spruce-fir timber in the middle, and rock-strewn alpine areas and barren mountain peaks on the north and east. The Area is very sparsely populated.

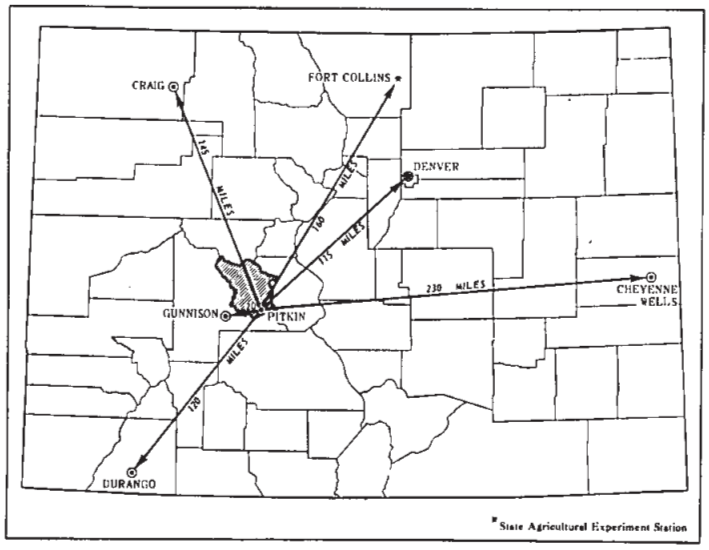

Figure 1.—Location of the Taylor River Area (Northeastern Part of Gunnison County) in Colorado.

U.S. Highway 50 connects Gunnison, which is southwest of the survey area, with Salida to the east and Montrose to the west. State Highway 135 connects the towns of Gunnison and Crested Butte and traverses the west side of the survey area. Within the Area, gravelled and light duty roads connect Almont, Ohio City, Pitkin, Tincup, Taylor Park, and Buena Vista to the east by way of Cottonwood Pass. Gunnison is the county seat of Gunnison County and the site of Western State College.

Geology

Precambrian intrusive and metamorphic rocks are the most extensive in the area. Sedimentary rocks of Paleozoic and Mesozoic era occur as remnants of synclines or down-faulted blocks, some of which are surrounded by chonoliths, stocks, sills, and dikes of early Tertiary igneous rocks. Quaternary deposits are common in the northeastern part of the area (fig. 2).

Precambrian metamorphic rocks include schist, gneiss, and granitic gneiss. The older schists and gneisses are mostly metamorphosed sedimentary rocks. The granitic gneiss is principally an injection gneiss (migmatite) formed by granitic intrusion and replacement of the older schists and gneisses.

Sedimentary rocks exposed in the Area include Paleozoic and Mesozoic sandstone, conglomerate, shale, and limestone. The sandstones are members of the Dakota and Morrison Formations, which also contain beds of shale. The Maroon conglomerate of the Permian and Pennsylvanian period is interbedded with sandstone. Pennsylvanian limestone occurs in a few areas.

Early Tertiary intrusive igneous rocks include rhyolite, quartz diorite, andesite, quartz diorite porphyry, and quartz monzonite porphyry.

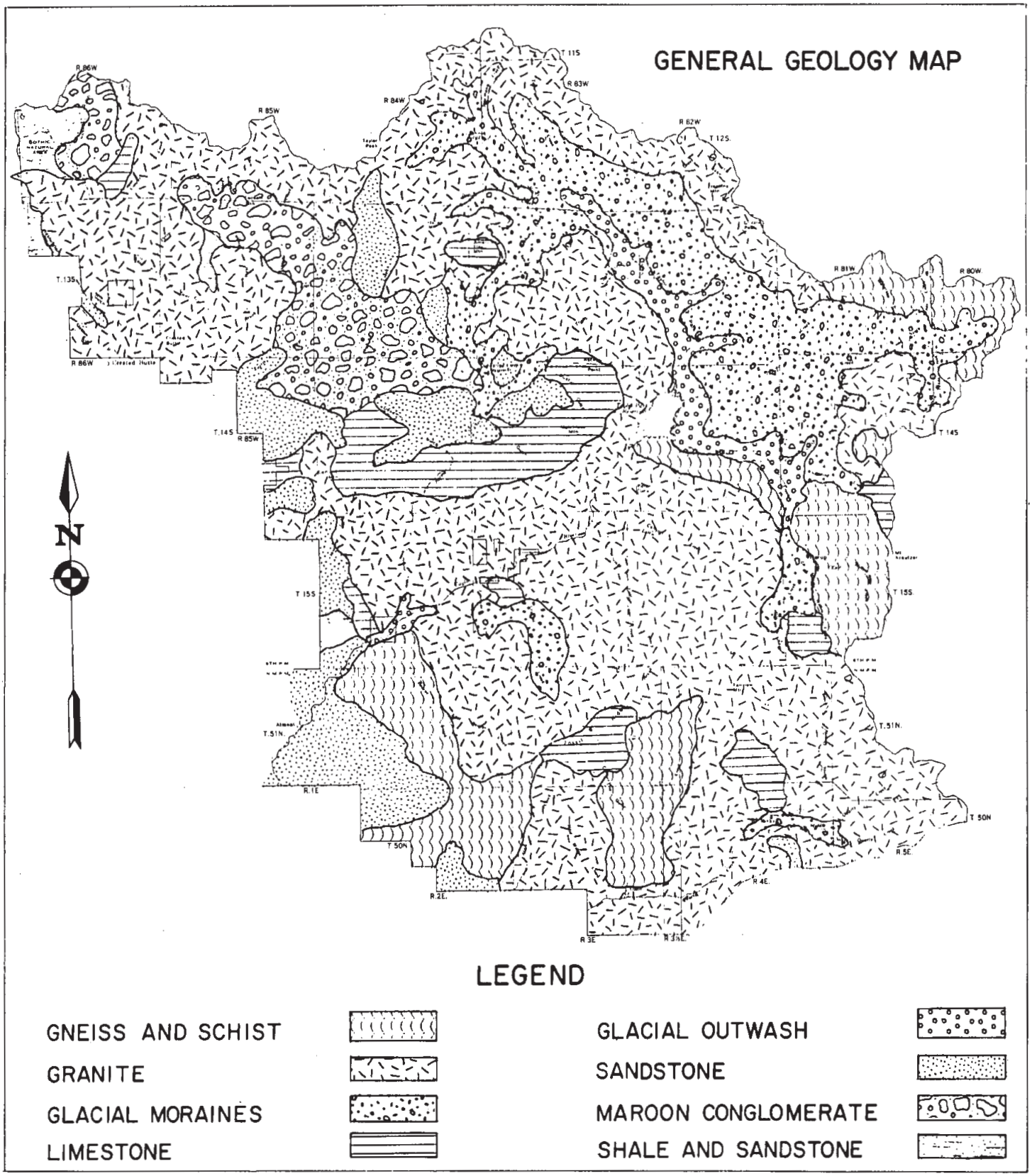

Figure 2.—**Surface geology map of the Taylor River Area.**

Pleistocene glacial moraines, glaciofluvial deposits, and terrace deposits are extensive along the Taylor River, Willow Creek, Texas Creek, and other small streams. Alluvial deposits of Holocene age occur in all valleys. The alluvial colluvial deposits are presumed to be Holocene. Talus deposits are common along most of the steep slopes at higher elevations.

Figure 2 shows that granite is the most extensive rock in the area. Most of the granite is fine grained and resistant to weathering, so outcrops of rock and precipitous slopes are common. Drainage patterns are dendritic. Shallow, medium-textured to coarse-textured soils formed in the material weathered from these rocks. The dominant minerals in the granites are quartz, orthoclase, and plagioclase feldspars and biotite, which weather to sand and gravel with varying amounts of clay.

Areas of Precambrian schist and gneiss are moderately extensive and are generally intermixed. However, there are local small areas of distinct gneiss or schist. Granitic gneiss is a very common rock with prominent structure. It forms outcrops and escarpments that indicate resistance to weathering. Schist weathers more easily, but the resistant gneiss intermixed with it creates rugged relief. Drainage patterns in these areas are coarsely dendritic. The soils vary from shallow to moderately deep and contain varying amounts of mica. The gneiss and granitic gneiss are chemically similar to granite. The schists consist of quartz, feldspar, biotite, and locally, muscovite. The feldspars are microcline and sodic plagioclase.

The sandstones are in the Morrison and Dakota Formations. The Morrison Formation consists of sandstone interbedded with shale. A pebble conglomerate is the basal member of the Cretaceous Dakota Formation. The pebbles are dominantly quartz with some chert and jasper. The topography of the sandstone areas is rugged, and the drainage pattern is fine dendritic. The soils are shallow to moderately deep over bedrock.

The Mancos Formation, of shale with lenses of sandstone, occupies a small part of the Area. The topography is hilly to steep, but because the shales are soft, the ridgetops are rounded and the lower slopes are gentle. The drainage pattern is dendritic. Soils developed from these rocks are shallow to moderately deep, fine-textured, and highly erodible.

Limestone of Pennsylvanian age is of minor lithology and mostly occurs at higher elevations above timberline. Some of the limestone is dolomitic, and most of it has inclusions of phyllitic shale. The topography is generally hilly to steep. Fine-textured, shallow to moderately deep soils formed in limestone.

In the Brush Creek and Cement Creek watersheds is an area of Maroon conglomerate of the Permian and Pennsylvanian periods. The Formation consists of sandstone interbedded with a conglomerate of cemented, rounded, granitic pebbles and cobbles, limestone fragments, and assorted other rocks. The topography is characterized by long, steep slopes with stairstep relief inherited from the parallel, more resistant sandstone beds. The Maroon Formation is an excellent aquifer, and many springs issue from it. Many perennial streams form a coarse dendritic drainage pattern. Reddish-brown, coarse-textured soils formed in these materials.

Pleistocene deposits are extensive to the east of the Taylor River above the Taylor River dam. Away from the river, these deposits occur as hummocky glacial moraines; near the Taylor River, along Willow Creek and Texas Creek, and elsewhere, they occur as outwash. The glacial till is dominantly composed of granitic materials, but there are admixtures of material from other rocks. Along Rocky Brook, a tributary of Spring Creek, are moraines consisting mainly of limestone material. It is apparent from the character of the deposits that there were several glacial stages. The landscape in areas of glacial moraines is hilly to steep with the hummocky relief characteristic of such deposits. Drainageways are very coarsely dendritic, and there are many kettles in the moraines. Coarse-textured, gravelly, very permeable soils formed in these deposits. Glacial outwash deposits occur as gently sloping terraces. Because of the permeability of these deposits, the drainage system is not well developed.

Alluvial deposits of Holocene epoch occur in most drainage valleys. Poorly drained soils and soils with highly variable characteristics are in areas of these deposits. Talus of large, angular rocks are at the bases of rock escarpments.

Geomorphology

The Taylor River Area is in the Southern Rocky Mountains Province of the Rocky Mountain System. The Southern Rocky Mountains Province consists of complex mountains of various types and intervening basins. This province consists mostly of broad, elevated, north-south strips of dominantly granitic rocks that are generally flanked by steeply dipping sedimentary rocks (*5*)[1].

Topography of the Taylor River Area is typical of glaciated mountainous regions. Altitude ranges from about 8,000 feet at the town of Almont to 14,000 feet at the crest of the Taylor River watershed. The Sawatch Range is part of the Continental Divide and is also the northern and eastern boundary of Taylor River Area. The Area is characterized by steep, glaciated mountains with barren, knife-edged ridges and peaks. Valleys are steep and U-shaped. In unglaciated parts of the Area, the stream divides are broad and rolling, and valley walls are V-shaped. The streams in both the glaciated and unglaciated areas have high gradients and narrow flood plains.

The mountains surround two relatively large mountain park areas, Taylor Park and Union Park. Taylor Park, much the larger of the two, is a long, narrow, open grassland in a basin enclosed on the north and east by glacial moraines and on the west by steep mountain foot slopes. This large, grassy park is a comparatively level, open mountain valley surrounded by forest. The geologic material occupying the park consists mainly of outwash that forms benchlike or terracelike positions with several levels. The more recent fluvioglacial material is adjacent to Taylor River and its tributaries. Scattered near the outer edges of the

[1] Italic numbers in parentheses refer to Literature Cited, p. 80.

park are older moraines deposited by glaciers that came down the main mountain valleys during the Pleistocene Epoch. Taylor Park has comparatively gentle valley walls and a relatively broad, poorly drained valley bottom.

Union Park occupies about 4 square miles. It differs from Taylor Park in being underlain mainly by colluvial-alluvial deposits of material derived from granite, gneiss, and schist in the mountains.

Between Taylor Park and the mountains to the north and east is a large area of glacial moraines with hummocky topography and kettles. The moraines are mostly of granitic till with a minor amount of limestone and other rocks.

Timberline is at about 11,800 feet in the Area. Above timberline are areas of alpine turf and alpine meadow with rock-strewn surfaces (fig. 3). Areas of alpine soils are not extensive, and most of the area above timberline consists of steep, barren rocky mountain sides and peaks. Cirques are common on the eastern and northern sides of high ridges and peaks. Rock glaciers and glacier-scoured rock domes are prominent topographic features. Rubble masses that assume various forms, including rock streams and lobes, are common in alpine areas (fig. 4). Talus is common at the bases of most steep, barren, rocky slopes.

Below timberline, in areas not covered by glacial deposits, are steep, timbered mountain slopes underlain by granite, gneiss, schist, sandstone, shale, and limestone. Areas underlain by granite are the most extensive. Areas of Rock land and Rock outcrop are common. Below Taylor Reservoir, the Taylor River flows in a narrow, steep-walled canyon of granite and gneiss.

Although Taylor Park has gentle slopes and many nearly level areas, the very short growing season limits use of the area largely to grazing and recreation. Due to the gentle slopes and the permeable soils, erosion is active mainly on the short, steep escarpments. There are occasional deep gullies, and damage due to trailing by livestock is considerable. Soil erosion is somewhat more serious in Union Park, where some of the soils are less permeable.

Areas of glacial moraines are managed principally for timber, but because the soils in these areas are somewhat droughty, they produce only a small amount of timber. Some soils are so stony and bouldery that hand tools must be used for replanting.

Timbered soils have slopes greater than 25 percent, generally between 40 and 65 percent. These soils must be carefully managed since erosion is difficult to control once it has started. Erosion is still more difficult to control on slopes because it is partly geologic erosion.

Most areas above timberline are managed to protect the soils and to produce water. Some narrow and largely isolated, steep-walled areas of alpine soils are grazed by big game. Other less isolated areas are grazed by domestic sheep.

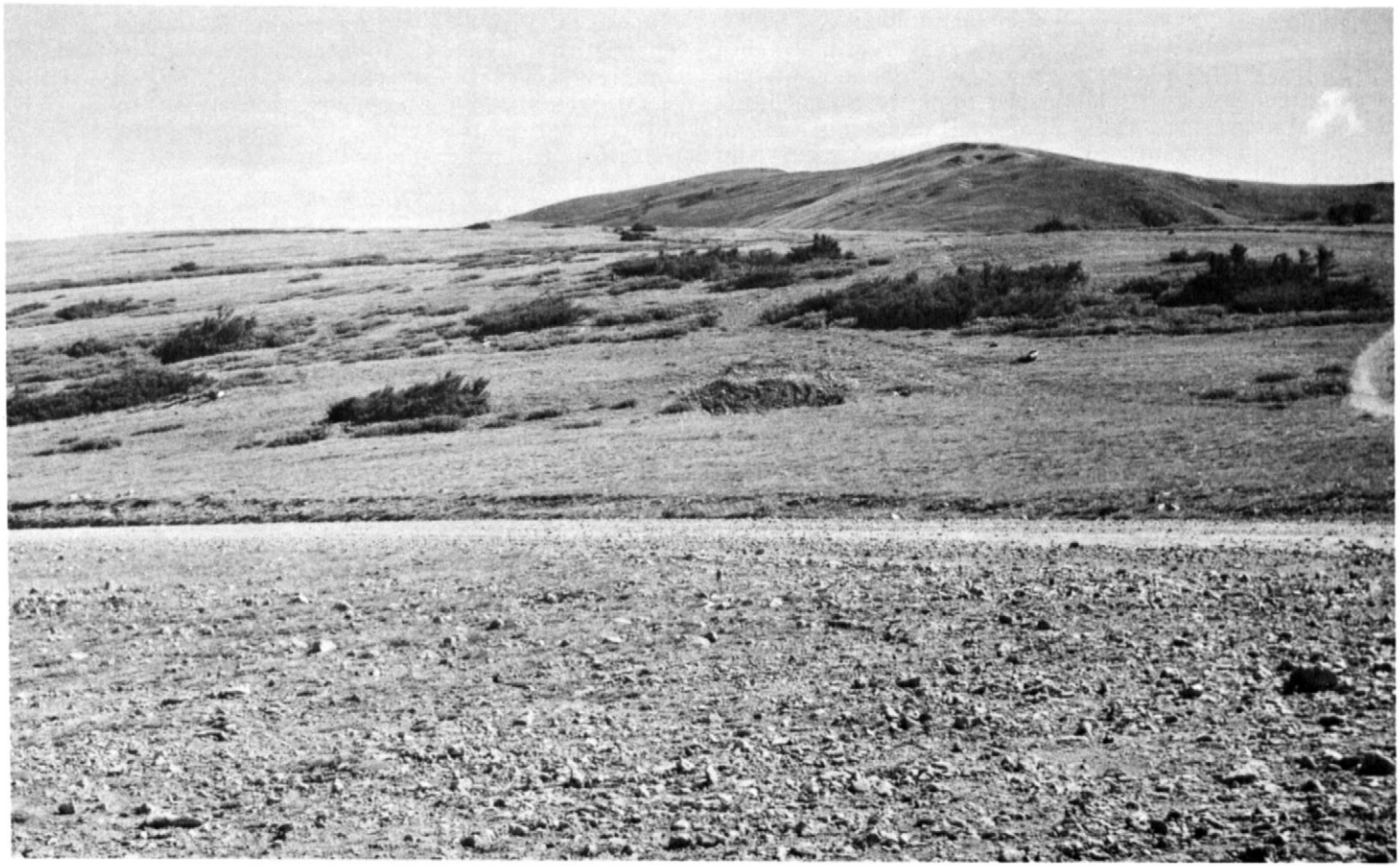

Figure 3.—**An alpine area in the Mirror-Haverly-Vasquez association.**

Figure 4.—**Rock streams and a snowfield in an alpine area.**

Drainage

The central part of the Taylor River Area is drained by the Taylor River and its tributaries. The larger tributaries of this river above Taylor Dam include Willow Creek, Texas Creek, Illinois Creek, and Italian Creek. These and other minor streams drain into Taylor Reservoir. The river then drains in a southwesterly direction toward the town of Almont and the Gunnison River. Spring Creek, a large tributary, joins the Taylor River about five miles above Almont. Beaver Creek, Crystal Creek, Lottis Creek, South Lottis Creek, and other minor tributaries join the Taylor River between Almont and Taylor Reservoir.

The southern part of the Area is drained by Quartz Creek, Gold Creek, Alder Creek, and other minor tributaries.

Principal drainageways in the northwestern part of the Area include the East River, with Brush Creek as its principal tributary, Cement Creek, and Washington Gulch. Washington Gulch flows into the Slate River, which crosses a corner of the Area.

Over most of the Area, runoff is rapid. Runoff is slow only on the broader flood plains of the Taylor River above the reservoir and on the flood plains of Lottis Creek, Quartz Creek, and Willow Creek. Streams are generally entrenched in deep, V-shaped gorges beneath steep mountain slopes, but they are less deeply entrenched in areas of glacial deposits and on foot slope positions where the slope gradients are less. Most streams in the Area are rapid, since a 10 percent gradient along perennial streams is not uncommon.

Valleys on steep mountain slopes in granitic areas have coarse to fine dendritic drainage patterns. In areas of gneiss and schist, the drainage pattern is coarse dendritic. Areas of Maroon conglomerate have a dendritic drainage pattern, but drainageways are widely spaced because the rocks are permeable. This permeability reduces runoff. Glacial deposits are deep and pervious, so runoff is comparatively low. As a result, few drainageways develop. Many of the glacial deposits are near the bases of steep mountain slopes. Streams that flow from a resistant material into nonresistant glacial material cut more or less straight, parallel channels. Drainage systems originating within the glacial deposits have a coarse dendritic pattern. In glaciated areas not influenced by drainage from higher areas, the drainage pattern may terminate in kettles. Drainage pattern into glacial lakes is radial.

Snow begins to melt in the Taylor River Area in May, and peak runoff occurs the first or second week in June. Snow is almost entirely gone by July except on higher north slopes and in some cirques. Stream flow fluctuates widely except in streams that originate in materials that are porous or that have deep regoliths, such as glacial deposits and the Maroon conglomerate. For this reason, the flows of Brush Creek, Cement Creek, Spring Creek, and Texas Creek do not fluctuate as much as the flows of many other streams in the Area. Beaver ponds are common throughout the Area

and are particularly numerous on Willow Creek, Illinois Creek, and Lottis Creek. They help maintain uniform stream flow in the Area. Many springs in the Area help maintain stream flow in late summer. More than 85 lakes and ponds in the Area also help to maintain stream flow and to provide recreation (fig. 5). Most of the ponds are in areas of glacial moraines and on streams dammed by beavers. Most of the lakes are of glacial origin and are at high elevations. Two large reservoirs, the Taylor River Reservoir and Spring Creek Reservoir, are important in regulating stream flow and in providing recreation. The Taylor River Reservoir stores 106,230 acre-feet of water. Since this water is released at intervals for irrigation and domestic use in the Uncompahgre Valley, it is extremely important in maintaining the flow of the Taylor River below the dam. The prolonged melt period of high-altitude snowfields reduces peak stream flow (7).

Climate

Due to topographic features, there are great differences in the climate within the county, and locally there are wide extremes. The local climatic differences are the result of differences in elevation, air drainage, and relief.

Stationary high pressure areas form in winter and remain for several days. Under these conditions, the sky is clear, the daytime temperatures are moderately high and uniform, and the nights are cold. Nighttime temperatures depend largely on the topography, but air drainage is more important than elevation. The lowest readings, from −40° to −54° F, occur in mountain parks, where the air becomes stagnant. In such localities, there is almost always a temperature inversion during cold spells, and the lowest temperatures are generally confined to lower strata of air below the higher altitudes. The mildest weather during cold spells is found below, or near, the mouths of the larger canyons. The average annual temperature for the area is 32.5° F. December, January, and February are the coldest months. Thundershowers are quite common in the summer and are occasionally accompanied by hail or sleet. Some cold but clear mornings occur during September and October.

In general, summer days are temperate, but frost may occur any night. In Taylor Park, a nighttime low of 22° F and a daytime high of 82° F were recorded in one 24-hour period.

Most precipitation falls in winter and early in spring, and May and October are the months of lowest precipitation. Summer precipitation is mainly in the form of short-duration showers. January, February, and March are the months of heaviest snowfall. There

Figure 5.—**High mountain lakes such as this one provide recreation.**

is a substantial increase in precipitation with increase in altitude. Average annual precipitation at the town of Crested Butte is 23 inches; at Pitkin, 15.7 inches; and in Taylor Park, 18.5 inches.

At the summits of the mountains, the winds are generally from the west and are frequently very strong in winter and spring. The wind removes snow from ridges and exposed areas and deposits it in cirque basins and on the lee sides of cirques and high ridgetops. Drifting and packing of snow contribute to sustained flow of streams and springs because packed snow melts slowly. Snowslides, or avalanches, originate where deep snow accumulates. They cause avalanche scars by removing the timber in their paths and by causing gullies (fig. 6).

The growing season at Crested Butte is 51 days. At elevations above 9,000 feet, as at Pitkin, frost can be expected in every month.

Records for high alpine areas are not available, but annual precipitation in areas above about 11,800 feet is probably more than 30 inches.

Tables 1 and 2 give temperature and precipitation data for the Taylor River Area. Most of these data are from "Climatological Data for Colorado," Annual Summary, 1964. Average dates of killing frosts can be found in the 1941 Yearbook of Agriculture, "Climate and Man."

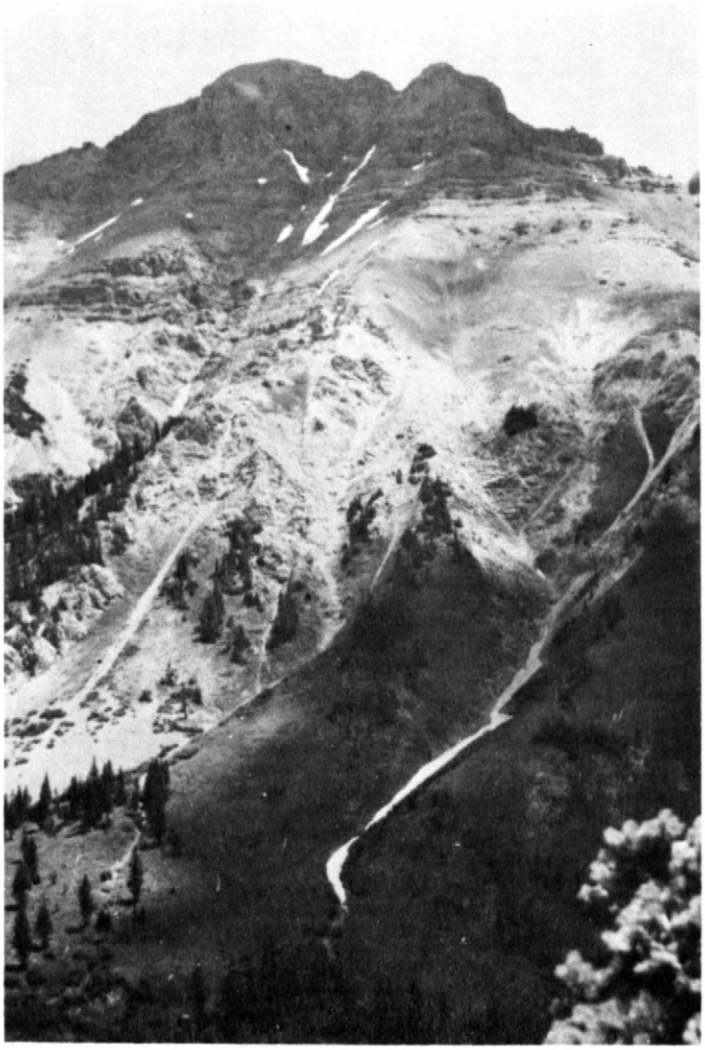

***Figure 6.*—Snowslides in alpine areas cause erosion and destroy timber.**

Vegetation

At the lowest elevations and in open mountain parks, the vegetation is dominantly big sagebrush and grass; this is the mountain bunchgrass zone. This vegetative type occurs between an elevation of about 8,500 feet and the lower edge of the timbered, or montane (intermediate), zone. In Taylor Park, timber begins at an elevation of about 10,000 feet. This zone continues up to the alpine zone, with a subalpine transition zone between. This narrow "bent timber" (Krummholz) belt marks the edge of the true alpine at about 11,800 feet. The alpine zone is the region above timberline. In discussing the vegetative types, it is convenient to refer to altitudinal zones which differ in topography and climate as well as in vegetation.

In alpine areas, the vegetation consists of sedges, grasses, lichens, and forbs with low, shrubby patches of alpine willows in moist depressions. Widely different plant communities occupy the alpine turf (the dry type), the alpine meadow (the wet type), and the alpine bogs. The alpine turf is made up of well drained soils with a dense, tough sod dominated by sedges and forbs. The alpine meadow type generally has less bare soil, and the sod is not so dense and tough as that of the turf. The meadow type generally has a lower percentage of grasses than the alpine turf. Species common to these two vegetative types include sedges, carex elynoides, and others. Grasses include Scribner wheatgrass, spike trisetum, alpine poa, and tufted hairgrass. In many places, forbs dominate, and some of the principal species include avens, alpine clover, sandwort, alpine dryad, and stonecrop. The principal shrub is alpine willow, which is the dominant plant in the alpine bog areas.

The "bent timber," or Krummholz, consists of stunted spruce and other conifers and is at an elevation of approximately 11,500 to 11,800 feet. Langenheim (*6*) considers patches of dwarfed trees, or Krummholz, as merely the upper outposts, or cripple line, of the forest; she defines timberline as the upper limit of normally developed trees. Engelmann spruce is the most common dwarfed tree and extends higher than any other in the Crested Butte area (*6, 7*). The trees of this narrow belt are dwarfed as a result of strong winds and blowing ice crystals.

The lower boundary of the subalpine zone is rather difficult to define. However, above Tincup it begins at about 10,700 feet, and in the vicinity of Crested Butte, at an elevation of about 9,500 feet. The spruce-fir vegetative type is associated with this zone, although the two species extend to much lower elevations along streams. The two species are Engelmann spruce and subalpine fir. In this Area, lodgepole pine or spruce-fir grow at elevations of about 11,000 feet and below.

TABLE 1.—*Temperature*

Station	Length of record	January average	July average	Maximum	Minimum	Last killing frost in spring	First killing frost in fall	Growing season (32° F)
	Years	*°F*	*°F*	*°F*	*°F*	*Date*	*Date*	*Days*
Crested Butte	45	13.5	58.0	95	−42	July 2	August 22	51
(Near) Gunnison	60	11.4	62.3	105	−47	June 21	August 31	71
Pitkin	2	7.9	56.8	-----	------	----------	----------	----
Taylor Park	24	6.1	58.3	----	------	----------	----------	----

TABLE 2.—*Precipitation*

Month	Crested Butte (61-year record)	(Near) Gunnison (71-year record)	Pitkin (57-year record)	Taylor Park (24-year record)
	Inches	*Inches*	*Inches*	*Inches*
January	2.68	0.97	1.45	0.50
February	2.56	.98	1.36	.55
March	2.36	.81	1.41	2.35
April	1.73	.80	1.41	1.35
May	1.31	.76	1.15	1.10
June	1.43	.78	.91	.90
July	1.95	1.47	1.86	2.15
August	2.27	1.46	1.82	3.00
September	1.66	.89	1.23	.85
October	1.43	.72	1.00	.05
November	1.52	.60	.89	2.00
December	2.10	.76	1.19	3.65
Year	23.00	11.00	15.68	18.45

Engelmann spruce and subalpine fir differ somewhat in their life cycles. The low reproductive rate of spruce is compensated by low mortality. Fir, with a high reproductive rate, also has a high mortality and thus takes a subordinate place in mature stands (*6*). The understory characteristically consists mainly of whortleberry, currant, and gooseberry. Vaccinium may occupy 40 percent or more of the ground surface in the understory. Some bristle cone pines are found on shallow soils and rocky ridges.

In the montane zone, which occurs between the subalpine and foothills zones, the dominant vegetation is lodgepole pine. Most stands of lodgepole pine include patches of quaking aspen, particularly in burned-over areas. Scattered Engelmann spruce, subalpine fir, and Douglas-fir are common. Lodgepole pine occurs mainly between elevations of 8,500 and 10,700 feet in this Area, except in high mountain parks that are "frost pockets" and that have grassland vegetation to an elevation of about 10,000 feet. The lodgepole pine type of forest includes many grassy openings, many of which are the result of past fires. The understory of lodgepole pine is scant, and the most common understory plants are kinnikinnick, twinflower, whortleberry, peavine, and lupines. There are scattered myrtle and prostrate juniper.

The mountain bunchgrass zone, dominated by Thurber fescue and sagebrush, is at the lowest elevations and has been called the foothills zone by some. The mountain bunchgrass climax community is identified by the dominance of Thurber fescue among the grasses, but big sagebrush is more commonly dominant. In the Crested Butte area, big sagebrush makes up an average of 33 percent of the cover, and Thurber fescue, 6 percent (*6, 7*). The composition of the plant community varies widely. Some areas have very little or no big sagebrush, and Thurber fescue dominates. In Taylor Park the plant community is in the Wyoming bunchgrass zone; the characteristic plant composition is Idaho fescue, slimstem muhly, junegrass, stonecrop, herbaceous cinquefoil, yellow owl clover, Jacobs-ladder, pussytoes, and big sagebrush.

Within the mountain bunchgrass zone and extending up most drainageways are the dry meadow and wet meadow types. Tufted hairgrass, shrubby cinquefoil, silver sagebrush, Kentucky bluegrass, slender wheatgrass, redtop, and sedges are principal plant species in the dry meadow type. Willows, tall sedges, rushes, meadow barley, tufted hairgrass, brookgrass, and other species characterize the wet meadow type.

Lodgepole pine, aspen, and grassland types replace burned spruce-fir in the Area. There are many areas in which aspen and grass have been released in burned conifer stands and appear as secondary successions.

Few historical data are available concerning burns in this Area, except that no major fires have occurred since the establishment of Gunnison National Forest in 1905. Ring counts of the largest trees now growing on the burned area indicate that most of the fires occurred approximately 55 to 65 years ago (*6*).

Some burned areas have very shallow soils, which indicates that considerable erosion occurred between the time of the burn and the time of reestablishment of a vegetative cover. Charcoal in many soil profiles indicates that the vegetation in much of the area has been burned. On fine-textured soils, such as those developed from limestone, grasses tend to come in on burned areas and prevent the establishment of tree seedlings.

Some relationships between vegetation and environ-

mental factors, some of which agree with Retzer's (*12*) observations in the Fraser Alpine Area are:

(1) Tree regeneration following burns is extremely slow near timberline.
(2) Timber is more easily reestablished following burns on coarse-textured soils, such as those derived from granite, while fine-textured soils tend to revegetate with grass.
(3) Thick, dark-colored surface soils form in burn areas where grass and aspen have replaced conifers.
(4) Regeneration in stands of lodgepole pine is about 50 percent spruce in many places.
(5) Lodgepole pine does not grow well on such well drained soils as Teoculli soils.
(6) Gophers have been active in soils that formed in alluvial-colluvial materials under grass, and their activities have helped create dark-colored surface layers as much as 24 inches thick. The grass in these areas has been replaced by forbs.
(7) Preliminary studies of well drained alpine soils suggest a relationship between herbage yield and effective rooting depth as related to soil depth.

Wildlife

There is an abundance of big game, small animals, birds, and fish in the Taylor River Area. Data for the Taylor River Area are not available, but the 1963 estimate of big game in Gunnison County was 33,500 mule deer, 7,800 elk, 1,050 black bear, and 170 bighorn sheep. Game birds include several species of grouse. There are many songbirds, hawks, and eagles. Fish are plentiful in streams, lakes, reservoirs, and beaver ponds. Trout is the favorite game fish, although the Taylor Reservoir has Kokanee salmon.

Areas above timberline are summer range for elk. Mule deer are found in increasing numbers throughout the timbered parts of the Area. The Taylor River Area, however, is too high for winter range for deer.

Beaver are plentiful in the area, particularly along Willow Creek, Cow Creek, Sanford Creek, and Texas Creek. They move from area to area according to the availability of the food supply. There are many abandoned and silted-up beaver ponds along Lottis Creek.

The several species of grouse in the area have distinct habitat preferences. Ptarmigan are at or above timberline. Blue and Franklin grouse inhabit the timber in the montane zone. The sage grouse inhabits the sagebrush-grass vegetative types in the foothills zone.

Furbearing animals include badger, weasel, mink, marten, red fox, bobcat, coyote, skunk, and beaver. Other animals include chipmunk, marmot, golden-mantled and Richardson ground squirrels, pine squirrel, pika, pocket gopher, and several species of forest mice.

The pocket gopher is a destructive rodent quite common in the Area. Its habitat is grassland areas. Pocket gophers eat the roots and fleshy underground parts of many herbaceous plants, shrubs, and some trees. In places where they are abundant, the soil surface is marked by many mounds and by areas of bare soil.

People and Their Use of the Land

Two early explorers to visit the area of Gunnison County were Captain Juan Maria de Rivera (1775) and Padre Francisco Escalante (1776). They were both Spanish explorers from Sante Fe. Captain John Gunnison led a party of U.S. War Department topographical engineers through the Area in 1853 seeking a central route for a railroad from the Mississippi River to the Pacific Ocean.

Stockmen and farmers came in 1872. In 1878, the discovery of gold-bearing areas near what is now Tincup and of bituminous coal near Crested Butte started the major influx of people. The discovery of gold and silver and the arrival of prospectors started the town of Tincup in 1878. In the next two years, five other towns were founded, and by 1882 the Area had a population of 4,000. Tincup is the only town remaining. Crested Butte, near the Taylor River Area, was founded in 1879, and the towns of Irwin, Pittsburg, and Gothic sprang up as boomtowns. These towns were mainly supported by gold and silver mines, and when the ore diminished, Irwin and Pittsburg declined. The ghost town of Gothic is now the location of the Rocky Mountain Biological Laboratory.

Ranching followed mining, and large herds of cattle were grazing the Area by 1900. Cattlemen grazed their cattle as they saw fit, and records show 8,000 head of cattle in Taylor Park alone in 1910.

There have been no large timber harvests or fires in the Area during the past 50 years, but the stumps from old logging operations and scars of large fires are still evident. Many of these old fire scars have naturally reforested to stagnated stands of lodgepole pine, while others are still barren.

Some of the early mines were large operations, and these operations brought about the construction of numerous trails. These trails have created zone erosion problems, but they provide access to areas that would be otherwise isolated.

History has left its scars. Past land uses and abuses still present problems in resource management. Most of the commercial timber lands were cut or burned over during the late 1800's or early 1900's. The result is that many acres of irregular stands of overmature spruce-fir and lodgepole pine timber missed by the fires are surrounded by extensive stands of pole-sized timber. The remaining sawtimber is well over 200 years old. Some is 400 years old and is stagnated and diseased. The pole stands are mainly lodgepole pine with so many stems per acre that most have stagnated for the past 30 years.

Past overgrazing has left eroded areas as scars and possibly has encouraged undesirable invaders. Most of the ranges are now grazed within their production capacities. Taylor Park, the largest range in the Area, has a low production capacity and many management problems.

The Taylor River Area is used for commercial timber, grazing, and recreation. The acreage devoted to farming is small and is limited to irrigated pastures and haylands associated with ranching. Recreational uses are rapidly increasing, but these uses are not always compatible with other uses.

Soil Associations

The general soil map at the back of this survey shows, in color, the soil associations in the Taylor River Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It generally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the overall potential of the Area, who want to compare different parts of the Area, or who want to know the best uses of large tracts of land. Perhaps the greatest value is for broad land management planning, such as aiding multiple use planning and the determination of management direction. Soil capabilities would be involved in deciding whether an area should be managed, for example, for timber production or for herbage production, or for both. General soil maps are not suitable for detailed project planning.

The soils and miscellaneous land types mapped in the survey area have been placed into 7 soil associations, each named according to the soil series or land types that dominate the association. Numbers preceding the names of associations in the text correspond to soil association numbers on the map. The individual soils in the Area are described in Part II of this survey.

Soil behavior characteristics form the basis for technical interpretations and suitabilities for various uses, potentials for different uses, management direction, and management response and requirements. These interpretations form the connection between the soil survey and land use planning and management.

The significance of soil properties depends on the intended use of the soil, because all soils are not equally suitable for all uses. For example, a soil with a high lime content at a depth of 15 inches may be well suited to range plants but poorly suited to ponderosa pine.

Soil interpretations do not dictate the use of the soil; they only evaluate their relative potential. Soil associations can be used for broad management planning. Within each soil association, the management requirements and the suitabilities of the dominant soils or miscellaneous land types determine the general, or overall, direction of management. Individual soils within any one soil association area may differ markedly from other soils in the association regarding use suitability and management requirements. However, characteristics of certain soils or land types dominate in determining use suitabilities and management consideration for the association as a whole.

Following are descriptions of each soil association and its suitabilities, potentials, limitations, and other information pertinent to its management. The descriptions of some associations have been combined where their management requirements are similar. Tables 3 and 4 show, respectively, major characteristics of each soil association and the suitability of each association for several uses.

TABLE 3.—*Major characteristics of soil associations*

Soil associations	Percentage of survey area	Component soils		Parent material	Pattern of soils	Vegetation zone	Landform and relief
		Series and land types	Percent of association				
1. Rock land-Rock outcrop-Rock slides association.	19.1	Rock land Rock outcrop Rock slides Stony rock land Stony colluvial land	44 30 20 4 2	Mixed rock types.		All	Serrate ridges, horns, and canyon walls. Steep.
2. Mirror-Haverly-Vasquez association.	9.6	Almont Cryaquolls and Histosols Doct Haverly-Vasquez Mirror Ptarmigan Rock land and Rock outcrop	1 44 8 9 25 7 6	Limestone, shale granite, gneiss, and schist.	Complex	Alpine	Cirques, colluvial slopes, and ridges. Steep and moderately sloping.
3. Teoculli-Cabin-Pierian association.	3.4	Alluvial land Cabin Charlos Mysten Pierian Teoculli	6 25 12 6 21 30	Mixed alluvial and glacial material.	Simple, uniform.	Sagebrush-grass.	Moraines, terraces, and swales. Gently sloping and nearly level.
4. Schofield-Tex-Stecum association.	38.0	Dinnen Leal Matcher Rarick	6 7 5 3	Residuum from granite, glacial moraines.	Complex	Lodgepole pine, spruce-fir.	Mountain slopes, ridges, glacial troughs, and

TABLE 3.—*Major characteristics of soil associations*—Continued

Soil associations	Percentage of survey area	Component soils: Series and land types	Component soils: Percent of association	Parent material	Pattern of soils	Vegetation zone	Landform and relief
4. Schofield-Tex-Stecum association—cont.		Rock land-Rock outcrop	9				moraines. Moderately and steeply sloping.
		Schofield-Peeler	32				
		Stecum	14				
		Supervisor	2				
		Tabernash	1				
		Tellman	1				
		Tex	15				
		Tine	1				
		Tomichi	4				
5. McIntyre-Kebler-Sanford association.	13.2	Emerald	2	Residuum from sandstone, schist, and gneiss.	Complex	Spruce-fir and sagebrush-grass.	Foothills, mountain slopes, ridges, and valleys. Moderately and gently sloping.
		Eyre	4				
		Gothic	1				
		Jenkins	7				
		Kebler	15				
		Landslides and Gullied land	12				
		Lucky	13				
		Mayoworth	12				
		McIntyre	17				
		Rock land and Rock outcrop	1				
		Sanford	14				
		Tongue River	2				
6. Bassel-Bucklon association.	2.5	Bassel	43	Residuum-colluvium from shale, glacial moraines.	Simple	Grass parks and spruce-fir.	Foothills and mountain slopes. Moderately sloping.
		Bucklon	41				
		Leaps	10				
		Shale rock land	6				
7. Ashcroft-Limber-Tilton association.	14.2	Ashcroft	31	Residuum from Maroon conglomerate and limestone.	Complex	Spruce-fir	Slopes of mountain valleys. Moderately sloping and steep.
		Hierro	2				
		Judy	10				
		Lamphier	5				
		Limber	18				
		Rock land and Rock outcrop	12				
		Sawcreek	7				
		Tilton	15				

TABLE 4.—*Relative suitabilities of soil associations for selected uses*

Soil associations	Dominant characteristics: Landscape	Dominant characteristics: Soil	Suitabilities for [1]— Herbage [2]	Timber [3]	Water [4]	Recreation [5]	Wildlife: Deer	Wildlife: Fish
1. Rock land-Rock outcrop-Rock slides association.	Precipitous, rocky, sparsely vegetated.	Very thin or absent.	Very poor.	Poor	High	Good	Good	Fair.[6]
2. Mirror-Haverly-Vasquez association.	Steep, stony, alpine meadows and turf areas. Granite and gneiss.	Dark, shallow, well drained and somewhat poorly drained.	Good	Very poor	High	Fair	Poor [7]	Very poor.

TABLE 4.—*Relative suitabilities of soil associations for selected uses*—Continued

Soil associations	Dominant characteristics		Suitabilities for [1]—				Wildlife	
	Landscape	Soil	Herbage [2]	Timber [3]	Water [4]	Recreation [5]	Deer	Fish
3. Teoculli-Cabin-Pierian association.	Nearly level outwash to hummocky moraines. Grassland.	Dark, sandy, well drained to mucky.	Fair	Very poor	Medium	Excellent	Fair	Excellent.
4. Schofield-Tex-Stecum association.	Hilly to steep, highly dissected. Lodgepole pine. Intermediate zone. Granite and glacial.	Light-colored soils low in organic matter and well drained.	Poor to fair.	Fair	High	Excellent	Good	Excellent.
5. McIntyre-Kebler-Sanford association.	Rolling to steep grasslands. Some aspen. Gneiss, schist, sandstone, and shale.	Dark, shallow to medium depth, well drained.	Fair	Poor	Low	Good	Good	Good.
6. Bassel-Bucklon association.	Sloping to steep, unstable shales. Mixed Engelmann spruce, aspen, and grasslands.	Dark, fine-textured, very erodible, shallow to deep.	Good	Fair	Medium	Excellent	Fair	Fair.
7. Ashcroft-Limber-Tilton association.	Hilly to steep, limestone and Maroon conglomerate. Mainly Engelmann spruce.	Dark, very friable with reddish subsoil and substratum. Well drained.	Good	Good	High	Good	Good	Good.

[1] In relation to other soil associations in the Taylor River Area.
[2] Appraisals based on plant communities in good to excellent condition.
[3] Lodgepole pine.
[4] Appraisals based on total water yield. For example, rocky alpine areas have soils with poor hydrologic characteristics but yield much water due to snow accumulations and slow rate of melt.
[5] Development sites and dispersed recreation.
[6] Taylor River passes through a part of this association, but other parts of the association are poor for fishing.
[7] Summer range for elk.

1. Rock land-Rock outcrop-Rock slides association

Fifty percent or more of the surface of this soil association is covered by barren rock. This association makes up 19.1 percent of the survey area. It is about 44 percent Rock land, 30 percent Rock outcrop, and 20 percent Rock slides. The rest is less extensive areas of Stony rock land, Stony colluvial land, and alpine wind-eroded soils.

The vegetative productivity of this association is very low because there is little or no soil. It is an excellent area for yielding water for sustained flow to springs and streams. The rock slides, or talus, at or near the bases of steep slopes accumulate much

water in the form of ice and snow during winter and release it slowly during spring and summer (fig. 7). There is virtually no runoff after rains because of the many voids between the rocks.

The Rock land-Rock outcrop-Rock slides association is used mainly for water production. The less steep slopes are grazed to some extent, but most slopes are too steep. This association provides the most spectacular scenery in the survey area (fig. 8).

Water production and recreation are the important uses of this association. Maintenance of the existing vegetation is essential for soil protection and for wildlife habitat. The rough, rugged terrain provides cover, concealment, and escape routes for big game. It has great esthetic value for sightseeing, and many trails follow the lower edges of Rock slides and other rocky areas.

2. *Mirror-Haverly-Vasquez association*

Well drained and poorly drained, shallow and moderately shallow soils in glaciated alpine areas along and adjacent to the Continental Divide and on Matchless Mountain

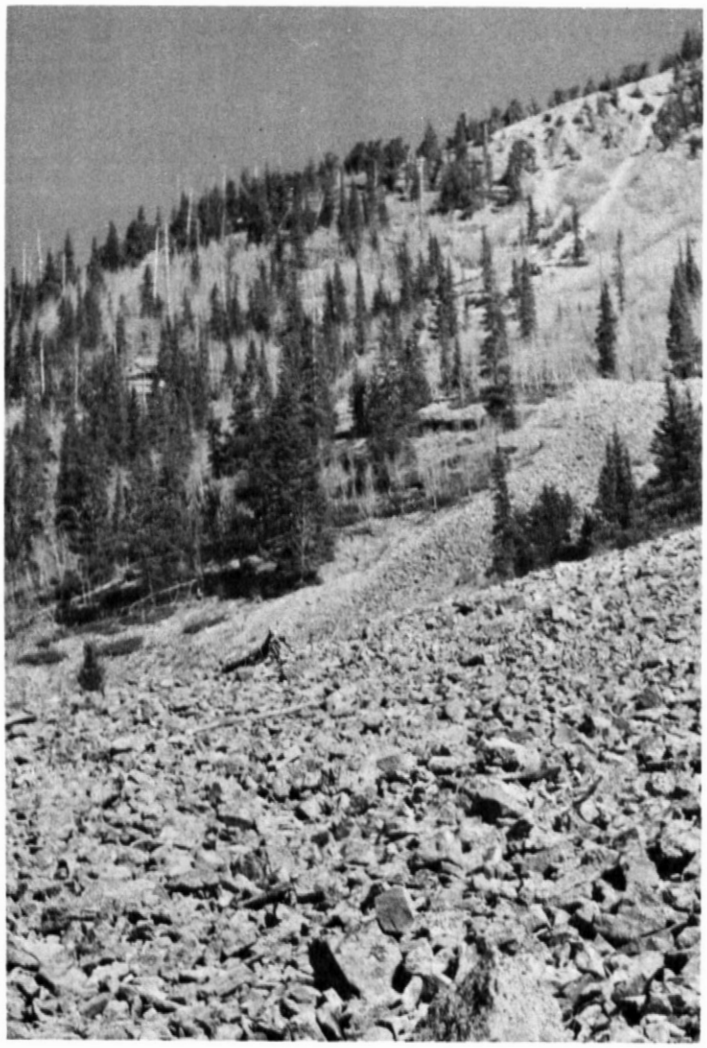

Figure 7.—This area of Rock slides at a high elevation takes in surface water and stores it for slower subsurface release.

This soil association is at elevations of 11,800 to more than 13,000 feet. Slope gradients range from less than 5 percent in cirque basins to 35 to 70 percent in the rest of the association. Vegetation consists of alpine sedges, grasses, forbs, and bushes. This association makes up about 54,000 acres, or 9.6 percent of the survey area. It is about 44 percent Cryaquolls and Histosols, 25 percent Mirror soils, 9 percent Haverly-Vasquez soils, and 8 percent Doct soils. The rest is less extensive areas of Ptarmigan and Almont soils and Rock land and Rock outcrop.

These soils formed in material weathered from limestone, shale, granite, and schist. The Mirror and Doct soils are well-drained alpine turf soils on ridgetops and steep mountainsides. Haverly, Vasquez, and Almont soils are poorly drained alpine meadow soils. Cryaquolls and Histosols also are poorly drained.

Water production, recreation, wildlife, and grazing are the important uses of this soil association. Precipitation occurs mainly as snow in alpine areas, but high winds remove most of the snow from the soils and deposit it in cirques, on the lee sides of alpine rims, and in talus deposits. Little can be done to increase the yield of water other than constructing snow barriers and greatly limiting or restricting use of these areas by livestock. Some areas are so steep that grazing by livestock should be prohibited. This helps improve vegetative cover and reduce erosion.

The area has high esthetic value for dispersed recreation use. These alpine areas are summer range for big game, particularly elk. Most lakes in the association are glacial lakes at the bases of cirques near the subalpine zone. Some of the deeper lakes provide fishing. This area is moderately well suited to herbage production, but grazing is detrimental to other uses.

3. *Teoculli-Cabin-Pierian association*

Well drained and excessively drained, deep soils on depositional landforms

This soil association occupies areas of glacial moraines and outwash and alluvium in Taylor Park and Union Park and along Quartz and Gold Creeks (fig. 9). Slopes are less than 25 percent. Vegetation consists of sagebrush and bunchgrasses on the better drained soils and bluegrass, potentilla, and willow on the less well drained soils. The association makes up about 19,000 acres, or 3.4 percent of the survey area. It is about 30 percent Teoculli soils, 25 percent Cabin soils, and 21 percent Pierian soils. The rest is less extensive areas of Charlos and Mysten soils and Alluvial land.

The Cabin, Charlos, Mysten, and Pierian soils are well-drained and somewhat excessively drained soils on glacial deposits. Teoculli soils, which are well drained, and Alluvial land, which is poorly drained, are on bottom lands.

Grazing and recreation are the important uses of this soil association. Cattle tend to concentrate on Teoculli soils and Alluvial land and often trample the soil. The soils on glacial deposits have slight limitations for construction of campgrounds, but they are

Figure 8.—Area of Rock land-Rock outcrop-Rock slides association. In the foreground is an area of the Schofield-Tex-Stecum association.

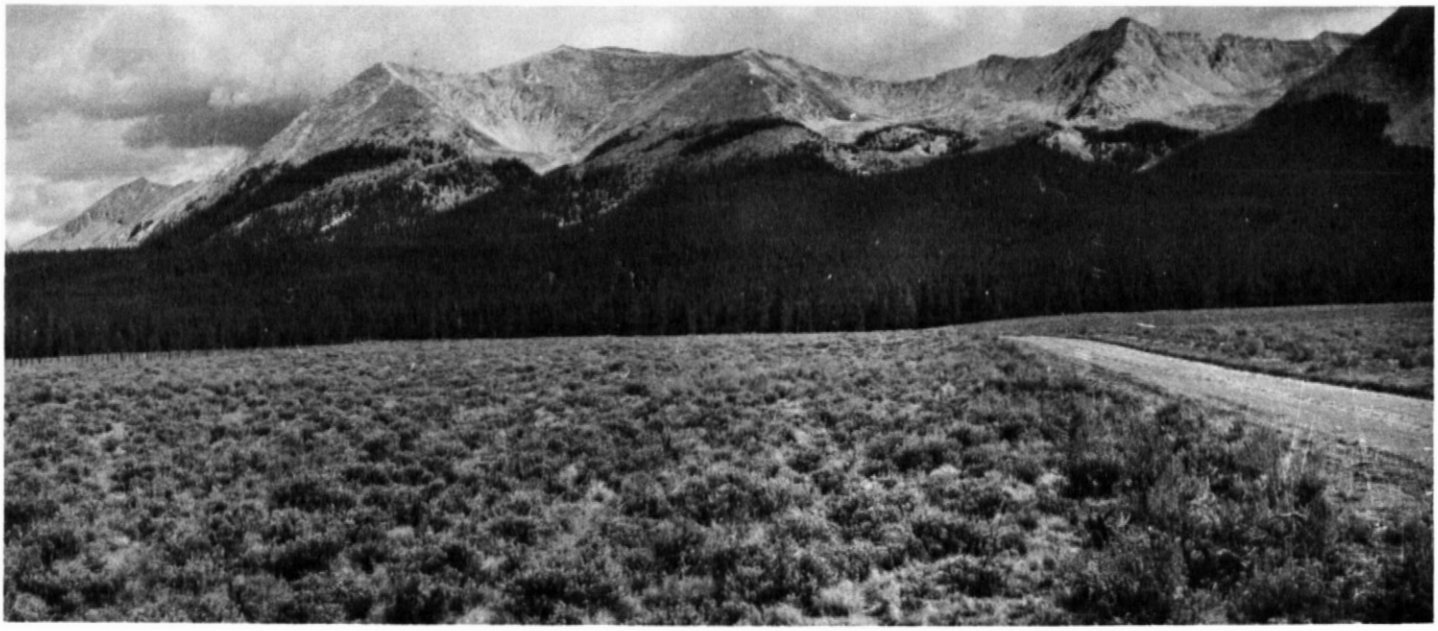

Figure 9.—Teoculli-Cabin-Pierian soil association in foreground; Elk Mountains, background.

droughty and have severe limitations to the establishment of vegetation.

All of the soils have high infiltration rates, are moderately to highly permeable, and are deep to bedrock. Therefore, they have a high capacity for storing detention water for sustained water yield. Precipitation is limited, so most of the water comes from higher areas.

4. *Schofield-Tex-Stecum association*

Well drained and somewhat excessively drained, moderately shallow and deep soils on glacial moraines and valley sides

This soil association occupies extensive areas in the montane zone in the eastern part of the survey area. The landform is hummocky glacial moraines flanked by moderately steep to steep mountain ridges and valleys. Vegetation is mainly lodgepole pine and Engelmann spruce. This association makes up about 215,000 acres, or 38 percent of the survey area. It is about 32 percent Schofield-Peeler soils, 15 percent Tex soils, and 13 percent Stecum soils. The rest is less extensive areas of Leal, Dinnen, Matcher, Tomichi, Rarick, Supervisor, Tabernash, Tellman, and Tine soils and Rock land and Rock outcrop.

Timber and water production are the important uses of this soil association. Recreation is an important use, and the association is well suited to sightseeing, camping, fishing, hunting, and hiking.

5. *McIntyre-Kebler-Sanford association*

Well drained, moderately deep soils on foothills and lower mountains

This association occupies areas of foothills and lower mountains in the southwestern part of the survey area between lower Brush Creek and the town of Pitkin. Elevation ranges from 9,000 to 10,000 feet. Slope gradients are mostly 5 to 20 percent, but are as much as 65 percent or more in the steep valleys. Vegetation is sagebrush-grass and spruce at the higher elevations. This association makes up about 74,724 acres, or 13.2 percent of the survey area. It is about 17 percent McIntyre soils, 15 percent Kebler soils, and 14 percent Sanford soils. The rest is less extensive areas of Lucky, Mayoworth, Jenkins, Eyre, Emerald, Tongue River, and Gothic soils, Landslides and Gullied land, Rock land, and Rock outcrop.

The soils formed in shale, sandstone, and metasedimentary material. Lucky and Sanford soils formed in material weathered from gneiss or schist, and Mayoworth, Kebler, and Eyre soils formed in material weathered from sandstone and shale. Kebler and Sanford soils formed under timber and have a thin surface layer underlined by a leached, light-colored subsurface layer. Mayoworth, Lucky, and Eyre soils formed under sagebrush-grass vegetation and have a darker and thicker surface layer. Bedrock is at a depth of about 20 to 40 inches.

Important uses of these soils are timber, forage, and winter game range. The shallow, stony soils produce bitterbrush and other browse plants. Some soils of this association are in timber, and although the site indices are low, timber is still the best use. This association is not a good water producer. Little snow accumulates on the grassy westerly and southerly exposures in winter, and it is soon melted. The soils are shallow in many places, so the area has a low capacity for storing water.

6. *Bassel-Bucklon association*

Well drained, shallow and deep soils that formed in glacial deposits, shale residuum, and colluvium

This association is in the East River valley between Schofield Pass and the Forest boundary. The moraines and colluvial areas are gently sloping, and the residual areas are steep. Vegetation consists of grass, sagebrush, and spruce. The total area is about 14,150 acres, or 2.5 percent of the survey area. It is about 43 percent Bassel soils and 41 percent Bucklon soils. The rest is less extensive areas of Leaps soils and Shale rock land.

This is an association of soils with dark-colored surface horizons. Bassel soils formed in glacial moraine deposits of mixed origin, Bucklon soils formed in residuum from shale, and Leaps soils formed in colluvial-alluvial foot slope deposits of shale origin. Bassel soils have a sandy clay loam subsoil, and Bucklon and Leaps soils have no textural subsoils—the surface soil directly overlies the parent material. The surface layer is deep and generally about 12 inches thick. The soils range from nearly neutral to moderately alkaline in reaction.

Runoff is rapid because the soils are shallow and slowly permeable, so the area rates rather low for water detention for sustained water yield. The soils are very erodible, and disturbing the vegetation can create sedimentation.

This association is used mainly for timber production, range, and recreation. Other important uses are for wildlife and water production. Recreation is becoming increasingly important in the Bassel-Bucklon soil association. In addition to the summer recreation that existed heretofore, it is becoming a winter sports area. Grazing and timber harvesting, unless strictly regulated, are not compatible with other uses.

7. *Ashcroft-Limber-Tilton association*

Well drained, moderately shallow and deep soils that formed mainly in material weathered from limestone and Maroon conglomerate

This soil association is in steeply sloping areas between Doctor Park and Cement and Brush Creeks. It makes up about 80,300 acres, or 14.2 percent of the survey area. It is about 31 percent Ashcroft soils, 18 percent Limber soils, 15 percent Tilton soils, and 10 percent Judy soils. The rest is less extensive soils in the Sawcreek, Lamphier, and Hierro series, Cryaquolls and Histosols (muck and peat), and Rock land and Rock outcrop.

Ashcroft soils formed under conifers, and Sawcreek soils formed under grass and scattered quaking aspen. Limber and Judy soils formed in material weathered from limestone—Limber soils mainly under Engelmann spruce and subalpine fir, and Judy soils in open, parklike areas surrounded by Engelmann spruce. Depth to bedrock ranges from 20 to 40 inches in most places.

This soil association is used for timber production, grazing, and recreation, especially camping, sightseeing, and fishing. Many areas now in grass and quaking aspen were once in coniferous forest that was destroyed by fire. The better sites on northerly and easterly slopes are suitable for replanting to trees. Grasses grow well in some areas, but these areas are small and widely scattered, so in most cases it is not feasible to graze them.

Because the Maroon Formation is highly permeable, there are many springs in the Area, and the Cement Creek Watershed is perhaps the best water yielder in the Area. Soils in limestone areas have a less permeable subsoil and substratum, so they do not have the storage capacity for water.

The perennial streams with their fishing possibilities and spectacular beauty make these areas very desirable for recreation. Unfortunately, suitable areas for campgrounds are difficult to locate in mucky areas or narrow, steep valleys.

Part II: The Soils

In order to obtain the basic information for this survey, soil scientists examined the soils to determine the characteristics of the surface soil, the subsoil, and the substratum. Then they delineated the extent of each kind of soil on aerial photographs. The soils were classified on the basis of information obtained during the survey and from data obtained by physical and chemical analyses in the laboratory.

In the following discussion of the soils in the Area, the observable and inferred characteristics of the individual soils are given. It should be understood, however, that no specific management is suggested.

Descriptions of the Soils

In this soil survey, the following kinds of mapping units were mapped: soil phases, soil complexes, and miscellaneous land types (*10*). Charlos sandy clay loam, 5 to 25 percent slopes, eroded, is a phase; Haverly-Vasquez loams, 5 to 25 percent slopes, is a complex; and Rock land is a miscellaneous land type.

In the following descriptions of the soils and miscellaneous land types, information considered of value to the forest manager is presented. Unless otherwise stated, color terms are for dry soil. In addition to the characteristics of the various mapping units, information is presented regarding their positions on the landscape, suitabilities and limitations for various uses, susceptibility to erosion and windthrow, and limitations for engineering uses and other uses are noted. The management considerations for various uses are discussed. From the information given, soil suitabilities for other uses, or responses to management systems considered in this survey, can be inferred to a reasonable degree.

Table 5 shows the approximate acreage and proportionate extent of the soils in the Taylor River Area.

TABLE 5.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent	Soil	Acres	Percent
Alluvial land	1,280	0.2	Lamphier loam, 5 to 45 percent slopes	3,971	.7
Almont silt loam, 10 to 70 percent slopes	485	.1	Landslides and Gullied land	244	(1)
Ashcroft sandy loam, 5 to 25 percent slopes	2,380	.4	Leal gravelly loamy sand, 5 to 25 percent slopes	1,832	.4
Ashcroft sandy loam, 25 to 60 percent slopes	22,270	3.9	Leal gravelly loamy sand, 25 to 60 percent slopes	12,258	2.2
Bassel sandy loam, 0 to 25 percent slopes	3,230	.6	Leaps silty clay loam, 5 to 45 percent slopes	1,344	.2
Bassel sandy loam, 25 to 60 percent slopes	2,930	.5	Limber gravelly loam, 5 to 25 percent slopes	3,870	.7
Bucklon silt loam, 15 to 75 percent slopes	5,865	1.0	Limber gravelly loam, 25 to 70 percent slopes	10,605	1.9
Cabin sandy loam, 0 to 3 percent slopes	1,090	.2	Lucky gravelly sandy loam, 5 to 25 percent slopes	3,128	.6
Cabin sandy loam, 3 to 25 percent slopes	3,688	.7	Lucky gravelly sandy loam, 25 to 65 percent slopes	6,575	1.2
Charlos sandy loam, 0 to 25 percent slopes	1,890	.3	Matcher stony sandy loam, 5 to 25 percent slopes	2,443	.4
Charlos sandy clay loam, 5 to 25 percent slopes, eroded	305	(1)	Matcher stony sandy loam, 25 to 60 percent slopes	5,621	1.0
Cryaquolls	1,090	.2	Matcher very stony sandy loam, 5 to 45 percent slopes	2,810	.5
Cryaquolls and Histosols	22,760	4.0	Mayoworth loam, 15 to 60 percent slopes	9,287	1.6
Dinnen sandy loam, 2 to 60 percent slopes	8,300	1.5	McIntyre loam, 5 to 25 percent slopes	9,483	1.6
Dinnen stony sandy loam, 5 to 60 percent slopes	4,460	.8	McIntyre loam, 25 to 65 percent slopes	3,201	.6
Doct silt loam, 10 to 25 percent slopes	1,520	.3	Mirror gravelly sandy loam, 10 to 25 percent slopes	2,566	.5
Doct silt loam, 25 to 70 percent slopes	2,566	.4	Mirror gravelly sandy loam, 25 to 70 percent slopes	11,197	2.0
Emerald sandy clay loam, 5 to 45 percent slopes	1,894	.3	Mysten loamy fine sand, 0 to 25 percent slopes	1,160	.2
Eyre sandy loam, 15 to 70 percent slopes	3,299	.6	Pierian stony sandy loam, 0 to 3 percent slopes	1,710	.3
Gothic fine sandy loam, 5 to 40 percent slopes	916	.2	Pierian stony sandy loam, 3 to 35 percent slopes	1,507	.3
Haverly-Vasquez loams, 5 to 25 percent slopes	2,260	.4	Pierian sandy loam, 0 to 3 percent slopes	753	.1
Haverly-Vasquez loams, 25 to 70 percent slopes	2,260	.4	Ptarmigan loam, 15 to 70 percent slopes	3,849	.7
Hierro loam, 5 to 45 percent slopes	1,710	.3	Rarick loam, 10 to 60 percent slopes	5,590	1.0
Jenkins gravelly loam, 15 to 60 percent slopes	5,640	1.0			
Judy silty clay loam, 5 to 25 percent slopes	1,710	.3			
Judy silty clay loam, 25 to 60 percent slopes	5,888	1.0			
Kebler sandy loam, 5 to 25 percent slopes	3,740	.7			
Kebler sandy loam, 25 to 60 percent slopes	7,200	1.3			

TABLE 5.—*Approximate acreage and proportionate extent of the soils*—Continued

Soil	Acres	Percent	Soil	Acres	Percent
Rock land	65,150	11.5	Teoculli loam, 0 to 25 percent slopes	5,804	1.0
Rock outcrop	44,989	8.0	Tex gravelly sandy loam, 5 to 25 percent slopes	8,036	1.4
Rock slides	30,773	5.4	Tex gravelly sandy loam, 25 to 60 percent slopes	12,380	2.2
Sanford fine sandy loam, 15 to 65 percent slopes	10,020	1.8	Tex very stony sandy loam, 5 to 25 percent slopes	2,025	.4
Sawcreek sandy loam, 15 to 50 percent slopes	5,865	1.0	Tex very stony sandy loam, 25 to 60 percent slopes	10,031	1.8
Schofield-Peeler gravelly sandy loams, 5 to 25 percent slopes	10,814	1.9	Tilton sandy loam, 5 to 25 percent slopes	2,686	.5
Schofield-Peeler gravelly sandy loams, 25 to 60 percent slopes	45,757	8.1	Tilton sandy loam, 25 to 45 percent slopes	9,164	1.6
Schofield-Peeler very stony sandy loams, 25 to 60 percent slopes	13,213	2.3	Tine sandy loam, 0 to 3 percent slopes	1,770	.3
Shale rock land	855	.2	Tine sandy loam, 3 to 30 percent slopes	1,305	.2
Stecum stony sandy loam, 15 to 70 percent slopes	27,204	4.8	Tomichi sandy loam, 0 to 25 percent slopes	1,344	.2
Stecum very stony sandy loam, 25 to 70 percent slopes	1,220	.2	Tomichi sandy loam, 25 to 60 percent slopes	2,505	.4
Stony colluvial land	5,040	.9	Tomichi stony sandy loam, 5 to 25 percent slopes	2,625	.5
Stony rock land	3,360	.6	Tomichi stony sandy loam, 25 to 60 percent slopes	1,645	.3
Supervisor loam, 5 to 25 percent slopes	1,955	.3	Tongue River loam, 5 to 60 percent slopes	1,710	.3
Supervisor loam, 25 to 70 percent slopes	3,482	.6	Total land area	563,653	99.6
Tabernash gravelly loam, 0 to 6 percent slopes	1,280	.2	Water	2,440	.4
Tellman sandy loam, 5 to 45 percent slopes	2,016	.4	Total	566,093	100.0

[1] Less than 0.1 percent.

Alluvial land

Ad—Alluvial land. This miscellaneous land type consists of alluvium that has a wide range in texture and that is subject to frequent changes by stream channel migration. It has remained stable long enough for plants to become established, although the deposits are too recent to exhibit soil development. The soil material is cobbly, stony, and bouldery in places. This unit generally occupies narrow stream bottoms in mountainous areas where stream flow at times is rapid and where the stream gradients are in places more than 30 percent. In cobbly areas, the cobbles are so numerous that walking is difficult. The sparse vegetation consists of big sagebrush, muhly, and fescues.

In a few areas a thin, darker surface layer (A1 horizon) is evident. It was derived, at least in part, from sediment containing appreciable quantities of organic matter.

Although the vegetation, consisting of grass and some scattered trees, is very sparse, areas of alluvial land are grazed by livestock because of its nearness to water. There is little or no erosion as a result of grazing.

Alluvial land is hydrologically important because the deep, permeable material absorbs precipitation and water from springs and melting snow at higher elevations moves through the material below the stream channel. Only a few streams contain trout. A few campgrounds are located on Alluvial land, but it is poorly suited to campsites because of poor trafficability, unsuitability for sanitation structures, and flooding hazard.

Management consists of restricting grazing in order to protect channelbank vegetation and to aid in controlling channel erosion.

Almont series

The Almont series consists of poorly drained, moderately steep to very steep soils that formed in residuum and in colluvial-alluvial material derived from limestone and phylitic shale.

These soils are in basin areas or lower slopes above timberline. Vegetation consists of willows, sedges, and other hydrophytic plants characteristic of high elevations. Elevations range from 11,500 to 12,500 feet. The mean annual precipitation is about 20 inches, and the mean annual soil temperature ranges from 32° to 34° F. Permeability is moderate, and available water capacity is high. Roots can penetrate to a depth of more than 60 inches.

Typically, the surface layer is dark grayish brown silt loam in the upper 8 inches and light olive brown, mottled stony silty clay loam in the lower 5 inches. The subsoil is grayish brown, mottled stony silty clay loam 6 inches thick. The substratum to a depth of 60 inches or more is grayish brown, mottled stony silty clay loam that is 20 to 35 percent limestone rock fragments (fig. 10).

Representative profile of an Almont silt loam having slope of 55 percent at an elevation of 11,700 feet at the head of Cement Creek in sec. 3, T. 13 S., R. 84 W.:

A11—0 to 5 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; strong fine granular structure; soft when dry, very friable when moist; 10 percent limestone flagstones on the surface; pH 6.8; clear smooth boundary.

A12—5 to 8 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; strong fine granular structure; soft when dry, very friable when moist; pH 7.0; gradual smooth boundary.

A13—8 to 13 inches; light olive brown (2.5Y 5/3) stony light silty clay loam, olive brown (2.5Y 3/3) moist; common medium distinct light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure that parts to moderate fine subangular blocky; slightly hard when dry, very friable when moist; a few thin discontinuous clay films on horizontal and vertical ped faces; 15 percent limestone rock fragments; pH 7.2; gradual smooth boundary.

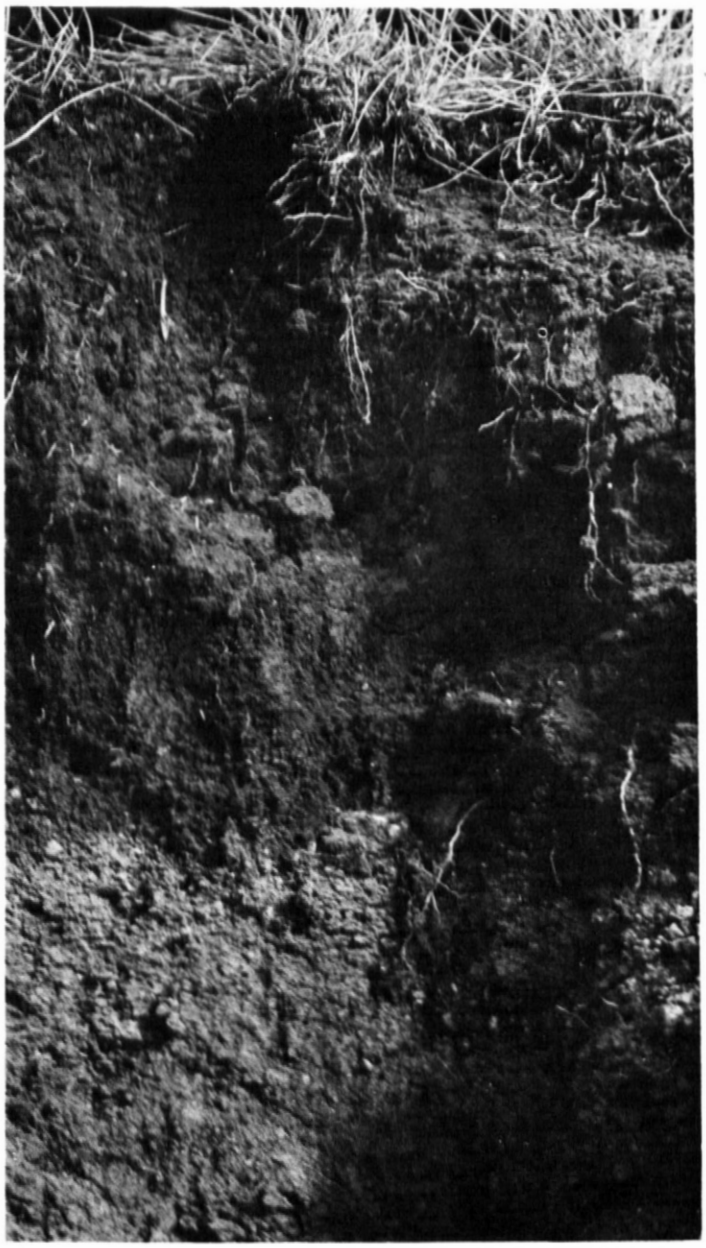

Figure 10.—Profile of Almont silt loam, 10 to 70 percent slopes. Note the thick, dark-colored surface layer and the evidence of wetness in the lower part of the profile.

B2g—13 to 19 inches; grayish brown (2.5Y 5/2) stony light silty clay loam, dark grayish brown (2.5Y 4/2) moist; common medium distinct dark gray (2.5Y 4/1) and dark yellowish brown (10YR 4/4) mottles; weak to moderate medium subangular blocky structure that parts to moderate fine subangular blocky; hard when dry, very friable when moist; approximately 30 percent limestone rock fragments; pH 7.2; gradual smooth boundary.

C1g—19 to 26 inches; grayish brown (2.5Y 5/2) stony silty clay loam, dark grayish brown (2.5Y 4/2) moist; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; hard when dry, very friable when moist; approximately 30 percent limestone rock fragments; pH 7.2; gradual smooth boundary.

C2g—26 to 60 inches; grayish brown (2.5Y 5/2) stony silty clay loam, dark grayish brown (2.5Y 4/2) moist; common medium distinct dark gray (2.5Y 4/1) and yellowish brown (10YR 5/6) mottles; massive; hard when dry, very friable when moist; approximately 35 percent limestone rock fragments; pH 7.0.

Limestone flagstones cover 5 to 20 percent of the soil surface. Limestone rock makes up 15 to 35 percent of the soil material.

AmF—Almont silt loam, 10 to 70 percent slopes. This is the only Almont soil mapped in the survey area. Included in mapping are small areas of Doct silt loam and closely associated Rock outcrop and Rock slides.

Runoff is medium to rapid, depending on slope. The erosion hazard is moderate to high.

This soil is used only for grazing by deer and elk and, to some extent, by sheep and cattle. It is summer range for elk.

This soil is well suited to water yield and herbage production. In addition to the water that seeps from higher alpine areas, appreciable quantities accumulate in this soil as the winter snowpack melts. Although the growing season is short, forage yields on this soil are among the highest in the Area.

Management of this soil involves supervision of grazing to reduce trailing and trampling damage because the soil is soft and moist much of the growing season. High winds that undercut the soil in exposed areas cause a minor amount of soil erosion.

Ashcroft series

The Ashcroft series consists of well drained, sloping to very steep soils that formed in material weathered from Maroon conglomerate under coniferous vegetation.

Ashcroft soils are on a series of sloping benches caused by soil slips. Vegetation is mixed lodgepole pine, Engelmann spruce, and subalpine fir. The mean annual precipitation is about 20 inches, and the mean annual soil temperature is 36° F. Permeability is moderately rapid, and available water capacity is low. Roots can penetrate to a depth of 40 inches or more.

Typically, a 3-inch layer of organic material covers the surface layer of pinkish gray sandy loam about 6 inches thick. The subsoil is reddish brown sandy loam, gravelly sandy loam, and gravelly loamy sand 26 inches thick. It is as much as 25 percent pebbles and cobbles. The substratum is weak red, loose gravelly sand. Hard conglomerate of the Maroon Formation is at a depth of 48 inches.

Representative profile of Ashcroft sandy loam having slope of 38 percent at an elevation of 10,400 feet, east of the junction of Cement Creek Road and Italian Creek Road in sec. 28, T. 13 S., R. 84 W.:

O1—3 inches to 2; undecomposed twigs, bark, and needles.

O2—2 inches to 0; partially decomposed organic material.

A2—0 to 6 inches; pinkish gray (5YR 6/2) sandy loam, dark reddish gray (5YR 4/2) moist; moderate fine granular structure, weak platy structure in places; soft when dry, very friable when moist; vescular when dry; pH 6.0; clear smooth boundary.

B21t—6 to 12 inches; reddish brown (2.5YR 5/3) sandy loam, reddish brown (2.5YR 4/3) moist; weak me-

dium subangular blocky structure that parts to moderate fine granular; slightly hard when dry, very friable when moist; thin discontinuous clay films on horizontal and vertical ped surfaces, clay bridges between sand grains, and clay coatings on sand grains; approximately 15 percent pebbles and cobbles; peds in the upper part of this horizon have gray coatings in places; pH 6.3; clear smooth boundary.

B22t—12 to 26 inches; reddish brown (2.5YR 5/3) gravelly sandy loam, reddish brown (2.5YR 4/3) moist; moderate medium subangular blocky structure that parts to moderate fine subangular blocky; slightly hard when dry, very friable when moist; thin discontinuous clay films on ped surfaces, clay bridges between sand grains, and clay coatings on sand grains; 25 percent pebbles and cobbles; pH 6.5; gradual smooth boundary.

B3—26 to 32 inches; reddish brown (2.5YR 5/3) gravelly loamy sand, reddish brown (2.5YR 4/3) moist; single grained; soft when dry, very friable when moist; few thin discontinuous clay films on some peds, and clay coatings on some sand grains; 20 percent pebbles and cobbles; pH 6.6; gradual smooth boundary.

C—32 to 48 inches; weak red (10YR 5/3) gravelly sand, weak red (10YR 4/3) moist; single grained; loose when dry or moist; 20 percent pebbles and cobbles; pH 6.3; gradual smooth boundary.

R—48 to 52 inches; hard Maroon conglomerate.

Depth to bedrock varies from 40 inches to 10 or 12 feet, but bedrock is at a depth of 4 to 5 feet in most places. Reaction of the solum ranges from pH 6.0 to 7.0. Content of rock fragments ranges from 0 to 35 percent.

AsE—Ashcroft sandy loam, 5 to 25 percent slopes. This soil is characteristically on a series of sloping benches separated by parallel lines of bedrock exposures. Apparently, this is because the interbedded sandstone of the Maroon Formation is more resistant to weathering than the conglomerate. The sandstone forms lines of rock ledges that support the interstratified unstable material weathered from the conglomerate.

Runoff is medium to rapid, and the erosion hazard is high. The slope gradients are not a particular concern in harvesting timber, but the erosion hazard imposes moderate limitations to tractor logging. Because of gentle slopes, good trafficability, and limited compaction, the soil is suited to recreational development. However, erosion can be a limitation under intense use. Landslide susceptibility is a concern in the location of roads and trails.

AsF—Ashcroft sandy loam, 25 to 60 percent slopes. This soil has the profile described as representative for the series. Included in mapping, and making up about 10 percent of this unit, are small areas of Rock land and Rock outcrop.

Runoff is rapid, and the erosion hazard is very high. This permeable soil is a high yielder of water.

This Ashcroft sandy loam is fairly well suited to herbage production and well suited to timber production. It is used mainly for timber, but some areas that have been burned are presently in grasses and forbs. Unstable soil aggregates contribute to the very high erosion hazard. Steep slopes and the very high erosion hazard impose moderately severe logging limitations, so harvesting of timber should be done with a minimum of soil disturbance.

Areas of this soil are esthetically pleasing due to the many colorful rocks. The main limitations for recreational uses are the steep, unstable slopes, which are susceptible to landslides.

Bassel series

The Bassel series consists of well drained soils that formed under a cover of sagebrush and grass in calcareous glacial deposits and alluvium. The deposits are composed of material derived from granite, sandstone, limestone, shale, and Maroon conglomerate.

The mean annual precipitation is 20 inches, and mean annual soil temperature is 40° F. Permeability is moderate, and available water capacity is low. Roots can penetrate to a depth of more than 60 inches.

Typically, the upper 12 inches of the soil is brown sandy loam. The finer textured part of the subsoil is weakly calcareous, brown very stony light sandy clay loam 10 inches thick. The substratum is brown, moderately calcareous very stony loamy sand to a depth of 60 inches.

Representative profile of Bassel sandy loam having slope of 44 percent at elevation of 9,500 feet between Brush Creek and the East River:

A1—0 to 7 inches; brown (7.5YR 4/2) sandy loam, dark brown (7.5YR 3/2) moist; weak very fine granular structure; soft when dry, very friable when moist; 5 percent cobbles and stones; many roots; pH 7.0; clear wavy boundary.

B1—7 to 12 inches; brown (7.5YR 5/4) sandy loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure that parts to moderate fine granular; soft when dry, very friable when moist; few pebbles and 5 percent cobbles and stones; many roots; pH 7.0; clear wavy boundary.

B2t—12 to 22 inches; brown (7.5YR 5/4) very stony light sandy clay loam, dark brown (7.5YR 4/4) moist; moderate medium angular structure that parts to moderate fine granular; hard when dry, friable when moist; thin nearly continuous clay films; 15 percent stones; many roots; pH 8.0; clear wavy boundary.

IIC—22 to 60 inches; brown (7.5YR 5/4) very stony loamy sand, dark brown (7.5YR 4/4) moist; single grained; soft when dry, very friable when moist; 5 percent pebbles and 20 percent stones; few roots; pH 8.0.

The soil is 7.5YR to 10YR in hue. The A horizon ranges from 5 to 4 in value and from 2 to 3 in chroma when dry. The A horizon is 7 to 15 inches thick and may be as thick as 18 inches where gophers have been active. Depth to carbonates varies slightly within short distances, and the soil may be noncalcareous to a depth of 8 to 20 inches. Content of stones ranges from 0 to 50 percent in the B and C horizons.

BaE—Bassel sandy loam, 0 to 25 percent slopes. In most areas of this soil, slope gradients exceed 10 percent, but in a small acreage slopes are less than 3 percent.

Runoff is slow to medium, and the erosion hazard is moderate.

This soil is well suited to herbage production. It is poor to fair for timber production. It has few recreational possibilities. This soil ranks high for water yield.

The primary management concern is controlling grazing because most soil erosion is the result of trailing by livestock.

BaF—Bassel sandy loam, 25 to 60 percent slopes. This soil has the profile described as representative for the series. Included in mapping are small areas of

Shale outcrop with soils of heavy silt loam or silty clay loam texture. These areas comprise less than 10 percent of this unit.

Runoff is rapid, and the erosion hazard is high. This Bassel sandy loam is used as range, although a minor acreage is in timber.

The soil is fairly well suited to herbage production although herbage growth is limited by rapid runoff and cold soil temperatures. Grazing must be carefully controlled. The soil is poor to fair for timber production. It rates about medium for water yield. It ranks moderately high for wildlife. This soil is little used for recreation, but soil properties are good for recreational development.

Bucklon series

The Bucklon series consists of well drained, moderately steep to very steep soils that formed in material weathered from shale on smoothly rounded mountains.

These soils are in parklike areas of grasses and forbs and scattered Engelmann spruce. Elevation is about 11,000 feet. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 36° F. Permeability is slow, and available water capacity is low. Roots can penetrate to a depth of 10 to 20 inches.

Typically, the surface layer is very dark grayish brown silt loam 13 inches thick. The next layer is grayish brown silty clay loam that has many black shale fragments and that is 5 inches thick. Black or dark gray, noncalcareous shale is at a depth of 18 inches.

Representative profile of Bucklon silt loam having slope of 20 percent along a trail near the center of sec. 30, T. 14 S., R. 83 W.:

A11—0 to 1 inch; very dark grayish brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) moist; moderate to strong fine crumb structure; soft when dry, very friable when moist; pH 6.6; clear smooth boundary.

A12—1 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) moist; moderate to strong fine crumb structure; soft when dry, very friable when moist; pH 6.8; clear smooth boundary.

A13—5 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) moist; moderate very fine subangular blocky structure that parts to moderate fine granular; slightly hard when dry, very friable when moist; few black shale chips; pH 6.8; gradual smooth boundary.

AC—13 to 18 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak fine subangular blocky structure; slightly hard when dry, very friable when moist; many black shale fragments; pH 6.8; gradual smooth boundary.

C—18 to 24 inches; black or dark gray, noncalcareous shale.

Some small areas have outcrops of fine grained sandstone, so the soil is coarser textured. On slopes of 30 to 50 percent, shale bedrock is at depths of 10 to 20 inches. Small areas of timbered soils have a thin A2 horizon.

BuF—Bucklon silt loam, 15 to 75 percent slopes. This is the only Bucklon soil mapped in the survey area. Included in mapping are small outcrops of sandstone or shale.

Runoff is rapid, and the erosion hazard is very high. This Bucklon silt loam is used as range. It is fair for this use, but it is better suited to herbage production than to other uses. It is poor for timber production and medium for water yield. Other than for hunting or sightseeing, this soil offers few recreational possibilities. It is summer range for elk and is fairly well suited to habitat for deer because scattered groves of Engelmann spruce provides concealment and escape routes. Much lateral seepage occurs on slopes, a factor to be considered in trail or road location. Shallow depth to bedrock, seepage, and susceptibility to piping make the soil material unsuitable for water retaining structures.

Management consists of controlling grazing. Because the soil is very erodible, the location of salt licks, where cattle will congregate and trample, is important. The soil is soft when wet, so much damage to grass occurs when the soil is grazed under these conditions.

Cabin series

The Cabin series consists of well drained, level to steep soils that formed in glacial outwash under grass.

Elevation ranges from 9,000 to 10,500 feet. The mean annual precipitation is 17 to 20 inches, and the mean annual soil temperature is 38° to 41° F. Frost may occur any day of the year. Permeability and available water capacity are moderate. Roots can penetrate to a depth of more than 60 inches.

Typically, the surface layer is brown sandy loam about 8 inches thick. The subsoil is brown gravelly sandy clay loam 24 inches thick. The substratum is yellowish brown very cobbly loamy sand. Rounded granitic pebbles and cobbles up to 10 inches in diameter make up about 60 percent of the substratum.

Representative profile of Cabin sandy loam at an elevation of 9,475 feet on a bench north of the Taylor Trading Post in the SW¼NW¼ sec. 16, T. 14 S., R. 82 W.:

A11—0 to 3½ inches; brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; weak very fine granular structure; soft when dry, very friable when moist; many roots; pH 6.5; clear wavy boundary.

A12—3½ to 8 inches; brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; weak medium angular blocky structure that parts to moderate fine granular; slightly hard when dry, very friable when moist; sand grains stained; 5 percent pebbles; many roots; pH 6.5; clear wavy boundary.

B1—8 to 14 inches; brown (7.5YR 5/4) gravelly sandy clay loam, dark brown (7.5YR 4/4) moist; weak medium angular blocky structure that parts to moderate fine granular; hard when dry, firm when moist; sand grains stained; few thin discontinuous clay films; 15 percent rounded granitic pebbles; many roots; pH 6.5; clear smooth boundary.

B2t—14 to 22 inches; brown (7.5YR 5/4) gravelly sandy clay loam, dark brown (7.5YR 4/4) moist; moderate medium angular blocky structure that parts to moderate fine granular; very hard when dry, firm when moist; thin discontinuous clay films; sand grains stained; 15 percent rounded granitic pebbles; few roots; pH 6.0; gradual wavy boundary.

B3—22 to 32 inches; brown (7.5YR 5/4) gravelly sandy clay loam, dark brown (7.5YR 4/4) moist; weak medium angular blocky structure that parts to weak fine granular; hard when dry, firm when moist; few thin discontinuous clay films; sand grains stained; 15 percent rounded granitic pebbles and cobbles; few roots; pH 6.0; gradual wavy boundary.

IIC—32 to 60 inches; yellowish brown (10YR 5/4) very cobbly loamy sand, dark yellowish brown (10YR 4/4) moist; single grained; hard when dry, firm when moist; 60 percent rounded granitic pebbles and cobbles; pH 6.0.

The A1 horizon is 7 to 14 inches thick and ranges from fine sandy loam to gravelly sandy loam. The B horizon ranges from heavy sandy loam to gravelly sandy clay loam or gravelly clay loam.

CaA—Cabin sandy loam, 0 to 3 percent slopes. This soil has the profile described as representative for the series. Some small areas of soils with slopes exceeding 3 percent and small areas of fine textured soils were included in mapping.

Runoff is medium, and the erosion hazard is slight.

This soil is used as range, but due to its proximity to the Taylor Reservoir, it receives considerable traffic from recreationists. Recreational developments include roads, trails, and campgrounds and their facilities.

Herbage production, recreation, and water production are the best uses of this soil, although herbage production is limited by cold nights and a short growing season. This Cabin sandy loam has a high infiltration rate, moderate permeability, and a deep, porous substratum, so it ranks high for water yield. Some erosion has occurred because of intense use by recreationists and by cattle trailing. Vegetation shows no response to nitrogen or phosphate fertilizers. Because of its gravelly substratum, this soil provides poor locations for water retaining structures.

Managing this soil becomes more difficult as the recreational demands increase. Conflicts between recreational uses of the soil and its use for range can occur. Grazing on this soil needs to be carefully controlled to prevent accelerated erosion. The short growing season, low nightly temperatures, and droughtiness of the soil make reestablishment of vegetation difficult.

CaE—Cabin sandy loam, 3 to 25 percent slopes. This soil occupies the slopes surrounding the benchlike areas of Cabin sandy loam, 0 to 3 percent slopes. It has a profile similar to the one described as representative for the series, but in places the texture of the surface horizon is gravelly sandy loam, and the profile contains more pebbles and cobbles. There is no subsoil in places where slope gradients are nearly 25 percent.

Runoff is medium to rapid, and the erosion hazard is moderate.

Herbage production and recreation are the best uses of this soil. The soil is a little more droughty than Cabin sandy loam, 0 to 3 percent slopes, since its available water capacity is less and its surface drainage is more rapid. Management of this soil does not differ significantly from management of Cabin sandy loam, 0 to 3 percent slopes.

Charlos series

The Charlos series consists of well drained, level to steep soils that formed in alluvial-colluvial material derived from granite and some gneiss and schist.

This soil is extensive in the Union Park area and is near Dinnen soils. Surface and internal drainage are good, and the soil has moderate susceptibility to erosion. The mean annual precipitation is 20 inches, and the mean annual soil temperature is about 40° F. Permeability and available water capacity are moderate. Roots can penetrate to a depth of more than 60 inches.

Typically, the surface layer is brown sandy loam about 7 inches thick. The subsoil is brown and light brown gravelly sandy clay loam, gravelly clay loam, and gravelly sandy loam 20 inches thick. The substratum is light brown gravelly sandy loam.

Representative profile of Charlos sandy loam having slope of 6 percent under sagebrush, fescue, and muhly in sec. 5, T. 15 S., R. 82 W.:

A1—0 to 7 inches; brown (7.5YR 4/3) sandy loam, dark brown (7.5YR 3/3) moist; moderate medium and fine granular structure; slightly hard when dry, very friable when moist; pH 6.2; clear smooth boundary.

B1—7 to 11 inches; brown (7.5YR 5/3) gravelly sandy clay loam, brown (7.5YR 4/3) moist; weak medium subangular blocky structure; hard when dry, very friable when moist; few thin clay films on peds; 15 percent angular granitic pebbles; pH 6.3; clear smooth boundary.

B2t—11 to 20 inches; brown (7.5YR 5/4) gravelly clay loam, brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; very hard when dry, friable when moist; thin continuous clay films on peds; 15 percent pebbles; pH 6.3; clear smooth boundary.

B3—20 to 27 inches; light brown (7.5YR 6/4) gravelly sandy loam, brown (7.5YR 4/5) moist; weak medium subangular blocky structure that parts to moderate medium granular; hard when dry, very friable when moist; few thin discontinuous clay films on peds and clay coatings on sand grains and pebbles; 15 percent angular granitic pebbles; pH 6.4; gradual smooth boundary.

C—27 to 50 inches; light brown (7.5YR 6/4) gravelly sandy loam, brown (7.5YR 4/5) moist; massive; hard when dry, very friable when moist; 15 percent angular granitic pebbles; pH 6.6.

The A1 horizon when moist varies from dark yellowish brown to dark brown or dark grayish brown sandy loam to loam. In uneroded soils, the A1 horizon ranges from 5 to 9 inches in thickness. The B horizon ranges from 15 to 72 inches in thickness and from gravelly sandy clay loam to gravelly clay loam. Less sloping soils east of Union Cow Camp are not quite so dark colored as steeper Charlos soils and are gravelly in the A1 horizon.

A small acreage of Dinnen and Teoculli soils were included with Charlos soils in mapping.

ChE—Charlos sandy loam, 0 to 25 percent slopes. This soil is mainly in Taylor and Union Parks. It has the profile described as representative for the series.

Runoff is medium, and the erosion hazard is moderate.

This soil is used for herbage production, although a minor acreage has thin stands of lodgepole pine.

This soil is fair for herbage production and poor for timber. It ranks high as a water yielder. In its position on mountain foot slopes, it receives water from higher areas. The deep alluvial-colluvial deposits in which this soil formed stores much of this water for slow release to springs and streams. This soil is mostly along the outer margins of mountain parks characterized by temperature inversions that create frost pockets. This soil is well suited to wildlife habitat because it is generally close to water and the nearby timbered areas provide cover. Hunting and some fishing are the principal recreational activities on this soil. The soil is well suited to recreational development, but

areas that do not receive much runoff from higher areas should be selected.

This soil should be managed principally for water yield and herbage production. Controlled grazing and improvement of existing vegetative cover are needed to help control erosion and to increase water yield.

ClE2—Charlos sandy clay loam, 5 to 25 percent slopes, eroded. The profile of this soil differs from the one described as representative for the series in that it has been severely eroded. The degree of erosion is not uniform; consequently, no soil profile typifies all of the unit. In about 60 to 70 percent of the area of this soil, the profile would be similar to the representative profile if the upper 7 to 11 inches were removed from the representative profile. The subsoil is at or near the surface, and the surface layer ranges from sandy clay loam to clay loam. In 10 to 15 percent of the area, part or most of the subsoil has been eroded. Also, gullying has destroyed nearly all of the profile in some areas. The profile below a depth of 11 to 16 inches in the rest of the area is similar to the one described as representative for the series.

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

The soil is used as range, for which it is poorly suited. It is very poorly suited to timber production, and is rated medium as a water yielder. It is poorly suited to wildlife habitat or recreation. Erosion is a major concern in forest management, and its control and subsequent revegetation are of prime importance. Efforts can be made to revegetate eroded areas and to restrict grazing until grass is well established. Water yield and herbage production are the best uses of this soil.

Cryaquolls

Cr—Cryaquolls. This land type consists of wet, nearly level to moderately steep soils. These soils are very mucky and peaty and have a thin organic surface horizon. They are in alpine basins or in long, narrow areas adjacent to perennial streams. Slope gradients range from 5 to 15 percent where the soil parallels the stream. The hummocky surface has 10 to 18 inches of microrelief, apparently due to frost heaving. Cryaquolls are generally wet, although many areas are dry in late summer.

General description of Cryaquolls having a concave slope of 5 percent along a stream at an elevation of 11,800 feet:

Organic layers; dark yellowish-brown (10YR 4/4) organic residue in various stages of decomposition, 3 inches thick. The lower part of this layer is about 50 percent mineral soil.

Substratum; dark brown (10YR 3/3) to very dark gray (10YR 3/1) loamy fine sand or fine sandy loam containing many mica flakes. Mottles are reddish brown (5YR 5/3) and gray (10YR 5/1). The material is very friable and has weak, fine crumb structure. Reaction ranges from pH 4.5 to 5.0.

Bedrock; fractured gneiss is at a depth of 30 inches.

Thickness of the organic layer ranges from 1 to 4 inches. There are boulders in the surface and varying amounts of coarse fragments in the profile in places. The underlying bedrock is granite, schist, or gneiss at a depth of 20 to 48 inches.

Cryaquolls and Histosols

Cs—Cryaquolls and Histosols. This land type consists of soils that are wet for long periods because of a high water table or prolonged seepage from springs or snowmelt in alpine areas.

The vegetation is dominantly willows, rushes, and sedges, with scattered shrubby cinquefoil near the edges. On Histosols, there are generally no willows, and the vegetation is mainly sedges and rushes.

Cryaquolls occupy wet areas of hummocky microrelief where organic matter has accumulated but has decomposed sufficiently to make identification of plant residues impossible. These soils are along major streams and narrow drainageways leading from mountains. Melting snow keeps these areas saturated for long periods. Beaver ponds are common, and they help to maintain the high water table. Narrow areas of muck occur in drainageways in subalpine areas, so slope gradients range from 0 to about 20 percent.

Cryaquolls have a dark surface layer that ranges from 4 to 16 inches thick. The underlying layer ranges from loam to gravelly coarse sand. The soil material is yellowish-brown to dark brown, but in many areas the underlying material is gleyed. Small areas of Teoculli loam were included in mapping.

Histosols occupy concave sites and nearly level areas along major streams. These soils are generally associated with Cryaquolls, and they are commonly within large areas of Cryaquolls. The fibrous, relatively undecomposed organic material averages about 8 inches in thickness and ranges from 3 to 16 inches thick. Beaver ponds are common in areas of Histosols, although most are no longer inhabited by beaver and have been filled with sediment.

The greatest variations in Histosols are in the thickness of the organic layer and in the texture of the underlying material, which ranges from silty clay to mixed sand, gravel, and cobbles. A gray gleyed layer is at a depth of about 10 inches in many places.

Areas of Cryaquolls and Histosols are grazed by livestock and big game. Many of the beaver ponds in areas of this mapping unit contain trout. These ponds are preferred by many fisherman over the fast-moving streams.

Cryaquolls and Histosols are important for their effect on water yield. Water emerging from seeps and springs is retained in these areas and released for sustained stream flow. Runoff is slow, and the erosion hazard is slight.

These soils produce much herbage and are grazed heavily by livestock, although grazing damages the soil. Trampling has produced a hummocky microrelief, although some of this results from freezing and thawing.

Water yield, wildlife habitat, and recreation are the best uses for these soils. The suitability of the soils for recreation varies widely, depending upon the presence of beaver ponds or flowing streams containing fish.

Dinnen series

The Dinnen series consists of well drained, gently sloping to very steep soils that formed in mountain toe slope alluvial-colluvial deposits at high elevations.

This soil is quite extensive around the fringes of the Union Park area between elevations of 9,500 and

10,000 feet. It supports both forest and grassland vegetation. The forest consists of lodgepole pine with a few spruce and an understory of vetch, lupines, kinnikinnick, sedges, and grasses. Areas of grassland consist of big sagebrush, fescues, and mountain muhly. The mean annual soil temperature is 39° F. Permeability is moderately rapid, and available water capacity is moderate. Roots can penetrate to a depth of more than 60 inches.

Typically, Dinnen soils have a surface layer of dark grayish brown and brown sandy loam about 6 inches thick. It is slightly acid to neutral. The underlying material is brown, slightly acid sandy loam and coarse sandy loam.

Representative profile of Dinnen sandy loam having slope of 15 percent at an elevation of 9,775 feet at the north edge of Union Park in the SW¼NE¼ sec. 4, T. 15 S., R. 82 W.:

A11—0 to 1 inch; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak thin platy structure that parts to weak very fine granular; slightly hard when dry, very friable when moist; few roots; pH 6.5; abrupt wavy boundary.

A12—1 to 6 inches; brown (10YR 5/4) sandy loam, dark brown (10YR 3/3) moist; weak thin platy structure that parts to weak fine granular; slightly hard when dry, very friable when moist; few roots; pH 6.5; clear wavy boundary.

C1—6 to 18 inches; brown (7.5YR 5/4) sandy loam, dark brown (7.5YR 4/4) moist; weak medium angular blocky structure that parts to moderate fine granular; slightly hard when dry, very friable when moist; few roots; pH 6.0; clear wavy boundary.

C2—18 to 60 inches; brown (7.5YR 5/4) coarse sandy loam, dark brown (7.5YR 4/4) moist; massive; soft when dry, very friable when moist; a few roots to a depth of 30 inches; pH 6.0.

The A horizon ranges from 6 to 9 inches in thickness, although in a few places on lower slopes it is 15 inches thick. Texture ranges from sandy loam to loam. The A horizon when dry is dark yellowish brown, brown, or dark brown. The C horizon is typically sandy loam, although there are strata of coarser and fine textured material in places. The C horizons range in hue from 7.5YR to 10YR, in chroma from 5 to 7, and in value from 3 to 4. There are a few areas where this soil formed in andesite and rhyolite; however, the soils in these areas are not significantly different from soils that formed in granite, except that they are more stony.

DnF—Dinnen sandy loam, 2 to 60 percent slopes. This soil has the profile described as representative for the series. Small areas of Histosols and Cryaquolls and Teoculli loams with deep, dark surface layers were included in mapping.

Runoff is medium to rapid, and the erosion hazard is moderate.

Although some of this soil is in timber, all of it is used as range. The lodgepole timber is class 4.

This soil is fair for herbage production and poor for timber production. Water yield is high. The soil is rated good for recreational development except where slopes are excessively steep. Its suitability for wildlife habitat, including habitat for deer and elk, is fair.

Water yield and forage production are the best uses for this soil. Management that increases herbage production also increases water yield.

DsF—Dinnen stony sandy loam, 5 to 60 percent slopes. The profile of this soil differs from the one described as representative for the series in that it is stony. The stoniness interferes with replanting and road construction. Areas of soils with a 20 to 90 percent cover of stones were included in mapping.

Runoff is medium, and the erosion hazard is moderate.

This soil is under grass and a sparse cover of lodgepole pine with scattered groves of quaking aspen. All of it is grazed.

Herbage production is fair, and water yield is high. The soil is poorly suited to timber, but areas presently in timber need to be kept in timber for soil protection, wildlife habitat, and water yield. This soil has enough stones and boulders to necessitate hand planting of trees. The stoniness makes the use of machinery impractical for either grass seeding or tree planting. The large stones and boulders greatly increase costs of maintenance of roads or trails.

Water yield, herbage production, and wildlife habitat—particularly for big game—are the best uses of this soil.

Doct series

The Doct series consists of well drained, moderately steep to very steep soils that formed in material weathered from limestone and shale.

These soils are above timberline in the alpine zone. Most of this soil is near the head of Cement Creek and on Matchless Mountain near Almont soils and Rock land and Rock outcrop. The vegetation includes annual fescue, sagebrush, and junegrass. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 30° F. Permeability is slow, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

Typically, the surface layer, to a depth of about 9 inches, is grayish brown silt loam and gravelly silt loam. The underlying material is mainly light olive brown and gray gravelly silty clay loam and channery silty clay loam. Interbedded limestone and shale are at a depth of 30 inches.

Representative profile of Doct silt loam having slope of 35 percent at an elevation of 12,300 feet in the alpine zone at the head of Cement Creek in the NW¼ sec. 34, T. 12 S., R. 84 W.:

A11—0 to 4 inches; grayish brown (2.5Y 5/2) silt loam, very dark grayish brown (2.5Y 3/2) moist; strong fine granular structure; soft when dry, very friable when moist; 10 percent pebbles; pH 7.6; clear smooth boundary.

A12—4 to 9 inches; grayish brown (2.5Y 5/2) gravelly heavy silt loam, very dark grayish brown (2.5Y 3/2) moist; weak fine subangular blocky structure that parts to strong fine granular; soft when dry, very friable when moist; 15 percent pebbles; pH 7.6; clear smooth boundary.

AC—9 to 12 inches; light brownish gray (2.5Y 6/2) gravelly light silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate very fine subangular blocky structure; slightly hard when dry, very friable when moist; 25 percent pebbles; pH 7.2; clear smooth boundary.

C1—12 to 15 inches; light olive brown (2.5Y 5/4) gravelly light silty clay loam, olive brown (2.5Y 4/4) moist; weak very fine subangular blocky structure; slightly hard when dry, very friable when moist;

15 percent pebbles; pH 7.0; gradual smooth boundary.

C2—15 to 19 inches; olive gray (5Y 5/2) gravelly light silty clay loam, olive gray (5Y 4/2) moist; weak very fine subangular blocky structure; slightly hard when dry, very friable when moist; 15 percent pebbles; pH 7.0; gradual smooth boundary.

C3—19 to 30 inches; gray (5Y 5/1) channery silty clay loam, dark gray (5Y 4/1) moist; massive; hard when dry, friable when moist; 50 percent limestone pebbles and shale channers; pH 6.8; gradual smooth boundary.

R—30 to 40 inches; interbedded limestone and shale.

The A horizon ranges from stony loam to silt loam, gravelly silt loam, and light silty clay loam. Limestone flagstones make up 10 to 50 percent of the C horizon. Depth to bedrock ranges from 20 to 40 inches. Although reaction of the soil is neutral in most places, depth to carbonates ranges from 0 to 30 inches. The lower surfaces of some flagstones have accumulations of secondary lime.

DtE—Doct silt loam, 10 to 25 percent slopes. Karst-like topography is more common on this soil than on Doct silt loam, 25 to 70 percent slopes. About 10 percent of this unit consists of Rock land and Rock outcrop.

Runoff is medium, and the erosion hazard is moderate.

Runoff is less rapid on this soil than it is on Doct silt loam, 25 to 70 percent slopes. Consequently, more water enters the soil, and the soil's water yield is medium. Management of this soil is similar to management of Doct silt loam, 25 to 70 percent slopes.

DtF—Doct silt loam, 25 to 70 percent slopes. This soil has the profile described as representative for the series. Small areas of Almont soils were included in mapping. About 10 percent of this unit consists of Rock land and Rock outcrop.

Runoff is rapid, and the erosion hazard is high.

Some areas of this soil are used for grazing sheep, but others are too inaccessible. This soil is summer range for elk.

This soil is fair for herbage production but is unsuitable for timber production. Areas of this soil are treeless. The water yield is low due to the shallow regolith and to the strong winter winds that remove snow from the ridges. Nearby soils, such as Almont silt loam, and miscellaneous land types yield much water. The soil blowing hazard is high. Although the soil is protected by tough turf, once this turf is destroyed, the fine soil materials are blown away, leaving a pavement of rock fragments. The soil is well suited to habitat for elk, and some mountain sheep live in areas of this soil. Most of this soil is poor for recreation because of its inaccessibility.

The soil is protected by controlling grazing. Herbage production and water yield are the best uses of this soil. Although this soil does not yield much water, much snow falls on it, so the construction of snow fences to increase snowpack is practical.

Emerald series

The Emerald series consists of well drained soils that formed in sloping to steep valley-filling sediment and alluvial fans under a cover of sagebrush and grass. This material weathered from sandstone.

The mean annual precipitation is 20 inches, and the mean annual soil temperature is 35° F. Permeability is moderately slow, and available water capacity is high. Roots can penetrate to a depth of more than 60 inches.

Typically, the surface layer is brown sandy clay loam about 10 inches thick. The next layer is brown stony sandy clay loam 11 inches thick. The underlying material is yellowish brown stony clay loam.

Representative profile of Emerald sandy clay loam having slope of 20 percent at an elevation of 10,600 feet adjacent to Rocky Brook in the NW¼ sec. 4, T. 13 S., R. 84 W.:

A1—0 to 10 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 3/3) moist; weak very fine granular structure; soft when dry, very friable when moist; 5 percent pebbles; many roots; pH 6.8; clear wavy boundary.

AC—10 to 21 inches; brown (10YR 5/3) stony sandy clay loam, dark brown (10YR 4/3) moist; moderate fine granular structure; soft when dry, friable when moist; 15 percent pebbles and stones; many roots; pH 6.5; clear wavy boundary.

C—21 to 45 inches; yellowish brown (10YR 5/4) stony clay loam; dark yellowish brown (10YR 4/4) moist; massive; soft when dry, friable when moist; 15 percent stones and sandstone pebbles; few roots; pH 6.0.

Sandstone or quartzite rock fragments cover 5 to 50 percent of the surface. Thickness of the A1 horizon ranges from 6 to 25 inches, but gopher activity causes the A1 horizon to be thicker. Rock fragments make up 10 to 50 percent of the C horizon. Where the soil has formed entirely from sandstone, the profile is coarser textured and is stony fine sandy loam or loam in the AC and C horizons.

EmF—Emerald sandy clay loam, 5 to 45 percent slopes. This is the only Emerald soil mapped in the survey area. Small areas of Eyre, Mayoworth, Kebler, and Jenkins soils were included in mapping.

Runoff is medium to rapid, and the erosion hazard is moderate.

This soil is used for grazing livestock.

The soil is fair for herbage production and for lodgepole pine. It is permeable and underlain by deep, unconsolidated material, so its capacity for storing water for slow release is high. Areas where the soil is gently sloping are well suited to recreational development. This soil is suitable for water retaining structures. The soil is only fair for recreation or wildlife habitat.

Herbage production and water yield are the best uses of the soil. Good grazing management increases its value for both of these uses.

Eyre series

The Eyre series consists of well drained, moderately steep to very steep soils on mountain slopes. These soils formed in material weathered from sandstone.

This soil occurs in high-elevation, open, parklike areas under aspen and grass. At lower elevations, the vegetation is big sagebrush, rabbitbrush, wild buckwheat, and scattered grasses. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 40° F. Permeability is moderately rapid, and available water capacity is very low. Roots can penetrate to a depth of 10 to 20 inches.

Typically, the surface layer is brown sandy loam about 8 inches thick. The underlying material is light yellowish brown very stony fine sandy loam 8 inches

thick. Fractured sandstone is at a depth of 16 inches.

Representative profile of Eyre sandy loam having slope of 38 percent at an elevation of 9,900 feet along a trail in the S½ sec. 23, T. 14 S., R. 84 W.:

A1—0 to 8 inches; brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; weak very fine granular structure; soft when dry, very friable when moist; 10 percent angular sandstone pebbles and flagstones; many roots; pH 6.0; clear wavy boundary.

C—8 to 16 inches; light yellowish-brown (10YR 6/4) very stony fine sandy loam, dark yellowish-brown (10YR 4/4) moist; single grained; loose when dry, very friable when moist; 60 percent stones; few roots; pH 6.0; abrupt irregular boundary.

IIR—16 to 24 inches; fractured sandstone.

Rock fragments cover 5 to 15 percent of the surface in most places and as much as 50 percent in small areas. Stones make up 50 to 70 percent of the soil material. Depth to bedrock ranges from 10 to 20 inches, but small areas of bedrock outcrops are common. Thickness of the A1 horizon varies from 2 to 12 inches due to mixing by rodents.

EyF—Eyre sandy loam, 15 to 70 percent slopes. This is the only Eyre soil mapped in the survey area. Small areas of Mayoworth and Kebler soils and of Rock land and Rock outcrop were included in mapping.

Runoff is medium to rapid, and the erosion hazard is high.

This soil is used for grazing. It is fairly well suited to this use at higher elevations where precipitation is higher. At lower elevations, precipitation is not adequate for good growth of grasses because the soil is shallow and droughty.

This Eyre sandy loam is poorly suited to timber production and water yield. The soil is fair for big game, but other than its value for hunting, it has little value for recreation.

This soil is best managed for herbage production. It has a high erosion hazard, which, combined with droughtiness, makes management requirements quite high. Eroded areas are difficult to revegetate.

Gothic series

The Gothic series consists of well drained, sloping to steep soils that formed in alluvial-colluvial material weathered from quartzite, granite, and Maroon conglomerate with components from limestone and shale. Locally, the alluvial-colluvial mantle overlies sandstone, quartzite, or shale.

The vegetation is big sagebrush and bunchgrass. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 40° F. Permeability is slow, and available water capacity is high. Roots can penetrate to a depth of more than 60 inches.

Typically, the surface layer is brown fine sandy loam about 5 inches thick. The subsoil is yellowish brown, light brown, and brown sandy clay loam and clay loam 43 inches thick. The substratum is brown gravelly sandy clay loam.

Representative profile of Gothic fine sandy loam having a west-facing slope of 20 percent at an elevation of 8,500 feet in a roadcut along Jack's Cabin cutoff, one-half mile east of the National Forest boundary in the center of sec. 19, T. 15 S., R. 84 W.:

A1—0 to 5 inches; brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) moist; moderate very fine granular structure; hard when dry, friable when moist; 5 percent cobbles and few pebbles; many roots; pH 6.5; clear wavy boundary.

B1—5 to 7 inches; brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) moist; strong fine granular structure; hard when dry, friable when moist; 5 percent cobbles and few fine pebbles; many roots; pH 7.0; clear wavy boundary.

IIB21t—7 to 18 inches; yellowish brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure that parts to strong fine granular; very hard when dry, firm when moist; common discontinuous clay films on peds; 10 percent pebbles; many roots; pH 7.0; clear wavy boundary.

IIB22t—18 to 40 inches; light brown (7.5YR 6/4) heavy clay loam, brown (7.5YR 5/4) moist; strong coarse angular blocky structure that parts to moderate medium granular; very hard when dry, very firm when moist; common nearly continuous clay films on peds; few fine pebbles and cobbles; few roots; pH 7.0; clear wavy boundary.

IIB3—40 to 48 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; weak coarse angular blocky structure that parts to moderate fine granular; very hard when dry, very firm when moist; few thin discontinuous clay films; few fine pebbles; few roots; pH 7.5; clear wavy boundary.

IIIC—48 to 70 inches; brown (7.5YR 5/4) gravelly sandy clay loam, dark brown (7.5YR 4/4) moist; massive; very hard when dry, firm when moist; 15 percent pebbles; pH 8.0.

Texture of the soil material varies, depending upon the origin of the parent material. Material that formed in limestone or shale is finer textured than material that formed in other parent material. The A horizon ranges from fine sandy loam to sandy clay loam. The C horizon ranges from gravelly sandy clay loam to sandy clay or clay loam. The parent material is calcareous below a depth of 40 inches in places.

GoE—Gothic fine sandy loam, 5 to 40 percent slopes. This is the only Gothic soil mapped in the survey area.

Runoff is medium to rapid, and the erosion hazard is high. This Gothic fine sandy loam is used as range. Its suitability for this use is poor to fair.

This soil is poorly suited to timber production and moderately suited to water yield and wildlife habitat. This soil is suitable for recreational development, except that its slow permeability is a limitation to septic tanks and drainage fields. Its value for water retaining structures is excellent. The composition of the vegetative cover consists mainly of big sagebrush and various forbs. There is about a 40 percent ground cover of big sagebrush. The low precipitation accounts for the poor grass cover.

In spite of these limitations, water yield and herbage production are the best uses of this soil. Good management prevents overgrazing and erosion. Elimination of sagebrush lowers the competition for moisture and might increase the amount of grasses in the plant community.

Haverly series

The Haverly series consists of poorly drained, sloping to very steep soils that formed in alluvial-colluvial materials of granitic origin with inclusions of gneiss or schist.

Haverly soils occur in the alpine area and occupy cirque basins and the lower slopes below alpine ridgetops (fig. 11). These soils receive seepage water from

Figure 11.—Area of Haverly-Vasquez loams (in the foreground).

higher lying areas and remain wet much of the time, but at times they are dry late in summer. Vegetation is mainly willows and other alpine hydrophytic forbs and sedges. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 30° F. Permeability is moderately rapid, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

Typically, the surface layer is brown and dark brown loam and fine sandy loam about 6 inches thick. The subsoil is brown, mottled stony loamy fine sand 19 inches thick. The substratum is yellowish brown very stony loamy fine sand. Bedrock is at a depth of 30 inches.

Representative profile of Haverly loam having slope of 24 percent at an elevation of 11,900 feet, southwest of Cottonwood Pass in sec. 14, T. 14 S., R. 81 W.:

O1—¾ inch to 0; willow twigs, leaves, and dead grass.
A11—0 to 2 inches; dark brown (10YR 3/3) loam, very dark brown (10YR 2/3) moist; weak very fine granular structure; soft when dry, very friable when moist; 10 percent stones; abundant roots; pH 5.0; clear wavy boundary.
A12—2 to 6 inches; brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) moist; weak very fine granular structure; soft when dry, very friable when moist; 10 percent stones; many roots; pH 4.5; clear irregular boundary.
IIB2—6 to 25 inches; brown (7.5YR 5/4) stony loamy fine sand, dark brown (7.5YR 4/4) moist; common fine distinct pinkish gray (7.5YR 6/2) and reddish-brown (5YR 4/4) mottles; weak very fine granular structure; loose when dry, very friable when moist; 30 percent granitic rocks; few roots; pH 5.0; clear irregular boundary.
IIC—25 to 30 inches; yellowish brown (10YR 5/4) very stony loamy fine sand, dark yellowish brown (10YR 4/4) moist; single grained; loose when dry and moist; 50 percent granitic stones; pH 5.0; abrupt irregular boundary.
IIIR—30 to 34 inches; gneiss.

Texture varies depending upon the amounts of granite, gneiss, or schist contributing to the parent material. Where the soils are dominantly of schist origin, the land surface is smoother and relatively free of stones. The A horizon ranges from fine sandy loam to loam or silt loam. The IIB2 horizon is very stony loamy fine sand to sandy loam or loam. The C horizon is very stony loamy fine sand or fine sandy loam. Where schist dominates, there are many fine mica flakes throughout the soil. In places, the soil is peaty in the upper 1 to 3 inches.

HaE—Haverly-Vasquez loams, 5 to 25 percent slopes. The soils in this complex have the profiles described as representative for their respective series.

Runoff is medium, and the erosion hazard is moderate.

This complex is used as grazing land for sheep. It is also in the summer grazing area for elk. Areas of this complex that are accessible to motor vehicles are popular with weekend sightseers.

This complex is fair for herbage production and unsuitable for timber production. It is fair for wildlife habitat but is particularly suited to elk. Deer do not inhabit these level elevations. Ptarmigan live in areas of this soil.

Water yield and herbage production are the best uses of these soils, particularly water yield. Winds remove much snow in winter, but in cirques and other protected places, snow accumulates to depths of several feet and contributes to springs and streams until about mid July. Many seeps and springs emerge from areas of these soils or at lower elevations. The scenic beauty of these alpine meadows attracts many visitors, who are impressed by the beautiful wildflowers in the immediate vicinity of snowbanks as well as by the other features of the landscape.

Management involves grazing control to prevent deterioration of the vegetative cover and to prevent erosion. It is impractical, and in many places impossible, to revegetate eroded soils at these elevations. Practices that increase snowpack in these areas increase water yield and may prove to be practical.

HaF—Haverly-Vasquez loams, 25 to 70 percent slopes. The soils in this complex have profiles similar to the ones described as representative for their respective series. Slopes range from steep to very steep.

Runoff is rapid, and the erosion hazard is high. Areas of these soils dry out earlier in the summer than do areas of less sloping soils.

This complex is fair for herbage production. Due to steeper slopes and greater surface runoff, it is not so good a water yielder as Haverly-Vasquez loams, 5 to 25 percent slopes.

Forage production and water yield are the best uses of these soils, and recreation is the next best use. Good management maintains or improves the vegetative cover on these soils. Because of the erosion hazard, revegetation is impractical or impossible.

Hierro series

The Hierro series consists of well drained, sloping to very steep soils that formed in alluvial fan material and other valley side alluvial-colluvial material. This material was derived from conglomerates and sandstones of the Maroon Formation.

The vegetation is mainly Engelmann spruce and subalpine fir with an understory of lupines, scattered grasses, and vaccinium. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 34° F. Permeability is moderately slow, and available water capacity is high. Roots can penetrate to a depth of more than 60 inches.

Under a layer of litter, the surface layer typically is reddish gray loam 4 inches thick. The subsurface layer is pinkish gray silt loam 6 inches thick. The subsoil is reddish brown sandy clay loam 19 inches thick. The substratum is reddish brown loam that contains 40 percent sandstone flagstones.

Representative profile of Hierro loam having slope of 35 percent facing east at an elevation of 11,050 feet, west of Cement Creek in the W½ sec. 3, T. 13 S., R. 84 W.:

O1—1½ inches to 1; forest litter.
O2—1 inch to 0; partially decomposed organic matter.
A1—0 to 4 inches; reddish gray (5YR 5/2) loam, dark reddish brown (5YR 3/2) moist; moderate very fine granular structure; soft when dry, very friable when moist; many roots; pH 6.2; clear wavy boundary.
A2—4 to 10 inches; pinkish gray (5YR 6/2) silt loam, dark reddish gray (5YR 4/2) moist; weak medium subangular blocky structure that parts to moderate very fine granular; soft when dry, very friable when moist; many roots; pH 7.0; clear wavy boundary.
B21t—10 to 15 inches; reddish brown (5YR 5/3) sandy clay loam, reddish brown (5YR 4/3) moist; moderate medium subangular blocky structure that parts to moderate very fine granular; soft when dry, very friable when moist; common thin clay films on peds; many roots; few reddish sandstone flagstones; pH 7.0; clear wavy boundary.
B22t—15 to 21 inches; reddish brown (5YR 5/3) sandy clay loam, reddish brown (5YR 4/4) moist; moderate medium angular blocky structure that parts to moderate very fine granular; soft when dry, very friable when moist; common thin clay films on peds; many roots; few sandstone flagstones; pH 6.4; clear wavy boundary.
B3—21 to 29 inches; reddish brown (5YR 5/3) sandy clay loam, dark reddish brown (5YR 3/3) moist; moderate very fine granular structure; soft when dry, very friable when moist; few thin discontinuous clay films; few roots; 30 percent sandstone flagstones; pH 6.0; clear wavy boundary.
C—29 to 40 inches; reddish brown (5YR 5/4) loam, dark reddish brown (5YR 3/4) moist; massive; soft when dry, very friable when moist; 40 percent sandstone flagstones; pH 6.0.

In places, clay films are not evident. The reddish hues in the soil material are apparently inherited from the Maroon Formation. When the soil is wet, the A2 horizon is not apparent, but it is easily recognized when the soil is dry.

HeF—Hierro loam, 5 to 45 percent slopes. This is the only Hierro soil mapped in the survey area.

Runoff is medium to rapid, and the erosion hazard is moderate.

Hierro loam is used for timber production, grazing, and recreation. The soil is well suited to lodgepole pine, and it is fair for Engelmann spruce and subalpine fir. Open areas produce considerable forage. The porous soil and deep substratum make this soil an excellent water yielder. The soil rates good to excellent for recreational development. Nearby streams provide fishing, and the colorful outcrops of rock add to the scenic value.

Although this soil is grazed to some extent, water yield, timber production, and recreation are its best uses. The erosion and windthrow hazards are moderate. Limitations for logging are moderately severe, and tractor logging should not be used on slopes of more than 25 percent. The soil is soft and friable and easily disturbed by logging operations or by trampling livestock.

Jenkins series

The Jenkins series consists of well drained, moderately steep to very steep soils that formed in ma-

terial weathered from sandstone, with interstratified shale, under forest vegetation.

Most of the acreage of this soil is at elevations above 10,500 feet. The vegetation is dominantly Engelmann spruce and subalpine fir with an understory of vaccinium and scattered lupines and ribes. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 36° F. Permeability is moderate, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

Under a layer of litter, the surface layer typically is pinkish gray gravelly loam 3 inches thick. The subsoil is brownish yellow and light olive brown gravelly loam and channery loam 15 inches thick. The substratum is light brownish gray channery sandy loam 10 inches thick. Interbedded sandstone and shale is at a depth of 28 inches.

Representative profile of Jenkins gravelly loam having slope of 45 percent facing east at an elevation of 11,100 feet in the Middle Quartz Creek watershed south of the town of Pitkin in the NE¼ sec. 13, T. 50 N., R. 4 E.:

O1—2 inches to 1; undecomposed organic material, mainly bark, twigs, and needles.

O2—1 inches to 0; decomposed and partly decomposed organic material.

A1—0 to 3 inches; pinkish gray (7.5YR 6/2) gravelly loam; brown (7.5YR 4/2) moist; weak thin platy structure that parts to moderate fine granular; soft when dry, very friable when moist; 15 percent sandstone pebbles and channery fragments; pH 4.8; clear smooth boundary.

B2—3 to 9 inches; brownish yellow (10YR 6/6) gravelly loam, dark yellowish brown (10YR 4/5) moist; moderate very fine subangular blocky structure; slightly hard when dry, very friable when moist; 15 percent sandstone pebbles; pH 4.6; gradual wavy boundary.

B3—9 to 18 inches; light olive brown (2.5Y 5/4) channery loam, olive brown (2.5Y 4/4) moist; weak very fine subangular blocky structure; slightly hard when dry, very friable when moist; 20 percent sandstone and hard shale channery fragments; pH 5.8; gradual irregular boundary.

C—18 to 28 inches; light brownish gray (2.5Y 6/2) channery sandy loam, dark grayish-brown (2.5Y 4/2) moist; massive; slightly hard when dry, very friable when moist; 20 percent sandstone and dark shale channery fragments; pH 6.0; gradual wavy boundary.

R—28 to 35 inches; interbedded sandstone and hard shale.

Rock fragments cover 2 to 20 percent of the surface and make up 5 to 40 percent of the soil material. The C horizon ranges from very channery sandy loam to channery or flaggy clay loam, depending on the amount of sandstone or shale in the local bedrock.

JeF—Jenkins gravelly loam, 15 to 60 percent slopes. This is the only Jenkins soil mapped in the survey area.

Runoff is medium, and the erosion hazard is high.

This soil is used for timber production and grazing. The soil is only fair for either herbage or timber production and is medium for water yield. The windthrow hazard is severe, and logging limitations are moderate. The soil is poor for water-retaining structures. It is poor for recreational uses and fair for big game.

The soil is best managed for water yield, wildlife habitat, and soil protection. Revegetation of eroded soils is very difficult because of low fertility and steep slopes. Good management maintains or improves the vegetative cover.

Judy series

The Judy series consists of well drained, sloping to very steep soils that formed in material weathered from limestone under grass at high elevations.

These soils are in open, parklike areas surrounded by stands of Engelmann spruce. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 38° F. Permeability is slow, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

Typically, the surface layer is brown silty clay loam about 12 inches thick. The subsoil is brown heavy silty clay loam in the upper 6 inches and calcareous, yellowish brown light silty clay loam in the lower 5 inches. Limestone is at a depth of 23 inches.

Representative profile of Judy silty clay loam having slope of 23 percent at an elevation of 10,600 feet along the trail that leads to Doctor Park in the SW¼NW¼ sec. 25, T. 14 S., R. 82 W.:

A1—0 to 12 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; strong fine crumb structure; soft when dry, very friable when moist; pH 6.6; gradual wavy boundary.

B2t—12 to 18 inches; brown (10YR 5/3) heavy silty clay loam, dark brown (10YR 4/3) moist; weak fine prismatic structure that parts to stronge fine angular and subangular blocky; hard when dry, very friable when moist; many thin discontinuous clay films on peds; pH 7.2; gradual smooth boundary.

B3ca—18 to 23 inches; yellowish brown (10YR 5/4) light silty clay loam, dark yellowish brown (10YR 4/4) moist; moderate fine subangular blocky structure; hard when dry, very friable when moist; few thin discontinuous clay films on peds; 5 percent limestone pebbles; secondary calcium carbonate coatings on undersides of pebbles; pH 8.2; gradual wavy boundary.

R—23 to 30 inches; fractured limestone.

Thickness of the A1 horizon ranges from 7 to 15 inches. The B2t horizon ranges from heavy clay loam to silty clay.

JuE—Judy silty clay loam, 5 to 25 percent slopes. This soil has the profile described as representative for the series. A small acreage of Limber soils was included in mapping. Also included, in mountain toe slope positions, were some soils with bedrock 4 feet to many feet below the surface. There are also minor inclusions of red lithochromic soils.

Runoff is medium, and the erosion hazard is moderate.

This soil is used mainly for grazing. The grassland areas include some areas of small stands of Engelmann spruce. These areas are grazed along with the open grassland.

The capacity of this soil to produce range herbage is good. The suitability of the soil for lodgepole pine is fair and for spruce or fir is poor. The soil has medium value for water yield, due mainly to its comparatively shallow depth over bedrock and its consequent low water storage capacity. Areas of this soil are visited occasionally by sightseers because of its scenic value, but the soil is poorly suited to recreational development. The soil is good for water retaining structures where it is not too shallow over bedrock.

Range herbage production and water yield are the best uses of this soil. For the most part, this soil has an excellent herbaceous cover, and management should be directed to maintaining this cover. The soil is fairly well suited to habitat for deer and elk.

JuF—Judy silty clay loam, 25 to 60 percent slopes. This soil has a profile similar to the one described as representative for the series, but its horizons are somewhat thinner, and bedrock is generally at a shallower depth.

Runoff is rapid, and the erosion hazard is high.

This soil is used for grazing, and it is well suited to this use. In general, this soil is suitable for the same uses as Judy silty clay loam, 5 to 25 percent slopes, but its value for water yield is low. This soil is fairly well suited to habitat for deer and elk.

Range herbage production and water yield are the best uses of this soil. Management is more complex on this soil than it is on Judy silty clay loam, 5 to 25 percent slopes, because of steeper slopes and a high erosion hazard.

Kebler series

The Kebler series consists of well drained, sloping to very steep soils that formed in material weathered from sandstone of the Dakota or Morrison Formations under lodgepole pine.

The mean annual precipitation is 20 inches, and the mean annual soil temperature is 36° F. Permeability is moderately rapid, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

Underlying a 2-inch organic layer, the surface layer typically is light brownish gray, very pale brown, and brown sandy loam and fine sandy loam 13 inches thick. The subsoil is yellowish brown very stony fine sandy loam 11 inches thick. Sandstone is at a depth of 24 inches.

Representative profile of Kebler sandy loam having slope of 22 percent at an elevation of 10,100 feet, 0.1 mile south of Junction of trails 743 and 431 in the SW¼ sec. 33, T. 51 N., R. 2 E.:

O1—2 inches to 1; undecomposed organic material, mainly needles, twigs, and bark.

O2—1 inch to 0; partially decomposed organic material.

A21—0 to 4 inches; light brownish gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak fine subangular blocky structure that parts to moderate very fine granular; vesicular; soft when dry, very friable when moist; pH 5.0; clear smooth boundary.

A22—4 to 9 inches; very pale brown (10YR 7/3) light sandy loam, brown (10YR 5/3) moist; weak fine subangular blocky structure that parts to moderate very fine granular; soft when dry, very friable when moist; vesicular; pH 5.0; clear wavy boundary.

A&B—9 to 13 inches; brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard when dry, very friable when moist; 80 percent of the material is similar to the material in the overlying horizon and the rest is imbedded nodules and seams of more clayey material similar to the material in the underlying B2t horizon; 5 percent rock fragments; pH 4.8; clear wavy boundary.

IIB2t—13 to 24 inches; yellowish brown (10YR 5/4) very stony fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; slightly hard when dry, very friable when moist; common thin discontinuous clay films on peds and clay coatings on sand grains and clay bridges between sand grains; 60 percent rock fragments; pH 5.0; gradual smooth boundary.

IIR—24 to 30 inches; hard sandstone.

In some places, the soil has a thin A1 horizon. The A22 horizon when dry ranges from light gray (7.5YR 7/2) to pale brown (10YR 6/3) and very pale brown (10YR 7/3). Hue of 10YR is most common. Sandstone flagstones cover 3 to 15 percent of the surface in most places. In small areas, they cover as much as 70 percent. Sandstone rock fragments range from 5 to 80 percent of the soil material, and the content of stones increases with depth. Stones make up more than 50 percent of the B2t horizon. Depth to hard sandstone ranges from 20 to 40 inches, but small areas are shallower or deeper.

KeE—Kebler sandy loam, 5 to 25 percent slopes. This soil has the profile described as representative for the series. Small acreages of Eyre, Jenkins, and Mayoworth soils were included in mapping. Also included were areas of sandstone or shale Rock outcrop.

Runoff is medium, and the erosion hazard is moderate.

This soil is in lodgepole pine but is grazed to some extent. It is poor for range herbage, fair for lodgepole pine, poor for Englemann spruce or subalpine fir, and medium for water yield. The windthrow hazard is severe. The soil is fair for wildlife habitat, including habitat for big game, but it is generally poor for recreation.

The best uses of this soil are for timber, water yield, and wildlife habitat. Management of the existing timber increases water yield, favors wildlife, and protects the soil.

KeF—Kebler sandy loam, 25 to 60 percent slopes. This soil has a profile similar to the one described as representative for the series, but bedrock is at a shallower depth. This soil contains a higher proportion of bedrock outcrops than Kebler sandy loam, 5 to 25 percent slopes.

Runoff is medium to rapid, and the erosion hazard is high.

This soil is mainly in lodgepole pine. It can be used for about the same purposes as Kebler sandy loam, 5 to 25 percent slopes, although its value for water yield is low.

This soil should be managed for timber, water yield, and wildlife habitat. Managing for these uses also protects the soil, which is very droughty because of the shallow depth to bedrock.

Lamphier series

The Lamphier series consists of well drained, sloping to steep soils that formed in valley-filling materials in fan or toe slope positions below areas underlain by Maroon conglomerate.

Vegetation is dominantly grasses and forbs. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 36° F. Permeability is moderately slow, and available water capacity is high. Roots can penetrate to a depth of more than 60 inches.

Typically, the surface layer is brown loam about 16 inches thick. The subsoil is brown light clay loam 15 inches thick. The substratum is brown heavy loam to a depth of 60 inches.

Representative profile of Lamphier loam having

slope of 18 percent at an elevation of 10,500 feet near the upper end of Cement Creek in the SW¼ sec. 15, T. 13 S., R. 84 W.:

A11—0 to 10 inches; brown (7.5YR 5/2) loam, dark brown (7.5YR 3/2) moist; strong fine crumb structure; soft when dry, very friable when moist; pH 6.4; gradual smooth boundary.

A12—10 to 16 inches; brown (7.5YR 5/2) loam, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure that parts to moderate fine granular; soft when dry, very friable when moist; pH 6.4; clear smooth boundary.

B2—16 to 31 inches; brown (7.5YR 5/3) light clay loam, dark brown (7.5YR 3/3) moist; moderate medium subangular blocky structure that parts to moderate fine subangular blocky; soft when dry, very friable when moist; few thin discontinuous clay films on vertical ped surfaces; 5 percent pebbles; pH 6.2; gradual smooth boundary.

C—31 to 60 inches; brown (7.5YR 5/3) heavy loam, dark brown (7.5YR 4/3) moist; massive; slightly hard when dry, very friable when moist; 10 percent pebbles and cobbles, some of which are weathered; pH 6.4.

Thickness of the A horizon ranges from 16 to 40 inches. Pebbles, cobbles, and stones make up 0 to 15 percent of the soil material.

LaF—Lamphier loam, 5 to 45 percent slopes. This is the only Lamphier soil mapped in the survey area. Small acreages of Ashcroft, Hierro, and Sawcreek soils were included in mapping.

Runoff is medium, and the erosion hazard is moderate.

This soil is used as range, and it produces excellent range herbage. The suitability of this soil is fair for lodgepole pine and poor for Engelmann spruce or subalpine fir. The soil's capacity to store water for slow release is high. In its position in the landscape, the soil receives water from higher lying areas. In addition, since the soil is at high elevations, much snow falls and does not melt rapidly in spring.

Areas on lower slopes are excellent for recreational development. This soil is close to streams with good fishing. Most areas of this soil are remote from good roads. Fishermen are the major recreationists.

This soil is best suited to range herbage production and water yield. Any system of management must consider the pocket gopher.

Landslides and gullied land

Ld—Landslides and Gullied land. This land type consists of very severely eroded soils. Gullies or landslides dominate the landscape. The soil material is silty clay in many places. There are areas of very severely eroded soils where the vegetation has been destroyed by fire, cattle concentrations, or other causes. Landslides are most prevalent in areas where the bedrock is shale. During or after heavy rains or rains of long duration, soil and rock fragments slide down slopes, leaving behind a scarred surface and very irregular piles of debris at the slope base.

Vegetation is very sparse or absent on such areas. Although areas of Landslides and Gullied land have little or no vegetation, they are mostly in areas that are being grazed.

This land type is poor to very poor for either range herbage or timber production. Runoff is rapid, so little water enters the soil. Consequently, the soil's value for water yield is low. This unit is very poor for wildlife habitat or for recreation.

Because the erosion hazard is very high and because these soils become dry and hard, management to revegetate these areas is extremely difficult. The value of the land does not justify engineering structures which might in fact only cause more landslides. Livestock should be kept away from such areas to prevent trampling and to allow natural revegetation. Seepy areas and some gully channels that remain wet can be planted to willows. However, channels that carry considerable water should not be blocked by willows. In any case, the land manager will find any kind of rehabilitation difficult due to low fertility, excessive runoff, droughtiness, and soils that become very hard on drying.

Leal series

The Leal series consists of well drained, sloping to very steep soils that formed in valley filling deposits of granitic origin.

These soils are in steep mountainous areas between elevations of 10,500 and 11,500 feet. Vegetation is mixed lodgepole pine and Engelmann spruce, or Engelmann spruce and subalpine fir. The mean annual precipitation is about 26 inches, and the mean annual soil temperature is about 35° F. Permeability is moderately rapid, and available water capacity is moderate. Roots can penetrate to a depth of more than 60 inches.

Underlying about 2 inches of forest litter and partially decomposed organic material, the surface layer typically is mostly pinkish gray gravelly loamy sand 4 inches thick. The subsoil is brown and reddish brown gravelly sandy loam 24 inches thick. The next layer is light yellowish brown gravelly sandy loam 13 inches thick. The substratum is light yellowish-brown very gravelly loamy coarse sand about 20 inches thick.

Representative profile of Leal gravelly loamy sand having slope of 50 percent at an elevation of 10,800 feet in New Dollar Gulch in the NE¼ sec. 19, T. 51 N., R. 4 E.:

O1—3 inches to 2; undecomposed pine needles and other organic debris.

O2—2 inches to 0; partially decomposed organic remains.

A1—0 to 1 inch; dark gray (10YR 4/1) gravelly sandy loam, very dark gray (10YR 3/1) moist; strong very fine granular structure; soft when dry, very friable when moist; 25 percent angular granitic pebbles; pH 6.6; abrupt smooth boundary.

A2—1 to 4 inches; pinkish gray (7.5YR 7/2) gravelly loamy sand, dark brown (7.5YR 4/3) moist; moderate fine granular structure; soft when dry, very friable when moist; 25 percent fine angular granitic pebbles; pH 6.4; clear smooth boundary.

B21—4 to 8 inches; brown (7.5YR 5/4) gravelly sandy loam, dark brown (7.5YR 4/4) moist; strong fine and very fine subangular blocky structure that parts to moderate fine granular; soft when dry, very friable when moist; 30 percent angular granitic pebbles; pH 6.0; clear smooth boundary.

B22—8 to 19 inches; reddish brown (5YR 5/4) gravelly sandy loam, reddish brown (5YR 4/4) moist; moderate fine and very fine subangular blocky structure that parts to moderate fine granular; slightly hard when dry, very friable when moist; 25 percent fine angular granitic pebbles; pH 6.2; gradual smooth boundary.

B23—19 to 28 inches; brown (7.5YR 5/4) gravelly sandy

loam, dark brown (7.5YR 4/4) moist; moderate fine subangular blocky structure that parts to moderate fine granular; slightly hard when dry, very friable when moist; 20 percent fine angular granitic pebbles; pH 6.0; gradual smooth boundary.

B3—28 to 41 inches; light yellowish-brown (10YR 6/4) gravelly sandy loam, yellowish brown (10YR 5/4) moist; weak very fine subangular blocky structure; slightly hard when dry, very friable when moist; 40 percent angular pebbles; pH 5.6; gradual wavy boundary.

C—41 to 60 inches; light yellowish brown (10YR 6/4) gravelly loamy coarse sand, yellowish brown (10YR 5/4) moist; single grained; soft when dry, very friable when moist; 40 percent angular pebbles; pH 6.2.

The A2 horizon ranges from 3 to 6 inches thick. The B2 horizon ranges from gravelly sandy loam to loam. When dry, colors range in hue from 5YR to 7.5YR, in value from 4 to 6, and in chroma from 4 to 6. There are burned-over areas of soils that do not have O1 and O2 horizons.

LeE—Leal gravelly loamy sand, 5 to 25 percent slopes. This soil has a profile similar to the one described as representative for the series. Some areas of soils of alluvial origin were included in mapping.

Runoff is slow, and the erosion hazard is slight.

This soil is in forest which is grazed to some extent. This soil has a slightly wider range of potential uses than Leal gravelly loamy sand, 25 to 50 percent slopes, because it is more gently sloping. The soil is fair for herbage or timber production. Areas in forest should not be cleared with the intention of establishing grasses because the low soil fertility makes establishment of grasses difficult. Because of lower slope gradients, logging limitations are moderate. Timber production and water yield are the best uses of this soil, even though the soil has only fair potential for these uses.

LeF—Leal gravelly loamy sand, 25 to 60 percent slopes. This soil has the profile described as representative for the series. A few small areas of Schofield soils were included in mapping.

Runoff is medium, and the erosion hazard is moderate.

Most of this soil is forested with lodgepole pine at lower elevations. Lodgepole pine, spruce, and fir are at higher elevations.

This soil is poor for herbage production and only fair for timber. Its value for water yield is medium. It is poorly suited to recreational development.

Although timber production and water yield are not well suited to the soil, these are its best uses. The windthrow hazard is moderate and logging limitations are moderately severe because of steep slopes and the erosion hazard. A system of logging that provides a minimum of soil disturbance is recommended.

Leaps series

The Leaps series consists of well drained, sloping to steep soils that formed in material in alluvial fans and alluvial-colluvial material weathered from Mancos shale with minor amounts of sandstone.

The vegetation is wheatgrass, nodding brome, stipa, false hellebore, larkspur, and fireweed. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 36° F. Permeability is very slow, and available water capacity is high. Roots can penetrate to a depth of more than 60 inches.

Typically, the surface layer is very dark grayish brown, dark grayish brown, and grayish brown silty clay loam about 14 inches thick. The underlying material is grayish brown silty clay loam more than 46 inches thick.

Representative profile of Leaps silty clay loam having slope of 23 percent at an elevation of 10,000 feet in a newly bulldozed trench near the head of Washington Gulch in the SW¼ sec. 31, T. 12 S., R. 86 W.:

A11—0 to 3 inches; very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate very fine granular structure; soft when dry, very friable when moist; few angular sandstone fragments and flat, black shale fragments; many roots; pH 6.5; clear wavy boundary.

A12—3 to 8 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure that parts to moderate fine granular; slightly hard when dry, friable when moist; few angular sandstone fragments and flat shale fragments; many roots; pH 6.0; clear wavy boundary.

A13—8 to 14 inches; grayish brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate coarse subangular blocky structure that parts to strong fine granular; hard when dry, firm when moist; peds have numerous root and worm holes and organic coatings; a few sandstone and shale fragments; many roots; pH 6.0; clear wavy boundary.

C—14 to 60 inches; grayish brown (10YR 5/2) silty clay loam; dark brown (10YR 4/3) moist; massive; very hard when dry, very firm when moist; 10 percent weathered sandstone fragments; few roots to a depth of 45 inches; pH 6.0.

The A horizon ranges from 10 to 15 inches thick and from silt loam to silty clay loam. The C horizon ranges from clay loam to silty clay loam.

LlF—Leaps silty clay loam, 5 to 45 percent slopes. This is the only Leaps soil mapped in the survey area.

Runoff is medium to rapid, and the erosion hazard is high. Most of this soil is used for range, although a small acreage is in forest.

This soil is good for herbage production and poor to very poor for timber. Its value for water yield is medium. This soil is poor for recreational development because the fine textured material compacts under foot traffic. Permeability of the soil and substratum is slow, which makes the soil poor for sanitation structures. The soil is fair for water retaining structures. Value for wildlife is good. Food, water, cover, and escape routes are available on this or associated soils.

Herbage production, wildlife habitat, and water yield are the best uses of this soil. The soil is highly susceptible to erosion when the vegetative cover is disturbed or destroyed. Runoff is rapid in areas where the soil is eroded, and the soil surface becomes hard on drying and it cracks, which makes revegetation difficult.

Limber series

The Limber series consists of well drained, sloping

to very steep soils that formed in material weathered from limestone under forest vegetation.

In places, the soil material has been transported as slopewash or soil slips. Vegetation is Engelmann spruce with some subalpine fir at higher elevations, and in many places, scattered quaking aspen. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 38° F. Permeability is moderate, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

A layer of litter overlies a surface layer that typically is pinkish gray gravelly loam 2 inches thick. The subsoil is reddish brown, light brown, and pinkish gray gravelly clay loam and gravelly loam 20 inches thick. The substratum is pinkish gray calcareous gravelly loam. Fractured limestone is at a depth of 34 inches.

Representative profile of Limber gravelly loam having slope of 50 percent at an elevation of 8,900 feet, 400 feet southwest of the Pioneer Ranch on Cement Creek:

O1—2 inches to 1; undecomposed organic material, mainly twigs, bark, needles, and leaves.
O2—1 inch to 0; partially decomposed organic material.
A2—0 to 2 inches; pinkish gray (7.5YR 6/2) gravelly loam, dark brown (7.5YR 4/3) moist; moderate fine granular structure; soft when dry, very friable when moist; 15 percent limestone pebbles; pH 6.4; abrupt smooth boundary.
B21t—2 to 8 inches; reddish brown (5YR 5/3) gravelly clay loam, reddish brown (5YR 4/3) moist; moderate fine subangular blocky structure; slightly hard when dry, very friable when moist; common thin discontinuous clay films on peds; 15 percent limestone pebbles; pH 7.0; clear smooth boundary.
B22t—8 to 13 inches; light brown (7.5YR 6/3) gravelly clay loam, dark brown (7.5YR 4/3) moist; moderate fine subangular blocky structure; soft when dry, very friable when moist; common thin discontinuous clay films on peds; 30 percent limestone pebbles; pH 7.4; clear smooth boundary.
B3—13 to 22 inches; pinkish gray (7.5YR 6/2) gravelly loam, dark brown (7.5YR 4/2) moist; weak very fine subangular blocky structure; slightly hard when dry, very friable when moist; few thin discontinuous clay films on peds; 30 percent limestone pebbles; pH 8.0; gradual smooth boundary.
Cca—22 to 34 inches; pinkish gray (7.5YR 7/2) gravelly loam, light brown (7.5YR 6/3) moist; massive; soft when dry, very friable when moist; 30 percent limestone pebbles and cobbles; common calcium carbonate coatings on rocks; pH 8.2; gradual smooth boundary.
R—34 to 38 inches; fractured limestone.

The A2 and B horizons range from gravelly loam to gravelly silty clay loam. Depth to bedrock varies from 20 to 40 inches. The depth to secondary calcium carbonates ranges from 10 to 24 inches.

LmE—Limber gravelly loam, 5 to 25 percent slopes. This soil has a profile similar to the one described as representative for the series, but depth to bedrock is generally greater. Much of the acreage of this soil occupies smoothly rounded ridgetops and lower alluvial-colluvial slopes. Depth to bedrock or highly fractured rock ranges from 30 to 40 inches. Included in mapping were soils with bedrock below a depth of 40 inches.

Runoff is medium, and the erosion hazard is moderate.

This soil is used principally for timber production. This is its best use although it is fairly well suited to herbage production. Where the soil is forested, it should remain in timber production. The soil ranks medium for water yield. It is well suited to recreational development, except that it is unsuitable for septic tanks and drainage fields.

Due to the lower slope gradients, logging limitations are slight for this soil compared to the moderately severe limitations for Limber gravelly loam, 5 to 25 percent slopes.

LmF—Limber gravelly loam, 25 to 70 percent slopes. This soil has the profile described as representative for the series. Included in mapping were some soils, transitional to Judy soils, with an inch-thick A1 horizon. Small acreages of Judy, Schofield, and Stecum soils were also included in mapping. Rock outcrop was included in a few places.

Runoff is medium to rapid, and the erosion hazard is high.

This soil is fairly well suited to herbage and timber production. Most of this soil is in Engelmann spruce and subalpine fir. Mainly because of its relatively shallow depth over bedrock and its steep to very steep slopes with rapid runoff, this soil ranks low for water yield. The windthrow hazard is moderate. This soil is fairly well suited to wildlife habitat and recreation. Because of the hazard of erosion and steep slopes, this soil has moderately severe logging limitations. Although timber production is the best use of this soil, extreme care is necessary to prevent too much soil disturbance. On the steeper slopes, some system of cable logging, in preference to tractor logging, is recommended.

Lucky series

The Lucky series consists of well drained, sloping to very steep soils that formed in material weathered from schist and gneiss under sagebrush and grass.

Lucky soils have slopes with north and northeast aspects. Elevation is more than 8,000 feet. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 38° F. Permeability is moderate, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

Typically, the surface layer is dark brown gravelly sandy loam about 8 inches thick. The subsoil is yellowish brown and brown gravelly sandy loam and gravelly sandy clay loam 29 inches thick. Gneiss is at a depth of 37 inches.

Representative profile of Lucky gravelly sandy loam having uniform slope of 24 percent at an elevation of 9,150 feet in the NE¼ sec. 10, T. 48 N., R. 1 E.:

A1—0 to 8 inches; dark brown (10YR 3/3) gravelly sandy loam, very dark brown (10YR 2/3) moist; weak very fine granular structure; soft when dry, very friable when moist; 15 percent angular pebbles; many roots; pH 6.5; clear smooth boundary.
B1—8 to 13 inches; yellowish brown (10YR 5/4) gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure that parts to moderate fine granular; slightly hard when dry, very friable when moist; 15 percent angular pebbles; many roots; pH 6.0; clear smooth boundary.
B2t—13 to 20 inches; yellowish brown (10YR 5/4) gravelly sandy clay loam, dark yellowish brown (10YR

4/4) moist; moderate medium subangular blocky structure that parts to moderate fine granular; very hard when dry, firm when moist; common thin continuous clay films on peds; 15 percent angular gneiss and schist pebbles; few roots; pH 6.5; clear wavy boundary.

B3—20 to 37 inches; brown (7.5YR 5/4) gravelly sandy clay loam, dark brown (7.5YR 4/4) moist; weak medium angular blocky structure that parts to strong fine granular; a few thin clay films on peds; 15 percent angular gneiss and schist pebbles; very few roots; pH 6.5; abrupt wavy boundary.

IIR—37 to 41 inches; gneiss.

In places the A1 horizon is several inches thicker directly under sagebrush. The A1 horizon in places is gravelly fine sandy loam.

LuE—Lucky gravelly sandy loam, 5 to 25 percent slopes. This soil has the profile described as representative for the series.

Runoff is medium, and the erosion hazard is moderate.

This soil is used as range and is fairly well suited to this use. Suitability for timber ranges from poor to fair. The soil is medium for water yield. Although there are plenty of browse plants, areas of this soil are not frequented by big game because there are few concealment plants and few escape routes. This soil is well suited to habitat for game birds, but it is only fair for recreational development because the shallow depth to bedrock limits the construction of sanitation facilities. Deeper soils are satisfactory for sanitary facilities if they are not too close to streams, springs, or lakes because the bedrock in shallower soils deflects water that could be a source of contamination.

Range herbage production and water yield are the best uses for this soil, although its potential for these uses is only fair. Precipitation is inadequate for good herbage production. Grass is sparse in many areas; the vegetative cover is dominantly big sagebrush. Good management emphasizes the reduction of plant competition for moisture to favor more desirable species in the plant community.

LuF—Lucky gravelly sandy loam, 25 to 65 percent slopes. This soil has a profile similar to the one described as representative for the series, but its horizons are somewhat thinner and depth to bedrock is less.

Runoff is medium, and the erosion hazard is high.

This soil is used as range. It can be used for the same purposes as Lucky gravelly sandy loam, 5 to 25 percent slopes, although its potential for water yield is low. The steeper slope gradients and shallower depth to bedrock enhance runoff, so less water is stored in the soil.

This soil can be managed for herbage production and water yield, with soil protection as an additional objective.

Matcher series

The Matcher series consists of well drained, sloping to very steep soils that formed in granitic glacial moraines under lodgepole pine with a few scattered spruce.

The mean annual precipitation is 20 inches, and the mean annual soil temperature is 36° F. Permeability is rapid, and available water capacity is low. Roots can penetrate to a depth of more than 60 inches.

Under a layer of litter 3 inches thick, the surface layer typically is grayish brown stony sandy loam about 9 inches thick. The subsoil is reddish gray, reddish brown, and yellowish brown very stony sandy loam and very stony loamy coarse sand 13 inches thick. The substratum is light olive brown very stony sand.

Representative profile of Matcher stony sandy loam having slope of 7 percent at an elevation of 9,900 feet near the confluence of Middle Quartz Creek and South Quartz Creek, 1,000 feet south of road junction in sec. 12, T. 50 N., R. 4 E.:

O1—3 inches to 1; undecomposed organic material, mainly needles, bark, and twigs.

O2—1 inch to 0; partially decomposed organic material.

A1—0 to 9 inches; grayish brown (10YR 5/2) stony sandy loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft when dry, very friable when moist; 20 percent stones; pH 6.6; abrupt smooth boundary.

B21—9 to 13 inches; reddish gray (5YR 5/2) very stony sandy loam, dark reddish brown (5YR 3/2) moist; moderate fine granular structure; slightly hard when dry, very friable when moist; 60 percent stones; pH 6.0; clear smooth boundary.

B22—13 to 18 inches; reddish brown (5YR 5/4) very stony sandy loam, reddish brown (5YR 4/4) moist; weak medium subangular blocky structure that parts to strong very fine subangular blocky; slightly hard when dry, very friable when moist; 60 percent stones; pH 6.2; clear smooth boundary.

B3—18 to 22 inches; yellowish brown (10YR 5/4) very stony loamy coarse sand, dark yellowish brown (10YR 4/4) moist; single grained; loose when dry and moist; 60 percent stones; pH 6.2; clear smooth boundary.

C—22 to 60 inches; light olive brown (2.5Y 5/4) very stony sand, olive brown (2.5Y 4/4) moist; single grained; loose when dry and moist; 60 percent cobbles and stones; pH 6.4.

The A1 horizon when dry ranges from grayish brown (10YR 5/2) to brown (10YR 5/3 or 7.5YR 4/2) stony sandy loam, gravelly loam, or fine sandy loam. Hues of the B2 horizon range from 5YR to 7.5YR, and chromas, from 2 to 4. The B2 horizon is commonly very gravelly sandy loam or stony sandy loam.

MaE—Matcher stony sandy loam, 5 to 25 percent slopes. This soil has the profile described as representative of the series. Several small areas of Tex soils were included in mapping.

Runoff is slow, and the erosion hazard is slight.

This soil is in lodgepole pine with scattered Engelmann spruce. Much of the timber was cut or burned over between 1800 and 1900, resulting in overmature stands missed by fires surrounded by extensive stands of pole sized lodgepole pine. These stands support so many trees per acre that growth has been retarded for the past 30 years. This soil is poor for range herbage and only fair for timber production but should remain in timber. Its value for water yield is high because the soil is very permeable and the underlying glacial deposits are permeable and deep. The soil is somewhat droughty since the soil is too pervious to store much water within the rooting zone. This soil is poor for wildlife habitat because food and water are scarce. Timber production and water yield are the best uses. Little can be done to increase water yield except through timber management.

MaF—Matcher stony sandy loam, 25 to 60 percent slopes. Much of the acreage of this soil is at an elevation of about 10,000 feet. The understory includes a high proportion of vaccinium, rather than the kinnikinnick found at lower elevations. The understory, however, is generally sparse.

Runoff is slow, and the erosion hazard is moderate.

This soil is poor for range herbage production. On this permeable soil, gully erosion rather than sheet erosion is common. The windthrow hazard is slight, but logging limitations are moderately severe because of steep slopes.

This soil should be managed for timber production and water yield. Much of the forest is infested with mistletoe.

McF—Matcher very stony sandy loam, 5 to 45 percent slopes. This soil has a profile similar to the one described as representative for the series, except that stones 10 to 24 inches in diameter cover 40 to 90 percent of the surface, or boulders cover 15 percent of the surface. The soils are sloping to very steep, although only a minor acreage has slope that exceeds 25 percent. Stones or boulders on the surface prohibit the use of machinery for timber plantings.

Runoff is slow and the erosion hazard is slight.

This soil is used for timber production. Logging limitations for this soil are severe because of the steep slopes and the stones or boulders that make tractor logging impractical or impossible. Some system of cable logging is needed where timber yield is sufficient to justify logging. The stones or boulders on the surface and within the soil greatly increase the cost of constructing roads or trails.

In general, this soil can be used for about the same purposes as Matcher stony sandy loam, 5 to 25 percent slopes, but it does have the limitations described in the preceding paragraph. It should be managed for timber production and water yield.

Mayoworth series

The Mayoworth series consists of well drained, moderately steep to very steep soils that formed in material weathered from sandstone under big sagebrush-grass vegetation.

The mean annual precipitation is 20 inches, and the mean annual soil temperature is 38° F. Permeability is moderately slow, and available water capacity is moderate. Roots can penetrate to a depth of 20 to 40 inches.

Typically, the surface layer is dark brown loam about 5 inches thick. The subsoil is pale brown and dark grayish brown or brown clay loam and light clay 16 inches thick. The substratum is light brownish gray clay loam that overlies sandstone at a depth of 30 inches.

Representative profile of a Mayoworth loam along the trail east of the town of Almont in the NW¼SE¼ sec. 24, T. 51 N., R. 2 E.:

A1—0 to 5 inches; dark brown (10YR 3/3) loam, very dark brown (10YR 2/2) moist; weak very fine granular structure; soft when dry, very friable when moist; a few angular sandstone pebbles and flagstones; many roots; pH 7.0; clear wavy boundary.

B1—5 to 9 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure that parts to moderate fine granular; very hard when dry, firm when moist; few thin discontinuous clay films on peds; 5 percent sandstone pebbles and flagstones; many roots; pH 6.5; clear wavy boundary.

B2t—9 to 13 inches; variegated pale brown (10YR 6/3) and dark grayish brown (10YR 4/2) light clay, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure that parts to moderate fine granular; very hard when dry, very firm when moist; common thin continuous clay films on peds; 5 percent sandstone pebbles and flagstones; few roots; pH 7.0; clear wavy boundary.

B3t—13 to 21 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate medium angular blocky structure; very hard when dry, very firm when moist; common discontinuous clay films; 10 percent sandstone pebbles and flagstones; few roots; pH 7.0; clear wavy boundary.

C—21 to 30 inches, light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; massive; very hard when dry, very firm when moist; 15 percent sandstone flagstones and pebbles; pH 7.0; abrupt wavy boundary.

IIR—30 to 36 inches, sandstone.

Thickness of the A1 horizon ranges from 5 to 10 inches. The A1 horizon ranges from loam to gravelly sandy loam or silty clay loam. The B2t horizon is light clay, silty clay, or heavy clay loam.

MhF—Mayoworth loam, 15 to 60 percent slopes. This is the only Mayoworth soil mapped in the survey area.

Runoff is rapid, and the erosion hazard is high.

This soil is used as range, but it is only fairly well suited to this use. The soil is droughty. It supports a sparse stand of grasses, much big sagebrush, and a variety of forbs. The soil is very poorly suited to timber and has a low capacity for water yield and a high erosion hazard. It is poorly suited to recreation and is fair for wildlife habitat, particularly for sage grouse.

This soil has low potential for most uses, but it is best used for range herbage production with wildlife habitat as an accessory use. Management of this soil should consider the low inherent fertility and the high erosion hazard. Relieving competition between grasses and undesirable species, particularly big sagebrush, might prove beneficial. Of course, elimination of big sagebrush would be detrimental to the habitat for sage grouse.

McIntyre series

The McIntyre series consists of well drained, sloping to very steep soils that formed in material weathered from sandstone of the Dakota and Morrison Formations under grass and quaking aspen. These plants replaced the original coniferous vegetation, which was destroyed by fire.

These soils occupy grassy, parklike areas that are intermingled with quaking aspen groves and widely scattered conifers. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 34° F. Permeability and available water capacity are moderate. Roots can penetrate to a depth of 20 to 40 inches.

Under a layer of organic material 2 inches thick, the surface layer typically is brown loam about 12

inches thick. The subsurface layer is pale brown very fine sandy loam 4 inches thick. The subsoil is light yellowish brown or very pale brown very fine sandy loam 9 inches thick. It has nodules or thin layers of clay loam. The substratum is very pale brown very fine sandy loam, 5 inches thick, that overlies soft sandstone at a depth of 30 inches.

Representative profile of McIntyre loam having slope of 5 percent at an elevation of 10,200 feet along Trail 434 in the SE¼ sec. 3, T. 50 N., R. 2 E.:

O1—2 inches to 1; undecomposed organic material composed of aspen leaves and leaves and stems of forbs.
O2—1 inch to 0; partially decomposed organic material.
A11—0 to 2 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; weak very fine granular structure; soft when dry, very friable when moist; many roots; pH 6.8; clear wavy boundary.
A12—2 to 12 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure that parts to weak very fine granular; soft when dry, very friable when moist; few angular sandstone pebbles; many roots; pH 6.0; clear irregular boundary.
A2—12 to 16 inches; pale brown (10YR 6/3) very fine sandy loam, variegated brown (10YR 5/3) and dark brown (10YR 4/3) moist; moderate medium angular blocky structure that parts to weak very fine granular; soft when dry, very friable when moist; few angular sandstone pebbles; few roots; pH 5.5; abrupt irregular boundary.
A&B—16 to 25 inches; variegated, very pale brown (10YR 8/4) and light yellowish brown (10YR 6/4) very fine sandy loam, yellowish brown (10YR 5/4) moist; moderate medium angular blocky structure that parts to weak very fine granular; soft when dry, very friable when moist; nodules and laminae of clay loam that are slightly hard when dry, firm when moist; 5 percent pebbles; few roots; pH 5.5; clear wavy boundary.
C—25 to 30 inches; very pale brown (10YR 7/3) very fine sandy loam, pale brown (10YR 6/3) moist; massive; soft when dry, very friable when moist; 20 percent sandstone pebbles; pH 5.5; abrupt wavy boundary.
IIR—30 to 33 inches; soft sandstone.

Thickness of the A1 horizon ranges from 6 to 24 inches, depending upon the extent of gopher activity. Where the A1 horizon is thickest, the A2 horizon is only 1 to 3 inches thick because it has been mixed with the upper horizons by gophers.

MnE—McIntyre loam, 5 to 25 percent slopes. This soil has the profile described as representative for the series. About 10 percent of this unit consists of included areas of Kebler sandy loam, 5 to 25 percent slopes.

Runoff is medium, and the erosion hazard is moderate.

This soil is used for range. Much of it is vegetated with unmanaged quaking aspen. The aspens provide shade for livestock on hot days, so the soil beneath them has been trampled.

This soil is fairly well suited to either range herbage or lodgepole pine production. It is poorly suited to Engelmann spruce, and it is at elevations too low for subalpine fir. Due to a shallow regolith, its value for water yield is low. This soil is only fair for wildlife habitat or recreation.

Production of range herbage is the best use of the soil. This also provides soil protection and increases water yield. This soil is fair for herbage production, but in some areas it produces large amounts of herbage. Timber replanting is difficult due to competition of grasses.

MnF—McIntyre loam, 25 to 65 percent slopes. This soil has a profile similar to the one described as representative for the series, but depth to bedrock varies from 22 to 30 inches.

Runoff is rapid, and the erosion hazard is high.

This soil is used for range and for timber production. It is fairly well suited to either range herbage or lodgepole pine production. The steep slopes require a logging method, other than tractor logging, that will cause a minimum of soil disturbance and erosion.

Production of range herbage is the best use of this soil. It is similar to McIntyre loam, 5 to 25 percent slopes, in its other suitabilities and limitations.

Mirror series

The Mirror series consists of well drained, moderately steep to very steep soils that formed in material weathered from quartz monzonite under alpine species of willows, grasses, sedges, and forbs.

This soil is above timberline in the alpine zone. The mean annual precipitation is 20 inches, and the mean annual temperature is 26° F. Permeability is rapid, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

Typically, under a 2-inch organic layer the surface layer is very dark gray gravelly sandy loam about 6 inches thick. The subsoil is brown and reddish yellow gravelly and very gravelly sandy loam 16 inches thick. The substratum is light yellowish brown extremely stony sandy loam, 8 inches thick, that overlies fractured quartz monzonite at a depth of 30 inches.

Representative profile of Mirror gravelly sandy loam having slope of 30 percent at an elevation of 12,050 feet on Cumberland Pass in the SW¼SE¼ sec. 11, T. 51 N., R. 4 E.:

O1—2 inches to 1; undecomposed organic material composed of alpine grasses.
O2—1 inch to 0; decomposed organic material.
A1—0 to 6 inches; very dark gray (10YR 3/1) gravelly sandy loam, black (10YR 2/1) moist; moderate fine granular structure; soft when dry, very friable when moist; 20 percent angular pebbles; abundant roots; pH 5.2; clear smooth boundary.
B21—6 to 12 inches; brown (7.5YR 5/3) gravelly loam, dark brown (7.5YR 4/3) moist; weak fine subangular blocky structure that parts to moderate fine granular; slightly hard when dry, very friable when moist; 15 percent angular pebbles; many sand-sized pellets of iron and humus; abundant roots; pH 5.0; clear wavy boundary.
B22—12 to 22 inches; reddish yellow (7.5YR 6/5) very gravelly sandy loam, strong brown (7.5YR 5/5) moist; weak fine subangular blocky structure that parts to weak fine granular; slightly hard when dry, very friable when moist; 60 percent pebbles with organic stains on their undersides; few roots; pH 4.8; gradual wavy boundary.
C—22 to 30 inches; light yellowish brown (10YR 6/4) extremely stony sandy loam, yellowish brown (10YR 5/4) moist; massive; slightly hard when dry, very friable when moist; 70 percent stones; pH 4.8; gradual wavy boundary.
R—30 to 34 inches; fractured quartz monzonite.

The A1 horizon is gravelly sandy loam, fine sandy loam, loam, or silt loam. In many places, there is a lag concentrate of gravel on the surface following the removal of fines by high winds. Depth to bedrock ranges from 20 to 40 inches.

MrE—Mirror gravelly sandy loam, 10 to 25 percent slopes. This soil has a profile similar to the one described as representative for the series, but thickness of horizons and depth to bedrock vary within short distances. Small acreages of Haverly-Vasquez loams, 5 to 25 percent slopes, Cryaquolls, Rock outcrop, and Rock slides were included in mapping.

Most of this unit occupies ridge crests in the alpine zone. Runoff is slow, and the erosion hazard is slight.

This soil is grazed for short periods by domestic sheep and is summer grazing area for elk. This soil is medium for water yield, and Mirror gravelly sandy loam, 25 to 70 percent slopes, is low. Runoff is not so rapid on this soil as it is on steeper soils, and more water enters the soil. Suitabilities, limitations, and management concerns of this soil are similar to those of Mirror gravelly sandy loam, 25 to 70 percent slopes.

MrF—Mirror gravelly sandy loam, 25 to 70 percent slopes. This soil has the profile described as representative for the series. Small acreages of Haverly-Vasquez loams, 25 to 70 percent slopes, Cryaquolls, Rock outcrop, and Rock slides were included in mapping.

Runoff is medium to rapid, and the erosion hazard is moderate.

Areas of this soil that are not isolated by steep, nearly vertical rock walls are grazed for short periods by sheep. This is also summer grazing area for elk. Where accessible to recreationists, as on Cumberland Pass, the soil provides scenic beauty to sightseers.

This soil is fair range for sheep and elk. It is relatively shallow to bedrock, so its capacity for storing water is limited. Its low water storing capacity and the violent winter winds that remove most of the snow make it low for water yield. Erosion results from winds that remove fine soil particles, leaving a gravel pavement on the surface. In a few areas, deep, slow-melting snowpacks have formed and caused snow burn of the underlying grasses. Such areas then become susceptible to soil blowing.

Range herbage production, wildlife habitat, and water yield are the best uses for this soil. Recreation is important but is limited mainly to sightseeing. The soil has low potential for water yield under present management; however, much snow falls on the area, and ways to increase the snowpack are under study.

Mysten series

The Mysten series consists of somewhat excessively drained, level to steep soils that formed in alluvial fan material weathered from granite.

The vegetation is mainly lodgepole pine and scattered quaking aspen with an understory of kinnikinnick, lupine, wild strawberry, wild roses, prostrate juniper, widely scattered grasses, and bitterbrush. The mean annual precipitation is 20 inches, and the mean annual air temperature is 37° F. Permeability is rapid, and available water capacity is low. Roots can penetrate to a depth of more than 60 inches.

Under a 2-inch organic layer, the surface layer typically is brown loamy fine sand about 6 inches thick. The underlying material is brown, gravelly loamy coarse sand.

Representative profile of Mysten loamy fine sand having slope of 10 percent at an elevation of 8,780 feet immediately west of the Spring Creek Campground in sec. 2, T. 15 S., R. 83 W.:

O1—2 inches to 1; undecomposed organic material, mainly needles, twigs, bark, and leaves.
O2—1 inch to 0; partially decomposed organic material.
A1—0 to 6 inches; brown (7.5YR 5/2) loamy fine sand, dark brown (7.5YR 3/2) moist; weak fine granular structure; soft when dry, very friable when moist; pH 6.8; clear smooth boundary.
C1—6 to 24 inches; brown (7.5YR 5/3) gravelly loamy coarse sand, dark brown (7.5YR 4/3) moist; single grained; soft when dry, very friable when moist; 25 percent angular fine pebbles; pH 6.2; gradual smooth boundary.
C2—24 to 60 inches; brown (10YR 5/3) gravelly loamy coarse sand, dark brown (10YR 4/3) moist; single grained; loose when dry and moist; 25 percent angular fine pebbles; pH 6.6.

The A1 horizon has dry values that range from 4 to 5 and dry chromas that range from 2 to 3. The A1 horizon is loamy coarse sand to loam 5 to 10 inches thick. The soil has loam texture where shale or Maroon conglomerate have contributed to the parent material.

MyE—Mysten loamy fine sand, 0 to 25 percent slopes. This is the only Mysten soil mapped in the survey area. A small acreage of gently sloping Teoculli loam on alluvial fans was included in mapping.

Runoff is very slow to slow, and the erosion hazard is moderate. Part of this soil is timbered, and some is in grassland. All of it is grazed to a lesser or greater extent. Most areas that are easily accessible by roads have been excavated to some extent for road construction material because the soil is excellent foundation material and good base course material.

This soil is poorly suited to range and very poorly suited to timber production. The soil is quite droughty. For unsurfaced roads it is poor because of insufficient clay. The substratum is so permeable that it is unsuitable for water retaining structures. Some campgrounds are located on this soil, but the soil is poorly suited to this use because of poor trafficability and compactibility. Its value for water yield is high because of rapid infiltration and permeability.

Water yield is the best use of this soil. Its value as road construction material is questionable because its esthetic value and its value for water yield would be destroyed.

Peeler series

The Peeler series consists of well drained, sloping to very steep soils that formed in alluvial-colluvial material weathered from granite.

Vegetation is lodgepole pine or mixed lodgepole pine and Engelmann spruce. Most of this soil is at elevations above 10,000 feet. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 38° F. Permeability and available water capacity are moderate. Roots can penetrate to a depth of more than 60 inches.

Under a 2-inch layer of litter the surface layer typically is light brownish gray gravelly sandy loam in the upper 5 inches and pale brown gravelly sandy loam in the lower 9 inches. The next layer is pale brown and brown gravelly sandy loam 22 inches thick. The subsoil is brown gravelly sandy clay loam 24 inches thick.

In the Taylor River Area, Peeler soils are mapped only in complex with Schofield soils.

Representative profile of Peeler gravelly sandy loam in an area of Schofield-Peeler gravelly sandy loams, 25 to 60 percent slopes, on the south side of Quartz Creek in the NE¼ sec. 20, T. 50 N., R. 4 E.:

O1—2 inches to 1; undecomposed organic material, chiefly needles, bark, and twigs.

O2—1 inch to 0; partially decomposed organic matter.

A21—0 to 5 inches; light brownish gray (10YR 6/2) gravelly sandy loam, dark grayish brown (10YR 4/2) moist; moderate to strong fine granular structure; soft when dry, very friable when moist; brittle and vesicular; 15 percent pebbles; pH 6.4; clear smooth boundary.

A22—5 to 14 inches; pale brown (10YR 6/3) gravelly sandy loam, dark brown (10YR 4/3) moist; moderate to strong fine granular structure; soft when dry, very friable when moist; brittle and vesicular; 15 percent pebbles; pH 6.2; gradual wavy boundary.

A&B—14 to 26 inches; pale brown (10YR 6/3) gravelly sandy loam, dark brown (10YR 4/3) moist; moderate fine subangular blocky structure that parts to moderate fine granular; soft when dry, very friable when moist; a few nodules and seams of material similar to material in the B2t horizon and embedded in a matrix of material similar to material in the overlying A2 horizon; 15 percent pebbles; pH 6.3; gradual wavy boundary.

B&A—26 to 36 inches; variegated pale brown (10YR 6/3) and brown (7.5YR 5/4) gravelly sandy loam, dark brown (10YR 4/3) and brown (7.5YR 4/3) moist; moderate fine subangular blocky structure; slightly hard when dry, very friable when moist; this horizon has material similar to material in the overlying A2 horizon embedded in material similar to material in the underlying B2t horizon; 15 percent pebbles; few clay films and seams; pH 6.4; gradual wavy boundary.

B21t—36 to 47 inches; brown (7.5YR 5/4) gravelly light sandy clay loam; dark brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; hard when dry, very friable when moist; common thin nearly continuous clay films on peds and sand grains; there is some tonguing of material from the A2 horizon into the upper 2 to 3 inches of this horizon; 25 percent pebbles; pH 6.4; gradual wavy boundary.

B22t—47 to 60 inches; brown (7.5YR 5/4) gravelly sandy clay loam; dark brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; hard when dry, very friable when moist; common thin nearly continuous clay films on peds and pebbles; 25 percent pebbles; pH 6.6.

There is an A1 horizon in places. The A2 horizon ranges from gravelly sandy loam to gravelly loam, fine sandy loam, or loam. Thickness of the A2 horizon ranges from 5 to 14 inches. In places there are no A&B and B&A horizons, and the A2 horizon directly overlies the B2t horizon.

Pierian series

The Pierian series consists of excessively drained, level to steep soils that formed in glacial outwash material derived from granite under sagebrush-grass vegetation.

The mean annual precipitation is 20 inches, and the mean annual soil temperature is 38° F. Permeability is rapid, and available water capacity is low. Roots can penetrate to a depth of more than 60 inches.

Typically, the surface layer is brown stony sandy loam about 8 inches thick. The underlying material is yellowish brown very stony loamy sand (fig. 12).

Representative profile of a nearly level Pierian stony sandy loam on a bench at an elevation of 8,300 feet, one-fourth mile east of the town of Almont in the NE¼SE¼ sec. 22, T. 51 N., R. 1 E.:

A1—0 to 8 inches; brown (10YR 4/3) stony sandy loam, dark-brown (10YR 3/3) moist; weak very fine granular structure; soft when dry, very friable when moist; 40 percent stones; many roots; pH 6.6; abrupt wavy boundary.

C1—8 to 22 inches; yellowish brown (10YR 5/4) very stony loamy sand, dark yellowish brown (10YR 4/4) moist; single grained; soft when dry, very friable when moist; 70 percent stones; many roots; pH 6.8; clear wavy boundary.

C2—22 to 60 inches; yellowish brown (10YR 5/4) very stony loamy sand, dark yellowish-brown (10YR 4/4) moist; single grained; loose when dry and

Figure 12.—**Profile of a Pierian stony sandy loam.**

moist; 70 percent stones; most stones are granite, but some are gneiss and schist, and a few are limestone fragments; pH 7.0.

The amount of boulders, stones, and cobbles in the soil varies greatly. The A1 horizon is 5 to 10 inches thick. It is stony sandy loam to very stony fine sandy loam.

PnA—Pierian stony sandy loam, 0 to 3 percent slopes. This soil has the profile described as representative for the series. A small acreage of Tine and Teoculli soils was included in mapping.

Runoff is slow, and the erosion hazard is slight.

This soil is used for range and recreation. It is used intensively for recreation because of its proximity to Taylor Reservoir, Taylor River, Willow Creek, Texas Creek, and other streams that provide excellent fishing. Campgrounds, guest ranches, a boat-rental establishment, and a trading post are on or near this soil.

Most of this soil is in Taylor Park, which is a temperature inversion area where frost can occur any night of the summer. The climatic conditions, plus droughtiness of the soils, are not favorable for the growth of range herbage, so these soils are poor for range. The soil is unsuitable for timber, and attempts at growing trees for ornamental purposes have failed. Due to its permeability and slope, the erosion hazard is slight. The deep, permeable substratum makes the soil's value for water yield high. Although there are a number of recreational developments on this soil, the poor trafficability creates concerns in the maintenance of some kinds of developments. The soil is suitable for sanitary developments, but the danger of pollution to lakes, streams, and springs needs to be considered because the substratum is very permeable. Recreation and water yield are the best uses for this soil. The soil does not produce much range herbage, and as the recreational pressures increase, there will be increasing conflicts between grazing and recreational uses. Boulders, ranging up to 4 feet in diameter, materially interfere with the use of machinery in any reseeding operation.

PnE—Pierian stony sandy loam, 3 to 35 percent slopes. This soil has a profile similar to the one described as representative for the series, but the surface layer is generally somewhat thinner. In a minor acreage of this soil, slopes have gradients between 25 and 35 percent, but most slopes do not exceed 8 percent. The areas are more dissected than areas of Pierian stony sandy loam, 0 to 3 percent slopes.

Runoff is slow to medium, and the erosion hazard is slight.

The soil is used for range and recreation. Most of this soil is at elevations too high to be winter range for deer.

This soil is used and managed similarly to Pierian stony sandy loam, 0 to 3 percent slopes. Some areas of this soil are not suitable for recreational development because of steep slopes.

PeA—Pierian sandy loam, 0 to 3 percent slopes. This soil has a profile similar to the one described as representative for the series, but it has only a few stones in the surface layer. The A1 horizon ranges from 5 to 10 inches in thickness, and it is underlain by sand and fine to coarse, rounded granitic gravel and a few cobbles up to 8 inches in diameter.

Runoff is slow, and the erosion hazard is slight.

The soil is used for range and recreation. It does not support forest vegetation, and because of its droughtiness and its location in a frost pocket, it is poorly suited to range. It is similar to Pierian stony sandy loam, 0 to 3 percent slopes, in its other suitabilities and limitation. The absence of surface stones makes it somewhat more desirable for recreational uses. A danger of water pollution from sanitary developments is a concern because of the shallow depth to highly permeable material.

Ptarmigan series

The Ptarmigan series consists of well drained, moderately steep to very steep soils that formed in material weathered from schist or gneiss on mountain crests and ridges above timberline.

Vegetation consists of alpine willows, alpine bluegrass, alpine fescue, geum, oxytropis, and white Indian paintbrush. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 26° F. Permeability is moderate, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

Typically, the surface layer is very dark grayish brown loam about 7 inches thick. The subsoil is yellowish brown loam 9 inches thick. The substratum is dark grayish brown loam 10 inches thick. Schist is at a depth of 26 inches.

Representative profile of Ptarmigan loam having slope of 27 percent at an elevation of 12,170 feet at Tincup Pass in the SW¼ sec. 27, T. 15 S., R. 81 W.:

A1—0 to 7 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 3/2) moist; weak very fine granular structure; soft when dry, very friable when moist; few angular gneiss pebbles; abundant roots; pH 5.5; clear wavy boundary.

B2—7 to 16 inches; yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 4/4) moist; weak very fine granular structure; soft when dry, very friable when moist; few gneiss pebbles; plentiful roots; pH 5.2; clear wavy boundary.

C—16 to 26 inches; dark grayish brown (2.5Y 4/2) loam, very dark grayish brown (2.5Y 3/2) moist; massive; soft when dry, very friable when moist; pH 5.0; abrupt irregular boundary.

IIR—26 to 36 inches; schist.

The A1 horizon is channery fine sandy loam to loam or silt loam. Stones make up 0 to 10 percent of the soil material. Depth to bedrock ranges from 20 to 40 inches. The A1 horizon ranges in hue from slightly redder than 10YR to 2.5Y, in chroma from neutral to 2, and in value from 2 to 4 when dry and 1 to 3 when moist. The B2 horizon ranges in hue from 10YR to 5YR, in chroma from 3 to 6, and in value from 5 to 7 when dry and 4 to 6 when moist.

PtF—Ptarmigan loam, 15 to 70 percent slopes. This is the only Ptarmigan soil mapped in the survey area.

This soil is grazed for short periods by domestic sheep, and it is summer range for elk. This Ptarmigan loam is in an area of scenic beauty that is visited by many sightseers, especially considering the road conditions in these areas. No lakes suitable for fish are within areas of this soil, but nearby Mirror Lake attracts many fishermen.

This soil is fairly well suited to range herbage production, but trees do not grow on this soil. Its value for water yield is medium.

Range herbage production, water yield, and recreation are the best uses of this soil, with wildlife habitat as an accessory use. Erodibility of this soil is a management concern. If turf is broken by overgrazing, soil blowing is severe. Increasing the snowpack, where practical, increases water production and makes the soil more productive.

Rarick series

The Rarick series consists of well drained, moderately steep to very steep soils that formed in material weathered from gneiss or schist under forest vegetation.

This soil is at high elevations, much of it in the subalpine zone. The vegetation is mainly Engelmann spruce and subalpine fir, but at lower elevations it is lodgepole pine and Engelmann spruce. The mean annual precipitation is 26 inches, and the mean annual soil temperature is 36° F. Permeability is moderately rapid, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

Under 3 inches of organic material the surface layer typically is dark brown loam about 8 inches thick. The subsurface layer is light gray gravelly loam 6 inches thick. The subsoil is brown gravelly sandy loam 7 inches thick. Gneiss is at a depth of 21 inches.

Representative profile of Rarick loam having slope of 57 percent at an elevation of 10,400 feet up Gold Creek from Ohio City and one-half mile beyond signpost showing directions to Gold Creek trail, Union Park, and Taylor River in T. 50 N., R. 3 E.:

O1—3 inches to 2; undecomposed organic material, mainly needles, bark, and twigs.
O2—2 inches to 0; partly decomposed organic material.
A1—0 to 8 inches; dark brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; strong medium granular structure; soft when dry, very friable when moist; 20 percent stones; pH 5.4; clear smooth boundary.
A3—8 to 14 inches; light gray (10YR 7/2) gravelly loam, grayish brown (10YR 5/2) moist; moderate very fine subangular blocky structure that parts to moderate fine granular; soft when dry, very friable when moist; 15 percent pebbles; pH 4.8; clear smooth boundary.
B2—14 to 21 inches; brown (7.5YR 5/3) gravelly sandy loam, dark brown (7.5YR 4/3) moist; moderate fine subangular blocky structure; slightly hard when dry, very friable when moist; 15 percent pebbles and stones; pH 5.0; gradual wavy boundary.
R—21 to 25 inches; fractured and partly weathered gneiss.

The parent material is variable, depending upon the proportion of gneiss or schist, and this is reflected in the texture of the horizons. The B2 horizon ranges from gravelly sandy loam to loam or silt loam.

RaF—Rarick loam, 10 to 60 percent slopes. This is the only Rarick soil mapped in the survey area. Small areas of Sanford, Leal, and Jenkins soils and Rock outcrop were included in mapping.

Runoff is medium to rapid, and the erosion hazard is high.

This soil is used for timber production and grazing. This Rarick loam is fair for range herbage and timber production. It is fair for recreation but poor for recreational development. The soil has a medium capacity for water yield. The windthrow hazard is high, and the soil has moderately severe limitations for logging. The soil material is very poor for water retaining structures because of its shallow depth to bedrock. This soil has only fair suitability as wildlife habitat because the sparse understory includes few browse plants.

The best uses of this soil are timber production and water yield. Although this friable soil has a high rate of infiltration and is very permeable, it is comparatively shallow to bedrock. Because this soil is shallow to bedrock, it has a limited capacity for storing water and there is more runoff. Under a forest canopy runoff is not very serious, but following soil disturbance by overgrazing or logging operations, the hazard of erosion is high. Because the soil is shallow over bedrock, tree roots take on a "pancake" form, which makes the trees susceptible to windthrow. Slope gradients in excess of 30 percent should be logged by some system other than by tractor.

Rock land

Rl—Rock land. This land type consists of outcrops of rock and very shallow soils. Fifty to 90 percent of the surface is barren rock; the remainder consists of shallow soil that is deepest in cracks or crevices in the rock. Texture of the soil material varies from silt loam to gravelly loamy sand, depending upon the kinds of rocks from which it weathered. The finer textured soils are associated with shale or limestone. Other kinds of bedrock exposed in areas of Rock land include granite, gneiss, schist, sandstone, and conglomerate. Locally, there is enough soil material to support some grass or trees. At lower elevations, the trees are lodgepole pine. At higher elevations, Engelmann spruce, Douglas-fir, and subalpine fir dominate. There are small patches of quaking aspen in places.

Rock land is an important source of water. Although its capacity for storing water is low, there is much runoff from the rock. The water is trapped in crevices, in rock slides, and in soils below areas of Rock land. At higher elevations, snow accumulates on Rock land. Because the snow melts slowly, it is a source of water that adds to stream flow following the peak runoff period. Because of its irregular relief, Rock land provides scenic beauty, concealment and escape routes for wildlife, and enhances the recreational opportunities in an area.

Recreation, wildlife habitat, and water yield are the best uses for Rock land. The sparse tree cover is managed for watershed protection, and at low elevations, grasses, shrubs, and forbs are managed for watershed stability.

Rock outcrop

Ro—Rock outcrop. This land type consists of areas that are over 90 percent barren rock. It includes great masses of bedrock that form the mountain peaks, the nearly vertical walls of cirques, and steep canyon walls. Included in mapping are areas of talus. The bedrock includes coarse grained and fine grained granite, gneiss, schist, sandstone, limestone, and conglomerate. The Maroon conglomerate adds color to the landscape where it crops out.

The highest mountain peaks are essentially devoid of vegetation except for lichens and mosses on rocks

that have been exposed for some time. Due to geologic erosion, there is practically no soil at that elevation. In the alpine zone and below about 11,800 feet, there is some soil in cracks and crevices, but this soil supports a few plants on less than 10 percent of the area. The type of vegetation is dependent upon elevation, aspect, and precipitation. In the alpine zone it consists of alpine willows and alpine species of grasses, sedges, and forbs. With decreasing elevation, the vegetation is subalpine fir and Engelmann spruce or Douglas-fir and lodgepole pine. At the lowest elevations, various species of grasses, shrubs, and forbs make up the sparse vegetative cover.

Rock outcrop is valuable for its scenery, and its wildlife habitat. Elk and mountain sheep inhabit the higher elevations, particularly in summer. At all seasons of the year, Rock outcrop at lower elevations provides concealment and escape routes for all kinds of wildlife. At lower elevations, runoff from rains and melting snow is rapid, but at the highest elevations, snowbanks may persist in cirques and other sheltered areas until late August. In some years these snowbanks do not completely melt. Snow at high elevations is important in maintaining the flow of springs and streams since it melts slowly and infiltration is slight except where Rock slides serve as catchment basins. At high elevations, large masses of Rock outcrop are likely places for snowslides that carry down large quantities of stone and soil, that cut swaths through the timber, and that bury the lower lands. In some places, these slides endanger human life.

Recreation, wildlife habitat, and water yield are the uses for Rock outcrop. On the high mountain peaks, Rock outcrop provides majestic beauty that enhances the esthetic value of all lower lying areas.

Rock slides

Rs—Rock slides. This land type consists of talus areas of coarse gravel and angular rock fragments at the bases of steep slopes. The angular rocks range from about 6 inches to 4 feet or more in diameter. These talus slopes have the form of fans or aprons at the bases of steep rock escarpments, from which rocks have been loosened by frost riving. Some areas are in glacial cirques, where the rocks were moved by glacial action or snowslides. Also included in this land type are rock glaciers, felsenmeers (block fields on or near ridge crests), and "stone rivers" in the alpine and subalpine zones.

Rock slides generally have slope gradients of 65 percent or more, so most areas are relatively unstable. Downcutting streams and road cuts near their bases in some instances have initiated secondary Rock slides or have accelerated movement of the whole mass.

Rock slides have little vegetation. If the rocks have been stable for a long time, material weathered from the rocks accumulates in sufficient quantities to support scattered grasses, forbs, and trees.

Areas of Rock slides are excellent for storing water for slow release to springs and streams because there is little or no runoff. Since Rock slides are made up mostly of large, angular boulders with large voids between them, they absorb all the rain and snow that falls upon them. In addition, they intercept runoff from higher lying areas. Much of this moisture accumulates as the ice melts slowly during the warm season.

Since many roads are in narrow stream valleys where a large proportion of Rock slides occur, this land type hinders road construction and maintenance. For the land manager, Rock slides present no problems.

Sanford series

The Sanford series consists of well drained, moderately steep to very steep soils that formed in material weathered from gneiss or schist under forest vegetation of logepole pine with a sparse understory of kinnikinnick.

The mean annual precipitation is 20 inches, and the mean annual soil temperature is 38° F. Permeability is moderate, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

Under a thin litter layer, the surface layer typically is brown fine sandy loam 2 inches thick. The subsurface layer is pale brown and yellowish brown fine sandy loam and sandy loam 16 inches thick. The subsoil is yellowish brown sandy loam with loam to clay loam lamellae. It is 12 inches thick. Gneiss is at a depth of 30 inches.

Representative profile of Sanford fine sandy loam on a ridgetop immediately west of the Willow Creek Guard Station in SW¼NE¼ sec. 27, T. 14 S., R. 82 W.:

O1—2 inches to 1; undecomposed organic material consisting mainly of leaves, twigs, needles, and bark.

O2—1 inch to 0; partially decomposed organic material similar to the material in the horizon above.

A1—0 to 2 inches; brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) moist; moderate very fine granular structure; soft when dry, very friable when moist; pH 6.0; clear smooth boundary.

A2—2 to 13 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; moderate fine granular structure; soft when dry, very friable when moist; vesicular; 10 percent stones; pH 6.5; gradual wavy boundary.

A&B—13 to 18 inches; variable colors including yellowish brown (10YR 5/4) and pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) and dark yellowish brown (10YR 4/4) moist; weak subangular blocky structure that parts to fine granular; slightly hard when dry, very friable when moist; this horizon consists of material similar to material in the overlying horizon, in which nodules and discontinuous seams of more clayey material are imbedded; 10 percent stones; pH 6.5; gradual wavy boundary.

B2t—18 to 30 inches; yellowish brown (10YR 5/4) sandy loam containing lamellae (¼-inch to 2 inches thick) of loam and clay loam, dark yellowish brown (10YR 4/4) moist; slightly hard when dry, very friable when moist; thin nearly continuous clay films on peds in the lamellae; clay coatings and bridges on and between sand grains; pH 6.5; 10 percent stones; gradual wavy boundary.

R—30 to 35 inches; gneiss.

The A1 horizon when dry ranges from brown to dark brown. The A2 horizon when dry ranges from pinkish gray to pale brown. The lamellae and nodules in the A&B horizon range from heavy loam to clay loam. Depth to bedrock ranges from 20 to 40 inches. In a few areas, the bedrock is schist with a high proportion of muscovite mica. In these areas, the soils contain a large amount of mica, and a 1- to 2-inch thick, rust-colored sandy clay loam band is the only evidence of a B2t horizon.

SaF—Sanford fine sandy loam, 15 to 65 percent

slopes. This is the only Sanford soil mapped in the survey area. Small areas of Sanford soils with slopes of less than 15 percent were included in mapping.

Runoff is medium to rapid, and the erosion hazard is high.

This soil is used for timber production, though much of it is grazed.

Sanford fine sandy loam is fairly well suited to range and timber production. The windthrow hazard is severe because of the shallow depth to bedrock in many places. In addition, the bedrock deflects water to the surface in many places, causing the soil to be soft. This enhances the likelihood of windthrow. The soil has a medium capacity for water yield.

In spite of unfavorable potential, this soil is best suited to timber and water production. Logging limitations are moderately severe due to the high erosion hazard.

Sawcreek series

The Sawcreek series consists of well drained, moderately steep to very steep soils that formed in material weathered from the sandstone and conglomerate of the Maroon Formation.

The vegetation is dominantly grass with pitches of quaking aspen and, in some areas, sagebrush. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 38° F. Permeability is moderately rapid, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

Typically, the surface layer is dark brown sandy loam about 4 inches thick. The subsoil is reddish brown sandy loam about 9 inches thick. The substratum is reddish brown sandy loam, 17 inches thick, that overlies sandstone at a depth of 30 inches.

Representative profile of Sawcreek sandy loam having slope of 45 percent at an elevation of 10,800 feet just east of Cement Creek Road in the SE¼SE¼ sec. 21, T. 13 S., R. 84 W.:

A1—0 to 4 inches; dark brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; weak very fine granular structure; soft when dry, very friable when moist; few pebbles; many roots; pH 6.5; clear wavy boundary.

B2—4 to 13 inches; reddish brown (5YR 4/3) sandy loam, dark reddish brown (5YR 3/3) moist; weak fine subangular blocky structure; soft when dry, very friable when moist; few pebbles; many roots; pH 6.0; clear wavy boundary.

C—13 to 30 inches; reddish brown (5YR 5/4) sandy loam, reddish brown (5YR 4/4) moist; massive; loose when dry, very friable when moist; 5 percent pebbles; few roots; pH 6.0; abrupt irregular boundary.

IIR—30 to 36 inches; reddish sandstone.

The hue of the C horizon ranges from 7.5YR to 5YR. The A1 horizon ranges from 4 to 15 inches thick. In some places, the underlying bedrock is conglomerate.

ScE—Sawcreek sandy loam, 15 to 50 percent slopes. This is the only Sawcreek soil mapped in the survey area. Small areas of Lamphier and Ashcroft soils were included in mapping.

Runoff is medium, and the erosion hazard is high.

This soil is used for range. It is probably part of the summer range for elk. Nearby streams provide recreation for fishermen.

The soil is very poor for water-retaining structures because of the permeable nature of the underlying sandstone. It is fair for timber but very good for range herbage production. Because of the permeable soil, substratum, and bedrock, this soil has a high value for water yield. Streams in areas of this soil have a more consistent flow than do streams elsewhere in the survey area. The colorful rock exposures with majestic mountain peaks, such as Teocalli Mountain and others, make this area one of the most scenic in the Taylor River Area.

Water yield, recreation, and range herbage production are the best uses of this soil. The esthetic value of the area plus good fishing gives this soil a high value for recreation. In addition, the more gently sloping soils are well suited to recreational development. Good management considers the high erosion hazard and the tendency of the soils to become washboarded when used for unsurfaced roads.

Schofield series

The Schofield series consists of well drained, sloping to very steep soils that formed in alluvial-colluvial material weathered from granite.

Vegetation is lodgepole pine or mixed lodgepole pine and Engelmann spruce. Most of this soil is above an elevation of 10,000 feet. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 34° F. Permeability is moderate, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

Under a 2-inch layer of litter, the surface layer typically is light brownish gray gravelly sandy loam about 8 inches thick. The next layer is pale brown gravelly sandy loam 8 inches thick. The subsoil is brown gravelly coarse sandy clay loam 16 inches thick. Granite is at a depth of 32 inches.

Representative profile of Schofield gravelly sandy loam on the south side of Quartz Creek, ¼ mile along the trail to the mine between Ohio City and Pitkin in the SW¼ sec. 20, T. 50 N., R. 4 E.:

O1—2 inches to 1; undecomposed organic material, primarily leaves, twigs, needles, and bark.

O2—1 inch to 0; partially decomposed organic material.

A2—0 to 8 inches; light brownish gray (10YR 6/2) gravelly sandy loam, grayish brown (10YR 5/2) moist; moderate to strong fine granular structure; soft when dry, very friable when moist; vesicular; 15 percent fine angular granite pebbles; pH 6.2; gradual wavy boundary.

A&B—8 to 16 inches; pale brown (10YR 6/3) gravelly sandy loam, dark brown (10YR 4/3) moist; weak to moderate fine subangular blocky structure that parts to moderate fine granular; very hard when dry, very friable when moist; nodules and seams of platy material similar to material in the underlying horizon embedded in a matrix of material similar to material in the overlying horizon; 20 percent fine and very fine angular granite pebbles; pH 6.3; gradual wavy boundary.

B2t—16 to 32 inches; brown (7.5YR 5/4) gravelly coarse sandy clay loam, dark brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; extremely hard when dry, very friable when moist; common thin continuous clay films on peds; clay coatings on sand grains and pebbles; 25 percent fine angular granite pebbles; pH 6.6; abrupt smooth boundary.

IIR—32 to 37 inches; hard granite.

Depth to bedrock ranges from 20 to 40 inches. Rock fragments make up 15 to 35 percent of the soil material. The A2 horizon has hues of 10YR or 7.5YR, dry values of 6 or 7 and moist values of 4 or 5, and chromas of 1.5 to 3. The B2t horizon has hues of 10YR to 5YR, dry values of 5 or 6 and moist values of 4 or 5, and chromas of 3 to 6.

SdE—Schofield-Peeler gravelly sandy loams, 5 to 25 percent slopes. This is a complex of sloping to steep soils that have profiles similar to the ones described as representative for their respective series. Small areas of Stecum and Leal soils and a few areas of Rock outcrop were included in mapping.

Runoff is slow, and the erosion hazard is slight.

These soils are poor for range herbage production and fair for timber production. This complex differs from Schofield-Peeler gravelly sandy loams, 25 to 60 percent slopes, in that the erosion hazard is slight. In areas where the soil is not so steep, it is suitable for recreational development, but depth to bedrock, which is highly variable, needs to be determined before any development.

These soils are best suited for timber production and water yield. Much of the existing timber is badly infested with mistletoe and also is badly in need of thinning.

SdF—Schofield-Peeler gravelly sandy loams, 25 to 60 percent slopes. These soils have the profiles described as representative for their respective series. Small areas of Stecum and Leal soils and Rock outcrop were included in mapping.

Runoff is medium, and the erosion hazard is moderate to high.

These soils are used mainly for timber production, although most is also grazed to some extent. Much of the timber is overmature. Infestation with mistletoe is common.

These soils are poor for range herbage production and only fair for timber production. The value for water yield is medium. Logging limitations are moderately severe mainly because many slopes are too steep for tractor logging. Because of steep slopes, this complex is poorly suited to recreational uses. It is fairly well suited as habitat for elk, but it generally is at too high an elevation for deer.

These soils are best suited to timber production and water yield, even though their potential for these uses is only fair. Where slopes are steepest, it is desirable to leave the timber for protection. Logging operations should be carried out with a minimum of soil disturbance because of the erosion hazard.

SeF—Schofield-Peeler very stony sandy loams, 25 to 60 percent slopes. This is a complex of soils that have profiles similar to the ones described as representative for their respective series, except the surface is very stony. Stones and boulders cover 50 to 90 percent of the surface. Small areas of Stecum and Leal soils and Rock outcrop were included in mapping.

Runoff is medium, and the erosion hazard is moderate.

These soils have sufficient stones and boulders in the surface layer to make the use of planting machinery impractical. All planting of seedlings in burned-over areas or in areas to be reforested must be done by hand. Stones and boulders greatly increase the difficulty and cost of building trails and roads.

These soils are used mainly for timber production. Some areas are grazed, but herbage is sparse.

Water yield and timber production are the best uses for these soils. The soils are fairly well suited as wildlife habitat, principally for elk, although browse plants are not abundant. Because of steep to very steep slopes and stones and boulders, this complex has severe logging limitations. Some system other than tractor logging should be used in harvesting the timber.

Shale rock land

Sh—Shale rock land. This land type consists of areas in which 50 to 100 percent of the surface is composed of barren shale outcrops and very shallow clay soil weathered from shale. The shale of the Mancos Formation is noncalcareous in most places. Areas of Shale rock land are unstable, so erosion is active and landslides are common.

Vegetation is sparse or absent. At lower elevations, the vegetation consists of grasses and forbs, and at higher elevations, scattered Engelmann spruce and subalpine fir. About 25 percent of this land type is rock outcrops, but because the land type is of limited extent, management concerns are the same for the entire land type.

Most of this land type is in small areas in the vicinity of Gothic. Erosion is partly geologic and partly accelerated due to disturbance of the vegetative cover by fires, logging activities, and grazing.

It is not economically feasible to manage this land in any way other than to exclude it from grazing. Existing vegetation should be left to help protect the unit from further erosion. Some natural revegetation may take place, and revegetated areas have some value for wildlife.

Stecum series

The Stecum series consists of well drained, moderately steep to very steep soils that formed in material weathered from granite under sagebrush grass or lodgepole pine.

The mean annual precipitation is 20 inches, and the mean annual soil temperature is 38° F. Permeability is moderately rapid, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches. Typically, the surface layer is pinkish gray stony sandy loam about 9 inches thick. The next layer is brown stony sandy loam, 6 inches thick. The substratum is yellowish brown stony sandy loam, 9 inches thick that overlies fractured granite at a depth of 24 inches (fig. 13).

Representative profile of Stecum stony sandy loam having slope of 65 percent at an elevation of 9,050 feet along the Quartz Creek road, 2.1 miles west of the Ranger station at Pitkin in the NW¼ sec. 16, T. 50 N., R. 4 E.:

A1—0 to 9 inches; pinkish gray (7.5YR 6/2) stony sandy loam, dark brown (7.5YR 3/2) moist; moderate very fine granular structure; soft when dry, very friable when moist; 25 percent pebbles, cobbles, and stones; pH 6.8; clear smooth boundary.

AC—9 to 15 inches; brown (7.5YR 5/3) stony sandy loam, dark brown (7.5YR 4/3) moist; weak fine subangular blocky structure that parts to moderate fine granular; slightly hard when dry, very friable

Figure 13.—Profile of a Stecum stony sandy loam.

when moist; 35 percent rock fragments; pH 6.8; gradual wavy boundary.

C—15 to 24 inches; yellowish brown (10YR 5/4) stony sandy loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard when dry, very friable when moist; 35 percent rock fragments; pH 6.8; gradual irregular boundary.

R—24 to 30 inches; fractured granite.

The A horizon ranges from gravelly or stony loamy sand to sandy loam. It is 1 to 10 inches thick. The soil has hue of 10YR throughout in places. The C horizon ranges from gravelly or stony loamy sand to sandy loam. Depth to bedrock is 20 to 40 inches.

SmF—Stecum stony sandy loam, 15 to 70 percent slopes. This soil has the profile described as representative for the series. Small areas of Schofield-Peeler soils and Rock outcrop were included in mapping.

Runoff is slow to medium, and the erosion hazard is high.

This soil is used as range, although there are some thin stands of lodgepole pine. This soil is fair for either range herbage or timber production. It has medium capacity for water yield. Its high susceptibility to erosion is due to steep slopes and shallow depth to bedrock. The shallow depth to bedrock also makes this soil poor for water-retaining structures. The soil is poorly suited to recreational development. Stecum soils are somewhat droughty because they are shallow and consequently have low available water capacity.

This soil has only fair potential for range, wildlife habitat, and water yield, but these are its best uses. Areas presently in timber should not be converted to range herbage production. Most of the soil is now in range, and management should be directed toward improving it and toward controlling grazing in order to prevent erosion.

SoF—Stecum very stony sandy loam, 25 to 70 percent slopes. This soil has a profile similar to the one described as representative for the series, but stones and boulders constitute 50 to 90 percent of the surface horizon. Small areas of Schofield-Peeler soils and Rock outcrop were included in mapping.

Runoff is medium, and the erosion hazard is moderate to high.

This soil is somewhat poorer range than Stecum stony sandy loam, 15 to 70 percent slopes, because more of the surface is covered with stones. Range, wildlife habitat, and water yield are the best uses of this soil. Because of the many stones on the surface and in the soil, the use of machinery is impractical for planting or seeding. Stones and boulders greatly increase the cost of constructing roads or trails through areas of this soil.

Stony colluvial land

Sr—Stony colluvial land. This land type is in close association with, and in many places adjoins, Rock slides. Stony colluvial land occupies old talus slopes or Rock slides that have been stable long enough for fine material, weathered from the rocks, to have filled the voids between the rocks. Stony colluvial land occupies fanlike and apronlike positions below steep, rocky areas of cliffs. Slope gradients are generally 60 to 70 percent. Most areas are very stony, but some are relatively free of stones at the surface, depending upon the texture of the soil, the origin of the rock from which it weathered, and the degree of weathering.

The thin surface horizon is dark grayish brown extremely stony loamy coarse sand. This horizon ranges from 1 to 4 inches thick, and it is underlain by stones and boulders.

Stony colluvial land supports lodgepole pine, Douglas-fir, quaking aspen, or grasses and forbs that help to stabilize these areas.

Many areas have a 50 to 70 percent ground cover of slimstem muhly, ring muhly, Arizona fescue, and big sagebrush. Scattered shrubby cinquefoil grows in moist lines or spots where transient water from higher lying areas collects.

Although Stony colluvial land has storage capacity for water, it cannot store as much water as Rock slides because soil material fills the voids between the rocks. There is some runoff during intense rains, but erosion is light due to the high infiltration rate and permeability.

This land type presents few problems to the land manager, but because of steep slope gradients, damage can result from overgrazing and trailing.

This land type is used for some grazing, but generally it is poor for range herbage production. It is poor for practically all uses except water yield. Its value for water yield is high, and good management maintains the capacity of the soil to yield water. Existing vegetation should be managed to protect the soil.

Stony rock land

St—Stony rock land. This land type consists of a complex of Stony land and Rock land with some soil between outcrops of rock. Included in this land type are areas above timberline and in the "bent timber" zone where high winds have removed most or all of the soil, leaving only stones, gravel, and some soil under an erosion pavement.

Most of this land type is in inaccessible alpine and subalpine zones. These areas are mostly small alpine ridgetops isolated by geologic erosion and surrounded by steep Rock outcrop. Areas subject to alpine soil blowing make up less than 100 acres of this mapping unit. These areas are generally 50 to 400 feet wide and are parallel on ridgetops with westerly exposures. High winds remove the fine soil particles, leaving behind a lag concentrate of gravel and coarse fragments on the surface. These eroding areas widen downslope by undercutting the sod. These areas, subject to severe soil blowing, apparently are a natural phenomenon because only indigenous animals graze them.

Vegetation on this land type is sparse or absent and consists of alpine willows and alpine species of grass, sedges, and forbs.

Stony rock land is associated with all of the rock types in the Area. However, a large part is on the sandstone, limestone, and conglomerate of the Maroon Formation.

Stony rock land is of little economic value. It is mostly inaccessible to domestic animals, though it provides some summer grazing for big game. Because of the high, windy position in the landscape, these areas are swept free of snow in the winter. The resulting snow accumulations on lee slopes and in cirques, however, yield considerable amounts of water.

This unit is used for summer grazing by elk and, possibly, by mountain sheep. Wildlife make the best use of this land type. Because these areas are inaccessible, there is little or nothing that need be done to manage them.

Supervisor series

The Supervisor series consists of well drained, sloping to very steep soils that formed in material weathered from gneiss or schist under lodgepole pine, sagebrush, and grass. The mean annual precipitation is 20 inches, and the mean annual temperature is 38° F. Permeability is moderately rapid, and available water capacity is moderate. Roots can penetrate to a depth of 20 to 40 inches.

Typically, the surface layer is dark grayish brown loam about 14 inches thick. The subsoil is yellowish brown stony loam 10 inches thick. The substratum is yellowish brown stony loam 12 inches thick. Fractured gneiss is at a depth of 36 inches.

Representative profile of Supervisor loam having slope of 45 percent near the junction of the Willow Creek and Union Cow Camp roads in sec. 28, T. 14 S., R. 82 W.:

A11—0 to 3 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; strong very fine granular structure; soft when dry, very friable when moist; 5 percent stones; pH 7.0; clear smooth boundary.

A12—3 to 14 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure that parts to moderate medium granular; slightly hard when dry, very friable when moist; 5 percent stones; pH 7.0; clear smooth boundary.

IIB2—14 to 24 inches; yellowish brown (10YR 5/4) stony loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; hard when dry, very friable when moist; few thin discontinuous clay films on vertical surfaces of peds; 30 percent stones; pH 6.8; gradual smooth boundary.

IIC—24 to 36 inches; yellowish brown (10YR 5/4) stony loam, dark yellowish brown (10YR 4/4) moist; massive; hard when dry, very friable when moist; 40 percent stones; pH 6.6; gradual wavy boundary.

IIR—36 to 41 inches; fractured gneiss.

The A1 horizon ranges from loam to fine sandy loam. There is a considerable amount of angular pebbles on the surface in places. This represents a lag concentrate from differential erosion. Soils on upper slopes are shallower, less developed, and coarser textured than Supervisor loam, 25 to 70 percent slopes. The soil material contains flakes of mica where schist is the bedrock.

SuE—Supervisor loam, 5 to 25 percent slopes. This soil has a profile similar to the one described as representative for the series, but it is somewhat deeper over bedrock. The soil is sloping to steep, but slope gradients generally exceed 10 percent. There are fewer bedrock outcrops on this soil than on Supervisor loam, 25 to 70 percent slopes. Small areas of McIntyre, Rarick, and Lucky soils were included in mapping.

Runoff is medium, and the erosion hazard is moderate.

This soil is used as range, to which it is fairly well suited. It is also fairly well suited to recreational development because of moderate slopes, but the comparatively shallow depth to bedrock must be considered in the construction of sanitation facilities.

Range herbage production is the best use of this soil.

SuF—Supervisor loam, 25 to 70 percent slopes. This soil has the profile described as representative for the series. Small areas of McIntyre, Rarick, and Lucky soils and small areas of Rock outcrop were included in mapping.

Runoff is rapid, and the erosion hazard is high.

This soil is used for timber and range. Much of the timber has been burned over in the past and now consists of dense, stagnated stands.

The soil is fair for range herbage and timber production. Where this soil is in forest, the windthrow hazard is high. The soil's value for water yield is low. The soil is poorly suited to recreational development.

Range is the best use of this soil, but management should consider its susceptibility to erosion. In addition, the soil is somewhat droughty, so revegetation of eroded areas is slow.

Tabernash series

The Tabernash series consists of well drained, level to sloping soils that formed in glacial outwash derived from granite.

The vegetation is lodgepole pine with a sparse understory of kinnikinnick. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 36° F. Permeability is moderate, and available water capacity is low. Roots can penetrate to a depth of more than 60 inches.

Under a 1-inch layer of litter, the surface layer typically is brown gravelly loam 2 inches thick. The subsurface layer is light brown gravelly sandy loam 6 inches thick. The subsoil is mainly yellowish red gravelly clay loam to a depth of 22 inches. The substratum is light brown gravelly coarse sand to a depth of 60 inches.

Representative profile of Tabernash gravelly loam having slope of 2 percent along a trail extending north from the Pieplant cow camp in the SE¼ sec. 20, T. 13 S., R. 82 W.:

O1—1 inch to ½; pine needles and twigs.
O2—½ inch to 0; partially decomposed organic matter.
A1—0 to 2 inches; brown (7.5YR 4/2) gravelly loam, dark brown (7.5YR 3/2) moist; moderate medium granular structure; soft when dry, very friable when moist; 20 percent pebbles; pH 5.6; clear wavy boundary.
A2—2 to 8 inches; light brown (7.5YR 6/4) gravelly sandy loam, brown (7.5YR 5/4) moist; weak very fine granular structure; soft when dry, very friable when moist; 20 percent pebbles; pH 5.8; gradual boundary.
A&B—8 to 10 inches; brown (7.5YR 5/4) gravelly sandy clay loam, dark brown (7.5YR 4/4) moist; moderate fine granular structure; hard when dry, firm when moist; 20 percent pebbles; pH 6.0; clear wavy boundary.
B2t—10 to 22 inches; yellowish red (5YR 5/6) gravelly clay loam, yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure; hard when dry, firm when moist; common thin clay films on peds; 20 percent pebbles; pH 6.4; clear wavy boundary.
IIC—22 to 60 inches; light brown (7.5YR 6/4) gravelly coarse sand, brown (7.5YR 5/4) moist; single grained; 35 percent pebbles; pH 6.7.

The A1 horizon ranges from 1 to 4 inches in thickness. The A2 horizon ranges from 3 to 10 inches in thickness. In places, it ranges in hue from 7.5YR to 2.5Y, in chroma from 2 to 4, and in value from 6 to 8 when dry and from 5 to 7 when moist. Depth to the IIC horizon ranges from 20 to 40 inches.

TaB—Tabernash gravelly loam, 0 to 6 percent slopes. This is the only Tabernash soil mapped in the survey area. A few small areas of Tex soils were included in mapping.

Runoff is slow, and the erosion hazard is slight.

This soil is used for timber, but it is also grazed to some extent. The sparse understory provides very little herbage for livestock.

The soil is only fair for timber production, but there are only slight limitations for logging because of the slight erosion hazard. The gravelly substratum is very permeable, so the soil is well suited to recreational development. The danger of contaminating nearby streams, lakes, or springs must be considered when installing sanitary structures because the soil has a permeable substratum.

Water yield and timber production are the best uses of the soil. Because of the permeable soil and substratum, the value of this soil for water yield is high.

Tellman series

The Tellman series consists of well drained, sloping to very steep soils that formed in alluvium on valley sides, in alluvial fans, and on terraces in material derived from granite.

The vegetation is dominantly Engelmann spruce with some lodgepole pine and an understory of recumbent juniper, some kinnikinnick, and a few other herbaceous plants. The mean annual precipitation is 20 inches, and the mean annual air temperature is 30° F. Permeability is moderately slow, and available water capacity is moderate. Roots can penetrate to a depth of more than 60 inches.

Typically, the surface layer is dark grayish brown sandy loam about 2 inches thick. The subsurface layer is light yellowish brown sandy loam 6 inches thick. The subsoil is mainly yellowish brown clay loam and silty clay loam to a depth of 24 inches. The substratum is yellow fine sand to a depth of 60 inches.

Representative profile of Tellman sandy loam having slope of 20 percent at an elevation of 9,800 feet in the NW¼ sec. 9, T. 15 S., R. 82 W.:

A1—0 to 2 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak very fine granular structure; soft when dry, very friable when moist; few roots; pH 6.0; abrupt wavy boundary.
A2—2 to 8 inches; light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) moist; weak very fine granular structure; soft when dry, friable when moist; a few granite pebbles; few roots; pH 5.0; clear irregular boundary.
A&B—8 to 12 inches; yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; hard when dry, firm when moist; few pebbles; few roots; pH 5.0; clear irregular boundary.
B2t—12 to 20 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard when dry, firm when moist; common thin nearly continuous clay films; few pebbles; few roots; pH 5.0; gradual wavy boundary.
B3—20 to 24 inches; yellowish brown (10YR 5/6) silty clay loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure that parts to weak fine granular; hard when dry, firm when moist; pH 5.5; clear wavy boundary.
IIC—24 to 60 inches; yellow (10YR 7/6) fine sand, yellowish brown (10YR 5/6) moist; single grained; loose when dry, very friable when moist; a few granite pebbles; pH 6.0.

Thickness of the A1 horizon ranges from 1 to 2 inches. It is sandy loam or gravelly loam. In a few places, there is no A&B horizon. The C horizon is fine sand, loamy sand, or very gravelly loamy sand.

TdF—Tellman sandy loam, 5 to 45 percent slopes. This is the only Tellman soil in the survey area. Small areas of Dinnen, Schofield, and Stecum soils were included in mapping.

Runoff is medium, and the erosion hazard is moderate.

This soil is used for timber production and is grazed to some extent, although it is poor range.

This soil is fair for lodgepole pine but poor for spruce or fir. The windthrow hazard is slight, and logging limitations are moderately severe. The soil's value for water yield is high because of the permeable substratum and its position near the bases of steep upland areas, from which it receives much runoff. Soils having more gentle slopes are well suited to recreational development.

Water yield and timber production are the best uses of the soil. Tractor logging should be limited to areas where slope gradient is less than 30 percent.

Teoculli series

The Teoculli series consists of well drained, level to steep soils that formed in alluvium derived from granite, schist, gneiss, or glacial deposits. Slopes are about 5 percent in most places; in only a few places do slopes exceed 10 percent.

Vegetation is shrubby cinquefoil, silver sagebrush, tufted hairgrass, fescues, brome, and sedges. The mean annual precipitation is 20 inches, and the mean annual air temperature is 34° F. Permeability is moderately rapid, and available water capacity is high. Roots can penetrate to a depth of more than 60 inches.

Typically, the surface layer is dark brown loam about 10 inches thick. The underlying material is yellowish brown very fine sandy loam to a depth of 40 inches.

Representative profile of Teoculli loam having slope of 5 percent at the extreme northern end of Union Park along the Union Cow Camp Road in sec. 32, T. 14 S., R. 82 W.:

A11—0 to 1 inch; dark brown (10YR 4/3) loam, very dark brown (10YR 2/2) moist; weak very thin platy structure that parts to weak very fine granular; slightly hard when dry, friable when moist; pH 6.5; clear smooth boundary.

A12—1 to 10 inches; dark brown (10 YR 4/3) loam, very dark brown (10YR 2/2) moist; weak medium angular blocky structure that parts to weak very fine granular; slightly hard when dry, friable when moist; pH 5.5; clear smooth boundary.

C—10 to 40 inches; yellowish brown (10YR 5/4) very fine sandy loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard when dry, very friable when moist; a few pebbles; pH 5.5.

The A1 horizon ranges from dark brown to very dark brown or black (10YR 2/1) when moist and from 8 to 15 inches thick. The A1 horizon is generally loam but ranges from silt loam to silty clay loam. In places, where this soil is near Cryaquolls, the C horizon is very pale brown or brown.

TeE—Teoculli loam, 0 to 25 percent slopes. This is the only Teoculli soil mapped in the survey area. A small acreage of Cryaquolls was included in mapping. Buried A horizons are common.

Runoff is slow, and the erosion hazard is slight.

Most of this soil is used as range. Teoculli loam is a good producer of range herbage. There is little timber on this soil except where deepening stream channels have improved drainage, but Engelmann spruce is coming in. The value of this soil for water yield is high.

Range herbage production, water yield, and recreation are the best uses of the soil. Much of this soil is near good fishing waters, and it therefore receives rather intense recreational use. The soil is well suited to recreational development, but relatively shallow depth to the water table precludes the use of septic tank sanitary facilities in places.

Tex series

The Tex series consists of hummocky, somewhat excessively drained, sloping to very steep soils that formed in glacial moraines and in till derived principally from granite.

Vegetation consists of lodgepole pine and some spruce with a sparse understory of kinnikinnick. Depressional areas have a cover of cinquefoil, grasses, and a few prostrate junipers. The mean annual precipitation is 20 inches, and the mean annual soil temperature ranges from 32° to 47° F. This soil is mostly at elevations above 9,500 feet. Permeability is rapid, and available water capacity is moderate. Roots can penetrate to a depth of more than 60 inches.

Under a thin layer of litter, the surface layer typically is dark grayish brown gravelly sandy loam 2 inches thick. The subsurface layer is pale brown gravelly coarse sandy loam 8 inches thick. The next layer is pale brown gravelly coarse sandy loam 4 inches thick. The subsoil is very pale brown gravelly coarse sandy loam, 31 inches thick, with thin discontinuous bands of clay loam. The substratum is pale brown gravelly loamy sand.

Representative profile of Tex gravelly sandy loam having slope of 32 percent at an elevation of 9,900 feet along the Forest Hill Road in the NE¼ sec. 14, T. 13 S., R. 83 W.:

O1—1 inch to ½; undecomposed organic material, mainly pine needles, bark, and twigs.

O2—½ inch to 0; partially decomposed organic material mixed with some mineral matter.

A1—0 to 2 inches; dark grayish brown (10YR 4/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; weak very fine granular structure; soft when dry, very friable when moist; 15 percent pebbles; many roots; pH 5.5; abrupt smooth boundary.

A2—2 to 10 inches; pale brown (10YR 6/3) gravelly coarse sandy loam, brown (10YR 4/3) moist; weak very fine granular structure; soft when dry, very friable when moist; clean sand grains; 15 percent pebbles; many roots; pH 5.2; clear wavy boundary.

A&B—10 to 14 inches; pale brown (10YR 6/3) gravelly coarse sandy loam; dark brown (10YR 4/3) moist; weak medium subangular blocky structure; hard when dry, very friable when moist; several thin discontinuous lamellae and nodules of sandy clay loam that is light brown (7.5YR 6/4) when dry to brown (7.5YR 5/4) when moist and that parts to weak fine granules; 15 percent pebbles; many roots; pH 5.0; clear wavy boundary.

B21t—14 to 24 inches; very pale brown (10YR 7/4) gravelly coarse sandy loam, yellowish brown (10YR 5/4) moist; moderate medium subangular blocky structure; hard when dry, very friable when moist; sand grains lightly stained; several ½ to 1 inch discontinuous lamellae of clay loam that is light brown (7.5YR 6/4) when dry to dark brown (7.5YR 4/4) when moist, that has moderate fine angular blocky structure, and that is hard when dry and very firm when moist; common thin clay films on peds; 20 percent pebbles; many roots; pH 5.0; clear wavy boundary.

B22t—24 to 45 inches; very pale brown (10YR 7/4) gravelly coarse sandy loam, yellowish brown (10YR 5/4) moist; moderate medium subangular blocky structure; hard when dry, friable when moist; several ¼ to 1 inch discontinuous lamellae of clay

loam that is light brown (7.5YR 6/4) when dry to dark brown (7.5YR 4/4) when moist, that has weak fine angular blocky structure, and that is very hard when dry and firm when moist; common thin clay films on peds; 20 percent pebbles; few roots; pH 5.2; gradual wavy boundary.

C—45 to 60 inches; pale brown (10YR 6/3) gravelly loamy sand, yellowish brown (10YR 5/4) moist; single grained; loose when dry or moist; 20 percent pebbles; pH 6.0.

Thickness of the A1 horizon ranges from ½ inch to 3 inches, and of the A2 horizon, from 5 to 10 inches. The A1 horizon is sandy loam or gravelly sandy loam. The A&B and B2t horizons when dry are light yellowish brown, very pale brown, pale brown, or strong brown. The matrix of the B2t horizon is coarse sandy loam in most places, and the lamellae are clay or sandy clay loam.

TgE—Tex gravelly sandy loam, 5 to 25 percent slopes. This soil has a profile similar to the one described as representative for the series. Small areas of Matcher and Tomichi soils and local areas of soils with 20 percent of the surface covered with stones and boulders were included in mapping. The relief is hummocky, and there are numerous depressions. Because of good internal drainage, few of these glacial potholes are ponded for long.

Runoff is slow, and the erosion hazard is slight.

There are only moderate logging limitations. This soil is suitable for recreational development, but its droughtiness makes the maintenance of a grass sod difficult.

This soil is best suited to water yield and timber production. In the construction of recreational developments, nearness to streams, springs, and lakes should be considered because there is danger of polluting ground water because of the permeable soil and substratum.

TgF—Tex gravelly sandy loam, 25 to 60 percent slopes. This soil has the profile described as representative for the series. Small areas of Matcher and Tomichi soils and local areas of soils with 20 percent of the surface covered with stones and boulders were included in mapping.

Runoff is medium, and the erosion hazard is moderate.

This soil is used for timber production. Lodgepole pine dominates, but much of it is badly infested with mistletoe. Many stands have so many stems per acre that they have stagnated.

Some areas are grazed, but the soil is poorly suited to this use. The soil is only fair for lodgepole pine production, and logging limitations are moderately severe. Roots penetrate deeply in this soil, so the windthrow hazard is slight. Most of the water that falls on this soil is rapidly absorbed, so the soil has a high value for water yield.

Water yield and timber production are the best uses of this soil, although it does not produce much timber. Logging operations on steeper soils should be handled to cause a minimum of soil disturbance. The soil is droughty, so regeneration is slow.

ThE—Tex very stony sandy loam, 5 to 25 percent slopes. This soil has a profile similar to the one described as representative for the series, but stones and boulders cover 50 to 90 percent of the surface and make up 50 to 90 percent of the surface layer. Small areas of Matcher and Tomichi soils were included in mapping.

Runoff is slow, and the erosion hazard is slight.

Logging limitations are severe because the stones and boulders interfere with logging operations. Stones and boulders on the surface necessitate planting with hand tools because the use of machinery is impractical. In addition, the cost of construction of roads and trails is greatly increased.

The value of this soil for water yield is high, and water yield is its best use. In spite of the fact that the soil is only fair for lodgepole pine and in spite of the logging problems involved, timber production is its second best use.

ThF—Tex very stony sandy loam, 25 to 60 percent slopes. This soil has a profile similar to the one described as representative for the series but stones and boulders cover about 50 percent of the surface. The stones exceed 10 inches in diameter, and the boulders range from 2 to 10 feet in diameter. Small areas of Matcher and Tomichi soils were included in mapping.

Runoff is medium, and the erosion hazard is moderate.

The stones and boulders are significant because they make the use of machinery impracticable. In addition, they greatly increase the cost of road construction through areas of this soil.

This soil is poor for either range herbage or timber production. The soils in this unit that are not too steep can be logged, but on soils that have slopes of nearly 60 percent, timber should be maintained for protection.

Water yield, wildlife habitat, and timber production, in that order, are the best uses of this soil.

Tilton series

The Tilton series consists of well drained, sloping to steep soils that formed in alluvium on valley sides and in alluvial fans. This alluvial material derived from granite with components of shale, sandstone, and limestone.

Vegetation is Thurber fescue, Idaho fescue, nodding brome, scattered wheatgrass, and in places, big sagebrush. The mean annual precipitation is 20 inches, and the mean annual soil temperature ranges from 32° to 47° F. Permeability is moderate, and available water capacity is high. Roots can penetrate to a depth of more than 60 inches.

Typically, the surface layer is brown sandy loam about 10 inches thick. The subsoil is yellowish brown sandy loam 14 inches thick. The substratum is pale brown sandy clay loam.

Representative profile of Tilton sandy loam having slope of 37 percent about one half mile north of the junction of Brush Creek and West Brush Creek in sec. 22, T. 13 S., R. 85 W.:

A1—0 to 10 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; weak very fine granular structure; soft when dry, very friable when moist; many roots; pH 6.8; clear irregular boundary.

B2—10 to 24 inches; yellowish brown (10YR 5/4) sandy loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure that parts to weak fine granular; soft when dry, very friable when

moist; 5 percent granite pebbles; few roots; pH 7.0; clear irregular boundary.

Cca—24 to 60 inches; pale brown (10YR 6/3) sandy clay loam, dark brown (10YR 4/3) moist; massive; slightly hard when dry, friable when moist; a few pebbles and cobbles; pH 8.0; weakly calcareous; no roots below a depth of 30 inches.

Thickness of the A1 horizon varies widely within short distances due to gopher activity. Typically, the A1 horizon ranges from 7 to 15 inches thick and from sandy loam to silt loam. The Cca horizon ranges from loam to sandy clay loam or clay loam. In places, strata of loamy fine sand provide evidence of a lithologic discontinuity below a depth of 40 inches.

TlE—Tilton sandy loam, 5 to 25 percent slopes. This soil has a profile similar to the one described as representative for the series. Small areas of Stecum and Bassel soils and Cryaquolls were included in mapping.

Runoff is medium, and the erosion hazard is moderate.

This soil is well suited to range herbage production. Range herbage production and water yield are the best uses of this soil. Because it is less susceptible to erosion, management requirements are not so restrictive as they are for Tilton sandy loam, 25 to 45 percent slopes. This soil is well suited to recreational development.

TlF—Tilton sandy loam, 25 to 45 percent slopes. This soil has the profile described as representative for the series. Small areas of Stecum and Bassel soils and Cryaquolls were included in mapping. In the vicinity of Rocky Brook (T. 14 S., R. 3 E.) is an area of a soil that formed in glacial material derived from limestone.

Runoff is medium to rapid, and the erosion hazard is high.

This soil is used for range. Gopher activity in some areas has caused grasses to be replaced by forbs. The soil is very poor for timber but is fair for range herbage production. This soil has high value for water yield. Range herbage production and water yield are the best uses of this soil. This soil is highly susceptible to erosion. Overgrazing by livestock results in accelerated erosion and should be considered in the management of this soil.

Tine series

The Tine series consists of well drained to somewhat excessively drained, level to steep soils that formed in glacial outwash weathered dominantly from granite.

The soil occupies benches and escarpments adjacent to the Taylor River in the Taylor Park area at elevations of about 9,500 to 10,000 feet. Vegetation consists of big sagebrush, fescue, and ring muhly, with a small acreage of lodgepole pine. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 36° F. Permeability is rapid, and available water capacity is low. Roots can penetrate to a depth of more than 60 inches.

Typically, the surface layer is dark grayish brown sandy loam and gravelly sandy loam about 13 inches thick. The underlying material is sand, gravel, and cobbles.

Representative profile of Tine sandy loam having slope of 2 percent on a bench at an elevation of 10,000 feet in the northwestern corner of a fenced test plot where a trail goes up Italian Creek in the NE¼ sec. 2, T. 13 S., R. 83 W.:

A11—0 to 5 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; moderate to strong fine granular structure; soft when dry, very friable when moist; 10 percent pebbles; pH 6.6; clear smooth boundary.

A12—5 to 13 inches; dark grayish brown (10YR 4/2) gravelly sandy loam, very dark brown (10YR 2/2) moist; moderate to strong fine granular structure; soft when dry, very friable when moist; 20 percent pebbles and cobbles; pH 6.8; clear wavy boundary.

IIC—13 to 60 inches; clean sand, pebbles, and cobbles; pH 7.2.

Thickness of the A1 horizon ranges from 10 to 24 inches. The A1 horizon ranges from fine sandy loam to gravelly sandy loam. Depth to clean sand, pebbles, and cobbles ranges from 10 to 24 inches.

TnA—Tine sandy loam, 0 to 3 percent slopes. This soil has the profile described as representative for the series. Small areas of Cabin soils and areas with sand and gravel at a depth of less than 10 inches were included in mapping.

Runoff is slow, and the erosion hazard is slight.

This soil is used as range. Much of it is in the vicinity of the Taylor Reservoir and along Willow Creek, both of which are excellent for fishing. Areas of this soil receive heavier recreation use than any other part of the Taylor River area.

This soil occupies a frost pocket where the growing season is short. It is only fair for range herbage production and does not support tree growth. Its value for water yield is high. Most of the erosion of this soil results from trailing by livestock. The soil is good to excellent as road construction material but only fair for use as unsurfaced roads because it becomes washboarded under heavy use. Because of the gravelly and cobbly substratum, it is unsuitable for water-retaining structures. It is well suited to recreational development, but there is danger of pollution when sanitary facilities are too close to streams and other bodies of water.

This soil is best suited to recreation, range herbage production, and water yield. There is some conflict between recreation and range uses, and this conflict becomes more severe with time. Controlled grazing is needed to improve and maintain vegetative cover. The soil is droughty, and range improvement takes a long time.

TnE—Tine sandy loam, 3 to 30 percent slopes. This soil has a profile similar to the one described as representative for the series, but the surface layer is thinner in most places. It is on slopes or escarpments around benchlike areas of Cabin soils, less sloping Tine soils, or areas dissected by stream channels. Most of this soil has slopes of about 15 percent. Small areas of Cabin soils and areas of soils that are less than 10 inches deep over sand and gravel were included in mapping.

Runoff is slow to medium, and the erosion hazard is moderate.

This soil is used for range and recreation. Range management requirements are somewhat more restrictive on this soil than on Tine sandy loam, 0 to 3 percent slopes. Areas of more gently sloping soils are

suitable for recreational development, but vegetative cover is difficult to maintain under intense use. The soil is best suited to recreation, range herbage production, and water yield, in that order.

Tomichi series

The Tomichi series consists of well drained to somewhat excessively drained, level to very steep soils that formed in glacial till or outwash under a cover of sagebrush-grass.

The mean annual precipitation is 20 inches, and the mean annual soil temperature is 33° F. Permeability is rapid, and available water capacity is low. Roots can penetrate to a depth of more than 60 inches.

Typically, the surface layer, is brown sandy loam about 8 inches thick. The underlying material is very pale brown coarse sand to a depth of 60 inches.

Representative profile of Tomichi sandy loam having slope of 30 percent at an elevation of about 10,000 feet in the SE¼NW¼ sec. 9, T. 14 S., R. 82 W.:

A1—0 to 8 inches; brown (7.5YR 5/2) sandy loam, dark brown (7.5YR 3/2) moist; weak medium subangular blocky structure that parts to moderate fine granular; soft when dry, very friable when moist; many roots; pH 6.8; clear smooth boundary.

C—8 to 60 inches; very pale brown (10YR 7/3) coarse sand, pale brown (10YR 6/3) moist; single grained; loose when dry or moist; few dark thin strata; pH 6.8.

Zero to 35 percent of the soil material is pebbles and cobbles. The A1 horizon ranges from 7 to 15 inches thick, and it is thinner on ridgecrests and knolls. It is sandy loam to gravelly sandy loam or loamy sand.

ToE—Tomichi sandy loam, 0 to 25 percent slopes. This soil has a profile similar to the one described as representative for the series, but the surface layer is 2 to 3 inches thicker. Slope gradients exceed 10 percent in most places. With hummocky relief, the soils are thinner on the knolls than on side slopes or in the swales between hummocks.

Runoff is medium, and the erosion hazard is moderate.

This soil is used for range. It differs from Tomichi sandy loam, 25 to 60 percent slopes, in that it is fairly well suited to range herbage and lodgepole pine production. The less steep soils are suitable for recreational development. The danger of contaminating nearby waters, however, needs to be considered in locating facilities because of the highly permeable substratum.

Water yield, range herbage production, and recreation are the best uses of this soil. Management requirements are less restrictive for this soil than they are for Tomichi sandy loam, 25 to 50 percent slopes. Droughtiness is the principal limiting factor.

ToF—Tomichi sandy loam, 25 to 60 percent slopes. This soil has the profile described as representative for the series. Runoff is medium, and the erosion hazard is moderate.

The soil is used as range. A small acreage has some scattered lodgepole pine of little commercial value. Much of this occurs along the outer margins of Taylor Park where the line between the grasslands and the montane zone is determined by temperature inversion.

The Tomichi soils have low available water capacity and are therefore droughty. Because of the deep, permeable substratum, the value for water yield is high. The soil is not suitable for water-retaining structures. This soil is poorly suited to either range herbage or timber production.

Although this soil is poorly suited to range herbage production, it is better suited to water yield and range herbage production than to other uses. Range managers should consider the droughtiness of the soil and the consequent difficulty of revegetation.

TpE—Tomichi stony sandy loam, 5 to 25 percent slopes. This soil has a profile similar to the one described as representative for the series, but granitic stones and boulders cover 15 percent of the surface.

Runoff is medium, and the erosion hazard is moderate.

This soil is not suited to cultivated crops. Therefore, stoniness has little significance except that it increases the cost of road construction through areas of this soil. In addition, trees must be planted with hand tools, not with machinery.

This soil is fairly well suited to range herbage or lodgepole pine production. Road and trail construction is considerably more expensive on this soil than it is on Tomichi sandy loam, 25 to 60 percent slopes, because of the many stones and boulders.

Water yield and range herbage production are the best uses of this soil. Where this soil has some timber cover, logging limitations are severe because of the stones and boulders.

TpF—Tomichi stony sandy loam, 25 to 60 percent slopes. This soil has a profile similar to the one described as representative for the series, but 25 percent of the surface is covered with stones and 5 percent is covered with boulders. Included in mapping are areas of soils that have as much as 90 percent stones and boulders on the surface. There are generally more stones on the surface on the crests of slopes than there are on the lower slopes. The soil material contains as much as 20 to 35 percent stones and boulders.

Runoff is medium, and the erosion hazard is moderate.

This soil is used for range, although a small acreage is in timber. This soil does not differ greatly from Tomichi sandy loam, 25 to 60 percent slopes, in use, suitability, or management, except that stones and boulders make planting operations difficult and the cost of road and trail construction is much higher. All tree seedlings must be planted by hand. Logging limitations are severe because of steep slopes and stones.

Water yield is the best use of this soil, and the soil is fairly well suited to wildlife, particularly elk.

Tongue River series

The Tongue River series consists of well drained, sloping to very steep soils that formed in material weathered from shale with inclusions of sandstone.

The vegetation is mainly Engelmann spruce and subalpine fir with an understory of vaccinium, ribes, Indian paintbrush, and widely scattered grasses. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 38° F. Permeability is moderate, and available water capacity is low. Roots can penetrate to a depth of 20 to 40 inches.

Under a layer of litter 2 inches thick, the surface layer typically is brown loam about 3 inches thick. The subsurface layer is pinkish gray loam 4 inches thick. The next layer is brown channery heavy loam 5 inches thick. The subsoil is brown channery clay loam and very channery loam 18 inches thick. Shale underlies the soil at a depth of 30 inches.

Representative profile of Tongue River loam having slope of 43 percent at an elevation of 10,760 feet on Schofield Pass, 200 feet south of pass to dead tree along road and then 150 feet west:

O1—2 inches to 1; undecomposed organic material, chiefly needles, twigs, and leaves.
O2—1 inch to 0; partially decomposed organic material.
A1—0 to 3 inches; brown (7.5YR 5/2) loam, dark brown (7.5YR 3/2) moist; strong fine granular structure; soft when dry, very friable when moist; 10 percent shale fragments; pH 6.0; gradual smooth boundary.
A2—3 to 7 inches; pinkish gray (7.5YR 6/2) loam, brown (7.5YR 4/2) moist; moderate very fine subangular blocky structure that parts to moderate fine granular; soft when dry, very friable when moist; 10 percent shale fragments; pH 6.2; gradual smooth boundary.
B&A—7 to 12 inches; brown (7.5YR 5/3) channery heavy loam, brown (7.5YR 4/3) moist; moderate very fine and fine subangular blocky structure; slightly hard when dry, very friable when moist; common thin discontinuous clay films on some peds; 80 percent material similar to material in the B2t horizon, with coatings and tongues of material from the A2 horizon; 20 percent shale fragments; pH 5.8; gradual smooth boundary.
B2t—12 to 18 inches; brown (7.5YR 5/3) channery clay loam, brown (7.5YR 4/3) moist; strong very fine subangular blocky structure; hard when dry, friable when moist; many thin clay films on peds; 30 percent shale fragments; pH 6.2; gradual smooth boundary.
B3—18 to 30 inches; brown (7.5YR 5/2) very channery loam, brown (7.5YR 4/3) moist; weak very fine subangular blocky structure; hard when dry, very friable when moist; few thin discontinuous clay films on some peds and on the shale fragments; 30 percent shale fragments; pH 6.4; gradual wavy boundary.
R—30 to 40 inches; dark gray to black phyllitic shale.

In some areas, the soil does not have an A1 horizon, and the A2 horizon is immediately below the O2 horizon. Hues range from 2.5Y to 5YR. The B2t horizon ranges from channery clay loam to silty clay loam. Depth to bedrock ranges from 20 to 40 inches. The B3 horizon is lithochromic in many places, so the color of the horizon may depend upon the color of the underlying bedrock. Content of shale fragments ranges from 5 to 35 percent in the B3 horizon immediately above the bedrock.

TrF—Tongue River loam, 5 to 60 percent slopes. This is the only Tongue River soil mapped in the survey area. Small areas of Bucklon silt loam were included in mapping.

Runoff is medium to rapid, and the erosion hazard is high.

Most of this soil is used for timber production. It is fairly well suited to either range herbage or timber, including lodgepole pine, Engelmann spruce, or subalpine fir. Because of its relatively shallow depth over shale, its value for water yield is low. Trees are shallow rooted in many places, so the windthrow hazard is severe, especially in wet, seepy areas. Because of the high erosion hazard, logging limitations are severe. Tractor logging is not recommended, and areas of soil disturbance require special attention. Extreme care is necessary when choosing the locations of roads and trails because the soil material is very unstable.

The soil is only fairly well suited to wildlife habitat. Timber and range herbage production and wildlife habitat are its best uses. The first consideration in timber production or range management should be the prevention of erosion.

Vasquez series

The Vasquez series consists of poorly drained, sloping to very steep soils that formed in alluvial-colluvial material weathered from gneiss or schist. These soils receive seepage water from higher lying areas and remain wet much of the time but may be dry late in summer.

Vegetation is mainly willows and other alpine hydrophytic forbs and sedges. This soil occurs in the alpine area and occupies cirque basins and the lower slopes below alpine ridgetops. The mean annual precipitation is 20 inches, and the mean annual soil temperature is 30° F. Permeability and available water capacity are moderate. Roots can penetrate to a depth of 60 inches or more.

Under a thin layer of litter, the surface layer typically is dark brown to brown loam about 8 inches thick. The subsoil is a brown, mottled stony loamy fine sand 20 inches thick. The substratum is yellowish brown gravelly loamy sand. Bedrock is at a depth of 60 inches.

In the Taylor River Area, Vasquez soils are mapped only in complex with Haverly soils.

Representative profile of Vasquez loam, in an area of Haverly-Vasquez loams, in sec. 14, T. 14 S., R. 81 W.:

O1—1 inch to 0; willow twigs, leaves, and remains of sedges and grasses.
A11—0 to 3 inches; dark brown (10YR 3/3) loam, very dark brown (10YR 2/3) moist; weak very fine granular structure; soft when dry, very friable when moist; 5 percent stones; abundant roots; pH 4.8; clear wavy boundary.
A12—3 to 8 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; weak very fine granular structure; soft when dry, very friable when moist; 10 percent stones; many roots; pH 4.6; clear irregular boundary.
IIB2—8 to 28 inches; brown (7.5YR 5/4) stony loamy fine sand, dark brown (7.5YR 4/4) moist; common fine distinct pinkish gray (7.5YR 7/2) and reddish brown (5YR 4/3) mottles; weak fine granular structure; loose when dry, very friable when moist; 40 percent granite and gneiss rock fragments; few roots; pH 5.0; clear irregular boundary.
IIC—28 to 60 inches; yellowish brown (10YR 5/4) gravelly loamy sand, dark yellowish brown (10YR 4/4) moist; single grained; loose when dry and moist; 40 percent rock fragments; pH 5.0; abrupt wavy boundary.
IIIR—60 to 72 inches; granite.

The A horizon ranges from loam to silt loam, and the IIB2 horizon, from stony loamy fine sand to loam or stony fine sandy loam. The C horizon ranges from gravelly loamy sand to fine sandy loam.

Genesis, Morphology, and Classification of Soils

The following discussion is intended principally for

individuals who want more detailed information regarding the nature and origin of the soils of the Taylor River Area.

Soil genesis

There are five principal factors of soil formation: parent material; topography; living organisms (biological activity); climate; and time. The soil-forming factors are interdependent, each modifying the effectiveness of the others (*3*).

Soil is the result of the combined effects of these five factors, and soil differences are due principally to the relative importance, or strength, of the various factors. In mountainous areas such as the Taylor River Area, changes in one or more soil-forming factors occur within relatively short distances. The many microclimates—the results of differences in elevation, air drainage, and topography with its modifying subfactors of slope gradient and aspect—and the accompanying differences help create many kinds of soils. Changes in the other factors—parent material, topography, and time—further increase the number of different kinds of soil in the Area.

The soil-forming factors are interrelated, so the relative effectiveness of each in determining soil characteristics at any particular site is difficult to evaluate.

Parent Material.—Soils of the Area are forming in the weathered material of igneous, metamorphic, and sedimentary rocks and unconsolidated deposits. The bedrock that contributes to soil parent material is discussed in Part I of this survey in the section "Geology."

The effects on soil development of the transportation of parent materials by creep, landslides, and water erosion is apparent in many soils. Creep occurs on all steep mountain slopes regardless of the type of parent material. It causes thickened A1 horizons and buried profiles. The depth to bedrock in the Schofield-Peeler soils, which formed in granitic materials, varies widely because of downslope movement of the parent material. Creeps and slides are very common in areas of Bucklon and Tongue River soils, which derived from shale, and in areas of Sawcreek and Lamphier soils, which weathered from Maroon conglomerate. Soils developing in valley-filling deposits commonly overlie profiles buried by more recent sediment.

Chemical and physical weathering of rocks and parent materials are both effective in the Area. The nature of the parent materials is reflected in the textures of the soils. Gneiss, granite, and sandstone have weathered to sandy, permeable soils. In most places, soils that formed over these rocks contain considerable amounts of gravel and rock fragments. These fragments are the result of differential weathering of the parent material or of uneven erosion of the soil material. In some places the soils that formed in gneiss and granite contain many mica flakes inherited from inclusions of biotite schist. Granite is principally quartz and feldspar with small quantities of other minerals. The soils derived from this rock are, for the most part, low in clay due to the content of quartz and its resistance to weathering and the leaching of the weathering products of the feldspar. On steep, south-facing and west-facing slopes, geologic erosion has been rapid, and soil characteristics, as typified by the Stecum series, have been largely inherited from the parent materials.

Pennsylvanian limestone, including some dolomite, has produced soils with loam to silty clay loam surface textures and medium to high fertility. The principal soil characteristic inherited from the parent material, other than the texture, is a higher soil reaction than encountered in soils derived from other parent materials. Reaction of the subsoil of the Judy and Limber series, which are derived from limestone, ranges from pH 6.4 to 8.2. The Schofield soils, which formed in granite, range from pH 6.0 to 6.6. The lower part of the subsoil of the Judy and Limber soils is calcareous, although most soils in the Area are noncalcareous throughout. Soils that formed in parent materials weathered from limestone have a significantly higher cation exchange capacity than most soils in the Area.

Soils that formed in material weathered from Mancos shale are high in silt and clay and are subject to slumping. The shale is dark gray to black, and the dark color of Bucklon soils probably has been inherited from the parent material. Bucklon soils are highly erodible, as are its parent materials. Reaction ranges from pH 6.5 to 6.8, which is not so high as the reaction of soils derived from limestone, but which is higher than that of soils that formed in other parent materials in the Area.

Siliceous sandstones have weathered to sandy, gravelly acid soil of low fertility. The subsoil of the Jenkins soils ranges from pH 4.6 to 5.8; the subsoil of the Kebler soils, from pH 4.8 to 5.0. In some areas, the sandstones have been metamorphosed to quartzite, and the soils contain many stones inherited from the parent material.

Soils that formed in material weathered from gneiss and schist range in texture from loam to gravelly sandy loam. The finer textured soils occur where the parent rock is dominantly schist. Rock fragments inherited from the parent materials are common. Reaction ranges from pH 6.0 to 7.0 except in the Rarick and Vasquez soils, where it ranges from pH 4.5 to 6.0.

The Maroon conglomerate consists of gravel, mostly granite and limestone fragments, cemented by reddish material and interbedded with reddish sandstone. Ashcroft, Hierro, and Lamphier soils forming in the weathered Maroon conglomerate have a reddish-brown subsoil and substratum and pebbles and cobbles that they inherited from this formation. The limestone fragments in the conglomerate have affected reaction, which ranges from pH 6.0 to 7.0.

Unconsolidated deposits include glacial moraines, glacial outwash, alluvial-colluvial deposits as valley fill, and recent alluvium. Soils that formed in these unconsolidated deposits have textures similar to the parent rocks from which the sediment was derived. Sediment from granite, gneiss, conglomerate, or sandstone have produced sandy, gravelly soils. Sediment from limestone, shale, and schist have produced fine-textured soils. However, the silty surface textures of some soils in the alpine zone suggest a thin loess mantle since, in many cases, the underlying rocks are associated with coarse-textured soils.

Topography.—Topography influences soil formation

by affecting the other soil-forming factors. Differences in elevation and aspect are associated with differences in climate and vegetation. In the Taylor River Area, shallow soils with little or no horizon development are most common on south-facing and west-facing slopes. Soils that have relatively strong horizonation are most common on east-facing and north-facing slopes. The differences result partly from the greater density of vegetation on the east-facing and north-facing slopes, and partly from more severe erosion on the other aspects, which are more affected by alternate freezing and thawing. For example, Stecum soils are on southerly and westerly aspects and have an A1–AC–C–R horizon sequence. Schofield soils are on northerly and easterly aspects and have an O1–O2–A1–A2–A&B–B2t–R horizon sequence. The affect of aspect on soil formation is the most pronounced at the highest elevations and where the difference in slope gradient is most pronounced.

Soil horizons are thinner and bedrock is at shallower depths in steep soils than in gently sloping soils because of greater runoff and erosion.

Slope configuration, as well as gradient, influences soil characteristics. Almont soils, in concave areas where sediment and moisture accumulate, have thicker profiles than Mirror soils, which are on convex slopes where erosion is active.

Living Organisms.—Living organisms affect the thickness, structure, and organic-matter content of the A1 horizon. Vegetative types seem to determine the presence or absence of an A2 horizon and the degree of subsoil development.

In the Taylor River Area, there are three major vegetative zones related to soil development: the foothills zone, the montane zone, and the alpine zone.

The foothills zone supports both the dry and wet meadow types of mountain bunchgrass. Soils associated with the mountain bunchgrass type have a brown to very dark grayish-brown A1 horizon that ranges from 5 to 18 inches in thickness. In addition to thickness in dark A1 horizons, reaction is higher because more bases are annually incorporated in the surface horizons under this type of vegetation. Most of the soils that formed under grass are slightly acid to slightly alkaline. McIntyre soils illustrate the influence of grass vegetation on soil development because these soils originally had a cover of conifers which was destroyed by fire. The present vegetation consists of grasses and patches of quaking aspen, so a thick, dark A1 horizon has formed over a distinct A2 horizon. The A1 horizon of McIntyre soils averages about 12 inches thick, but the associated Kebler soils, under coniferous forest, have an A2 horizon at the surface or only a very thin A1 horizon.

The montane zone of coniferous forest has acid, deeply leached soils with very thin or no A1 horizons. Many of the soils have a prominent A2 horizon and a B horizon with accumulations of eluviated clay or iron. Reaction ranges from pH 4.2 to 7.0.

In the alpine zone the vegetation consists of alpine species of sedges, grasses, lichens, forbs, and willows. Under this type of vegetation and low soil temperatures, organic matter decomposes slowly and accumulates in the soil. The A1 horizon is generally about 6 inches thick and is grayish brown or dark grayish brown. Reaction generally ranges from pH 4.5 to 5.5, but in soils that formed in limestone, reaction may be as high as pH 7.8.

With the exception of the grassland soils, few soils support activity by earthworms, insects, and other soil fauna; consequently there is little mixing of organic matter with the mineral soil. The pocket gopher influences soil formation in the grasslands and seems to prefer Emerald, Judy, and Tilton soils, which formed in alluvial-colluvial deposits. In many places, the A1 horizon is 25 inches thick and is dark colored because the organic matter was mixed into the soil by rodents.

Areas occupied by pocket gophers are characterized by mounds. Just after snowmelt, such areas have "winter-cores," or casts that form when snow tunnels are packed with soil brought from below ground (*4*). Pocket gophers create a deep, dark soil high in organic matter, but they destroy grasses, which are replaced by various forbs.

Beavers influence soil formation by building dams that raise the water tables in stream valleys, thereby creating poorly drained soils. Their dams and ponds slow the rate of stream flow, causing waters to spread, lose velocity and deposit sediment. Eventually the ponds fill with sediment or the dams break. When the latter occurs, the sediment is swept downstream, frequently causing damage in the valley below (*8*).

Climate.—A number of microclimates occur in the Area due to differences in elevation and aspect. Elevation ranges from 8,000 to 14,000 feet. The resulting range in climate is sufficient to cause vertical zonation of vegetation and therefore of kinds of soil (see "Living Organisms").

North-facing and east-facing slopes are cooler, more moist, and more densely vegetated than south-facing and west-facing slopes. South-facing and west-facing slopes are drier, warmer, and less densely vegetated.

The relationship of soils to climate, with its corresponding vegetative changes, as affected by aspect and elevation, are generalizations with many exceptions. Some south-facing slopes in deep canyons are exposed to the sun for only short periods of the day because of their depth. In these deep canyons are soils usually found at higher elevations or on northerly aspects.

Timberline is at an elevation of 11,800 feet in the Area. Almont, Mirror, Ptarmigan, Doct, Haverly, and Vasquez soils are above this elevation. Much snow falls in the alpine areas, although winter winds, with velocities that may exceed 100 miles per hour, remove most of this snow from exposed ridges and deposit it on lee slopes and in cirque basins.

Because the soils are frozen for much of the year and because of low summer precipitation, soil leaching is not great. The solum is generally about 12 inches thick. In some more exposed areas, winds have removed fines from the A1 horizon and left a pebble pavement on the surface. Avalanches, originating where deep snow accumulates, remove the vegetation and the soils in their paths.

Air drainage is also a factor in soil formation. In mountain parks like Taylor Park, there is an inversion of temperature during cold spells, and a frost pocket forms. During the warmest part of summer,

temperatures of 22° F at night are not uncommon. Low soil temperatures do not favor either vegetative growth or soil-forming processes. The Cabin soils have a weakly developed B2 horizon, and their solum is about 30 inches thick. Soil development in the Pierian and Tine series is limited to an A1 horizon 8 to 13 inches thick over a C horizon.

Time.—The effectiveness of time as a soil-forming factor depends, to a considerable degree, on the influence of climate and living organisms and the modifying effects of relief and parent material.

There is a wide range in soil age in the Area, as evidenced by soil depth, the degree of horizon development, and the intensity of weathering or leaching. Alluvial land and accumulations at the bases of steep slopes are young. Many of the soils on steep slopes, where geologic erosion tends to keep pace with soil formation, are also young. Examples of relatively young soils include Stecum, Tilton, Bucklon, and Tomichi soils.

Tex, Peeler, Jenkins, and Leal soils exhibit the greatest depth of leaching and degree of horizon development. Peeler soils are leached to depths of 72 inches or more, and the B2t horizon may extend to depths of more than 60 inches. Bedrock limits solum thickness in the Jenkins soils, but the Leal soils have been leached to a depth of 40 inches or more.

Classification of soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965 (*11*). Because this system is under continual study, readers interested in developments of the current system should search the latest literature available.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 6, the soil series of the Taylor River Area are placed in four categories of the current system. Categories of the current system are briefly defined in the following paragraphs.

TABLE 6.—*Classification of soils*

Series	Family	Subgroup	Order
Almont	Fine-loamy, mixed	Pergelic Cryaquolls	Mollisols.
Ashcroft	Coarse-loamy, mixed	Typic Cryoboralfs	Alfisols.
Bassel	Coarse-loamy, mixed	Argic Cryoborolls	Mollisols.
Bucklon	Loamy, mixed, shallow	Typic Cryoborolls	Mollisols.
Cabin	Fine-loamy over sandy or sandy-skeletal, mixed	Argic Cryoborolls	Mollisols.
Charlos	Fine-loamy over sandy or sandy-skeletal, mixed	Argic Cryoborolls	Mollisols.
Dinnen	Coarse-loamy, mixed	Typic Cryoborolls	Mollisols.
Doct	Fine-loamy, mixed	Pergelic Cryoborolls	Mollisols.
Emerald	Fine-loamy, mixed	Typic Cryoborolls	Mollisols.
Eyre	Loamy-skeletal, mixed	Lithic Cryoborolls	Mollisols.
Gothic	Fine, montmorillonitic	Argic Cryoborolls	Mollisols.
Haverly	Coarse-loamy, mixed	Pergelic Cryumbrepts	Inceptisols.
Hierro	Fine-loamy, mixed	Typic Cryoboralfs	Alfisols.
Jenkins	Coarse-loamy, mixed	Typic Cryochrepts	Inceptisols.
Judy	Fine, montmorillonitic	Argic Cryoborolls	Mollisols.
Kebler	Loamy-skeletal, mixed	Typic Cryoboralfs	Alfisols.
Lamphier	Fine-loamy, mixed	Pachic Cryoborolls	Mollisols.
Leal	Coarse-loamy, mixed	Dystric Cryochrepts	Inceptisols.
Leaps	Fine, montmorillonitic	Typic Cryoborolls	Mollisols.
Limber	Fine-loamy, mixed	Typic Cryoboralfs	Alfisols.
Lucky	Fine-loamy, mixed	Argic Cryoborolls	Mollisols.
Matcher	Sandy-skeletal, mixed	Typic Cryumbrepts	Inceptisols.
Mayoworth	Fine, montmorillonitic	Argic Cryoborolls	Mollisols.
McIntyre	Fine-loamy, mixed	Boralfic Cryoborolls	Mollisols.
Mirror	Loamy-skeletal, mixed	Pergelic Cryumbrepts	Inceptisols.
Mysten	Mixed	Typic Cryopsamments	Entisols.
Peeler	Fine-loamy, mixed	Typic Cryoboralfs	Alfisols.
Pierian	Sandy-skeletal, mixed	Typic Cryoborolls	Mollisols.
Ptarmigan	Coarse-loamy, mixed	Pergelic Cryumbrepts	Inceptisols.
Rarick	Coarse-loamy, mixed	Typic Cryumbrepts	Inceptisols.
Sanford	Fine-loamy, mixed	Psammentic Cryoboralfs	Alfisols.
Sawcreek	Coarse-loamy, mixed	Typic Cryoborolls	Mollisols.
Schofield	Fine-loamy, mixed	Typic Cryoboralfs	Alfisols.
Stecum	Sandy-skeletal, mixed	Typic Cryorthents	Entisols.

TABLE 6.—*Classification of soils*—Continued

Series	Family	Subgroup	Order
Supervisor	Loamy-skeletal, mixed	Typic Cryoborolls	Mollisols.
Tabernash	Fine-loamy over sandy or sandy-skeletal, mixed	Typic Cryoboralfs	Alfisols.
Tellman	Fine-loamy over sandy or sandy-skeletal, mixed	Typic Cryoboralfs	Alfisols.
Teoculli	Coarse-loamy, mixed	Typic Cryoborolls	Mollisols.
Tex	Fine-loamy, mixed	Psammentic Cryoboralfs	Alfisols.
Tilton	Fine-loamy, mixed	Typic Cryoborolls	Mollisols.
Tine	Sandy-skeletal, mixed	Typic Cryoborolls	Mollisols.
Tomichi	Sandy, mixed	Typic Cryoborolls	Mollisols.
Tongue River	Fine-loamy, mixed	Typic Cryoboralfs	Alfisols.
Vasquez	Coarse-loamy, mixed, acid	Munic Pergelic Cryaquepts	Inceptisols.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates.

SUBORDER. Each order is subdivided into suborders that are based primarily on the soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or those that are brought about by climate or vegetation.

GREAT GROUP. Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots, movement of water, or both; and surface horizons that are thick and dark colored. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly

TABLE 7.—

Soil, sample number, and location	Particle size distribution				
	Horizon	Depth	Very coarse sand (2.0–1.0 mm)	Coarse sand (1.0–0.5 mm)	Medium sand (0.5–0.25 mm)
		Inches	*Percent*	*Percent*	*Percent*
Cabin sandy loam:					
S 59 Colo–26–4(1–6) SW¼NW¼ sec. 16, T. 14 S., R. 82 W.	A11	0–3½	21.6	18.7	6.4
	A12	3½–8	30.5	17.5	4.0
	B1	8–14	16.0	19.6	9.0
	B2t	14–22	20.3	23.7	9.4
	B3	22–32	20.9	23.9	9.9
	IIC	32–60	20.1	26.1	12.2
Cabin fine sandy loam:[1]					
S 59 Colo–26–5(1–6) SW¼NE¼ sec. 22, T. 14 S., R. 82 W.	A11	0–4	11.4	12.2	6.6
	A12	4–8	9.3	11.2	7.0
	B1	8–11	10.3	11.8	7.7
	B2t	11–22	16.1	16.1	9.9
	B3	22–34	9.0	16.7	9.5
	IIC	34–41	14.1	22.8	11.6
Tex gravelly sandy loam:[2]					
S 59 Colo–26–3(1–6) NE¼ sec. 14, T. 13 S., R. 83 W.	A1	0–2	14.4	17.5	7.6
	A2	2–10	15.3	16.7	9.7
	A&B	10–14	16.6	17.9	9.7
	B21t	14–24	20.9	21.7	11.2
	B22t	24–45	20.8	19.5	10.5
	C	45–60	30.0	24.4	11.6
Tex sandy loam:[2]					
S 59 Colo–26–6(1–6) SW¼NW¼ sec. 16, T. 13 S., R. 82 W.	A1[4]	0–½	-----	-----	-----
	A2	½–4	22.3	13.3	5.9
	A&B	4–8	19.5	13.1	6.0
	B21t	8–14	12.7	18.3	11.7
	B22t	14–19	15.5	18.2	10.8
	C1	19–32	13.6	18.5	11.8
	C2	32–42	14.2	19.7	12.2

[1] Cabin fine sandy loam was combined with Cabin sandy loam in correlation.
[2] Samples of horizons below 10 inches exclude band materials; *i.e.*, samples represent the interband material.

calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like.

SUBGROUP. Great groups are subdivided into the subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made if soil properties intergrade outside of the range of any other great group, suborder, or order.

FAMILY. Families are separated within a subgroup primarily on the basis of properties important to the group of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reactions, soil temperature, permeability, thickness of horizons, and consistence.

Laboratory Data

Physical and chemical characteristics of Cabin and Tex soils, two of the major soils in the survey area, are given in tables 7 and 8.

The two Cabin profiles have quite similar chemical and physical properties. Base saturation increases with depth, and calcium is the dominant extractable cation.

The two Tex profiles are also similar in chemical and physical properties. Particle-size analyses do not indicate any significant differences between them. These soils are moderately well saturated with bases, and calcium is the dominant extractable cation. The data in tables 7 and 8 are for samples of the interband or matrix materials in horizons with lamellae, or bands. Interpretations of data from the bands will be discussed later in this section. The A1 horizon of Tex sandy loam was not sampled because of its high content of charcoal.

Cabin and Tex soils are lower in clay and silt than soils derived from shale or limestone. Cabin and Tex soils formed in glacial deposits dominantly of granitic origin, and the low silt and clay contents reflect the composition of the granites. The granites are high in quartz and other minerals that are resistant to weathering. Rock material larger than 2 millimeters is not shown in the data, but should not be overlooked when interpretations are made.

The A1 horizons of these soils are moderately high in organic carbon, although in Tex soils, organic matter is concentrated in the upper 2 inches. The organic-matter content of the A1 horizon is 4 to 6 percent.

The cation exchange capacity of the Cabin soils is greater than that of the Tex soils. This may be attributed to more clay and a higher organic-matter content. Soils with more clay, such as Emerald, Bucklon,

Physical analyses

Particle size distribution—Continued				Moisture tension at—		
Fine sand (0.25–0.10 mm)	Very fine sand (0.10–0.05 mm)	Silt (0.05–0.002 mm)	Clay (< 0.002 mm)	1/10 atmosphere	1/3 atmosphere	15 atmospheres
Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
7.7	5.4	27.7	12.5	29.4	17.9	8.5
7.4	5.0	22.7	12.9	18.1	11.3	6.1
12.6	7.8	21.0	14.0	13.6	9.6	5.3
11.8	6.0	17.1	11.7	12.4	8.3	4.8
12.0	5.3	16.3	11.7	12.8	8.2	4.8
15.9	6.2	12.7	6.8	10.1	6.3	3.6
10.2	9.4	35.8	14.4	32.0	16.5	7.9
11.8	11.3	34.1	15.3	21.3	12.2	6.6
13.4	11.9	29.5	15.4	18.9	11.6	6.5
15.4	8.5	18.0	16.0	15.0	10.8	6.2
15.3	11.1	24.6	13.8	18.2	11.1	5.6
17.6	10.0	16.6	7.3	12.8	7.5	3.6
11.8	8.7	27.3	12.7	20.1	13.7	5.5
15.7	8.4	27.7	6.5	14.8	9.0	3.1
17.3	9.4	22.3	6.8	11.1	6.6	2.5
16.6	8.1	16.2	5.3	10.2	6.4	2.2
17.6	9.4	16.1	6.1	10.6	6.7	2.2
15.9	5.6	8.3	4.2	7.2	4.6	1.6
9.9	8.2	35.4	5.0	22.4	11.4	3.9
11.0	10.2	33.3	6.9	18.7	9.3	3.5
22.1	12.7	16.8	5.7	10.9	5.6	2.4
20.0	12.7	18.8	4.0	11.1	4.8	1.6
21.2	12.4	18.6	3.9	9.9	4.6	1.4
21.3	12.0	17.4	3.2	9.7	4.4	1.3

[3] Tex sandy loam was combined with Tex gravelly sandy loam in correlation.
[4] Not sampled because of high charcoal content.

TABLE 8.—

[Dashes indicate determinations

Soil and sample number	Horizon	Depth	ph (1:1 ratio)	Free iron (Fe203)	Organic carbon	Nitrogen
		Inches		*Percent*	*Percent*	*Percent*
Cabin sandy loam:						
S 59 Colo–26–4(1–6)	A11	0–3½	5.9	1.3	3.40	0.245
	A12	3½–8	6.1	1.2	1.10	0.110
	B1	8–14	6.2	1.3	0.55	0.046
	B2t	14–22	6.2	1.0	0.24	0.026
	B3	22–32	6.3	1.2	0.12	-------
	IIC	32–60	6.4	0.9	0.09	-------
Cabin fine sandy loam: [1]						
S 59 Colo–26–5(1–6)	A11	0–4	6.4	1.6	2.56	0.208
	A12	4–8	6.3	1.8	1.13	0.107
	B1	8–11	6.1	1.7	0.54	0.061
	B2	11–22	6.2	1.5	0.34	0.028
	B3	22–34	6.5	1.4	0.19	0.019
	C	34–41	6.7	0.9	0.05	-------
Tex gravelly sandy loam:						
S 59 Colo–26–3(1–6)	A1	0–2	5.9	1.0	2.95	0.118
	A2	2–10	5.8	1.0	0.51	0.022
	A&B	10–14	5.9	0.9	0.15	0.007
	B21t	14–24	6.0	1.0	0.09	0.007
	B22t	24–45	6.3	0.9	0.04	-------
	C	45–60	6.7	0.9	0.02	-------
Tex sandy loam: [2]						
S 59 Colo–26–6(1–6)	A1 [2]	-----	----	----	-----	-------
	A2	½–4	5.7	0.8	0.69	0.031
	A2B1	4–8	5.4	0.9	0.37	0.017
	A2B2	8–14	5.6	0.8	0.08	0.007
	B3C	14–19	6.0	0.6	0.06	0.003
	C1	19–32	6.3	0.5	0.02	0.001
	C2	32–42	6.5	0.6	0.04	-------

[1] Cabin fine sandy loam was combined with Cabin sandy loam in correlation.
[2] Tex sandy loam was combined with Tex gravelly sandy loam in correlation.

Judy, and Limber soils, probably have comparatively higher cation exchange capacities.

Moisture tension measurements indicate that these soils can be expected to be droughty, substantiating field observations. However, light rains are more beneficial to plants on Tex and Cabin soils than on heavier textured soils.

Some horizons of the Tex soils have lamellae, or bands, so three samples of the band materials were taken from Tex sandy loam for analyses and thin-section study. The band materials contain more clay, organic carbon, and free iron than the matrix materials. Thin sections of dark-brown bands in the A&B horizon show the upper boundary to be a sharply defined, light-colored silty layer about 1 to 1.5 millimeters thick with much less sand than most of the lamellae. The dark-brown portion of the bands contains numerous bodies of optically oriented fine clay 20 to 50 microns thick, as linings of pores and as coatings around sand grains. The major constituents of the sand and coarse silt are quartz, feldspar, and biotite. Some feldspar grains show evidence of weathering. A number of biotite grains show separation along cleavage traces at the edge of the grain suggesting weathering after deposition of the till parent material.

Part III: Soil Use and Management

In this section, use and management of the soils for timber, range, and water are discussed. The hazards of erosion, landslides, and fire are described, and the suitability of the soils for recreational development, as wildlife habitat, and for engineering purposes is discussed. Although the soils in the Taylor River Area are not placed in capability units, the system of capability classification used by the United States Department of Agriculture is described.

The estimated potential uses, limitations, and hazards of the soils are shown in table 9.

Timber

Suitability of soil areas for timber production has been determined from field observations and site index measurements of trees on key soils.

The Taylor River Area is not a good timber pro-

Chemical analyses

were not made]

Cation exchange capacity (NH40Ac)	Extractable cations (milliequivalents per 100 grams of soil)					Base saturation of sum of cations
	Calcium	Magnesium	Hydrogen	Sodium	Potassium	
Meq per 100g soil						*Percent*
15.5	9.7	1.9	6.9	0.1	0.9	64
12.1	7.6	1.7	4.8	0.1	0.8	68
10.1	7.0	1.9	3.3	0.1	0.4	74
9.7	7.5	1.8	3.1	0.1	0.2	75
9.1	7.8	1.7	2.8	0.1	0.1	77
6.9	6.2	1.5	1.4	0.1	0.1	85
14.8	10.4	1.9	7.9	0.1	1.0	63
11.6	7.6	1.9	5.5	0.1	0.6	65
11.4	7.8	2.0	4.3	0.1	0.4	70
12.5	9.8	2.6	3.6	0.1	0.2	78
11.2	10.9	2.5	3.1	0.1	0.1	81
8.0	8.0	1.5	1.9	0.1	0.1	84
12.5	7.1	1.1	8.8	0.1	0.4	49
5.9	3.3	0.7	3.5	0.1	0.2	54
4.1	2.2	0.4	2.4	0.1	0.1	53
3.4	2.0	0.7	1.6	0.1	0.1	64
3.3	2.1	0.8	1.4	0.1	0.1	68
2.5	1.6	0.7	0.9	0.1	0.1	73
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6.7	3.4	0.8	1.6	0.1	0.3	74
6.8	2.8	1.0	4.0	0.1	0.2	50
4.9	1.8	0.7	2.6	0.1	0.2	51
3.4	1.6	0.4	2.1	0.1	0.1	50
2.2	1.3	0.4	0.9	0.1	0.1	67
2.2	1.5	0.4	0.9	0.1	0.1	69

[1] Not sampled because of high charcoal content.

ducing area. The suitabilities of different areas for timber production are relative. If a soil has a rating of "good," it is good in relation to other soils in the Area. No soils in the Area are rated "excellent" for timber production.

The soil factor having the greatest influence on timber productivity in this Area appears to be moisture. This is apparent in very sandy and gravelly soils that have low available water capacity and in soils that are very shallow to bedrock. Very shallow soils do not have an adequate reservoir for storing soil moisture, and depth of rooting is limited by bedrock. The best timber growth and the highest site indices are found on soil that formed in alluvial-colluvial deposits on mountain toe slopes and along drainageways. These soils receive transient moisture from higher lying areas. The fertility level does not appear to be significant enough to account for differences in timber growth soils of the area. Trees are long lived, their root systems extend into a large volume of soil to draw nutrients, and their annual demands for plant nutrients are relatively low. Before soil fertility can become a limiting factor, plant growth must be rapid enough to cause a deficiency of available plant nutrients. This is unlikely if moisture is the limiting factor.

On a board-foot basis, lodgepole pine produces the greatest commercial volume of timber, and spruce-fir is next. For suitabilities of the various soils and land types for these species, see table 9, page 58. At the time of this writing, satisfactory growth curves for lodgepole pine in this Area have not been published. On a regional basis, however, lodgepole pine (100 years old) is rated good if the site index is 65 to 80; fair if 50 to 65; poor if 35 to 50; or very poor if 35 or less.

Soils rated "poor" for lodgepole pine include land types such as Rock land and Rock outcrop. These land types are very shallow, and bedrock exposures are extensive. Existing timber should be managed to protect the soil. Soils rated "poor" for spruce-fir include most of the soils now covered by lodgepole pine. All of these soils are below 10,700 feet. The average annual precipitation does not exceed 30 inches, and the average for areas of these soils is about 16 inches. The soils are sandy and very permeable. Due to soil-moisture conditions, temperature, and precipitation, these soils are poorly suited to spruce-fir.

TABLE 9.—*Estimated potential uses,*

Mapping unit	Suitability for [1]—	
	Lodgepole pine	Englemann spruce-subalpine fir
Ad—Alluvial land	Very poor	Very poor
AmF—Almont silt loam, 10 to 70 percent slopes	(2)	(2)
AsE—Ashcroft sandy loam, 5 to 25 percent slopes	Good	Fair
AsF—Ashcroft sandy loam, 25 to 60 percent slopes	Good	Fair
BaE—Bassel sandy loam, 0 to 25 percent slopes	Fair	Poor
BaF—Bassel sandy loam, 25 to 60 percent slopes	Fair	Fair
BuF—Bucklon silt loam, 15 to 75 percent slopes	Poor	Very poor
CaA—Cabin sandy loam, 0 to 3 percent slopes	Poor	Very poor
CaE—Cabin sandy loam, 3 to 25 percent slopes	Poor	Very poor
ChE—Charlos sandy loam, 0 to 25 percent slopes	Poor	Very poor
ClE2—Charlos sandy clay loam, 5 to 25 percent slopes, eroded	Very poor	Very poor
Cr—Cryaquolls	(2)	(2)
Cs—Cryaquolls and Histosols	(2)	(2)
DnF—Dinnen sandy loam, 2 to 60 percent slopes	Poor	Very poor
DsF—Dinnen stony sandy loam, 5 to 60 percent slopes	Poor	Very poor
DtE—Doct silt loam, 10 to 25 percent slopes	(2)	Very poor
DtF—Doct silt loam, 25 to 70 percent slopes	(2)	Very poor
EmF—Emerald sandy clay loam, 5 to 45 percent slopes	Fair	Very poor
EyF—Eyre sandy loam, 15 to 70 percent slopes	Poor	Very poor
GoE—Gothic fine sandy loam, 5 to 40 percent slopes	Poor	Very poor
HaE—Haverly-Vasquez loams, 5 to 25 percent slopes	(2)	(2)
HaF—Haverly-Vasquez loams, 25 to 70 percent slopes	(2)	(2)
HeF—Hierro loam, 5 to 45 percent slopes	Good	Fair
JeF—Jenkins gravelly loam, 15 to 60 percent slopes	Fair	Fair
JuE—Judy silty clay loam, 5 to 25 percent slopes	Fair	Poor
JuF—Judy silty clay loam, 25 to 60 percent slopes	Fair	Poor
KeE—Kebler sandy loam, 5 to 25 percent slopes	Fair	Poor
KeF—Kebler sandy loam, 25 to 60 percent slopes	Fair	Poor
LaF—Lamphier loam, 5 to 45 percent slopes	Fair	Very poor
Ld—Landslides and Gullied land	Poor	Poor
LeE—Leal gravelly loamy sand, 5 to 25 percent slopes	Fair	Fair
LeF—Leal gravelly loamy sand, 25 to 60 percent slopes	Fair	Fair
LlF—Leaps silty clay loam, 5 to 45 percent slopes	Poor	Very poor
LmE—Limber gravelly loam, 5 to 25 percent slopes	Fair	Fair
LmF—Limber gravelly loam, 25 to 70 percent slopes	Fair	Fair
LuE—Lucky gravelly sandy loam, 5 to 25 percent slopes	Fair	Poor
LuF—Lucky gravelly sandy loam, 25 to 65 percent slopes	Fair	Poor
MaE—Matcher stony sandy loam, 5 to 25 percent slopes	Fair	Fair
MaF—Matcher stony sandy loam, 25 to 60 percent slopes	Fair	Poor
McF—Matcher very stony sandy loam, 5 to 45 percent slopes	Fair	Fair
MhF—Mayoworth loam, 15 to 60 percent slopes	Poor	Very poor
MnE—McIntyre loam, 5 to 25 percent slopes	Poor	Poor
MnF—McIntyre loam, 25 to 65 percent slopes	Fair	Poor
MrE—Mirror gravelly sandy loam, 10 to 25 percent slopes	(2)	(2)
MrF—Mirror gravelly sandy loam, 25 to 70 percent slopes	(2)	(2)
MyE—Mysten loamy fine sand, 0 to 25 percent slopes	Very poor	Very poor
PeA—Pierian sandy loam, 0 to 3 percent slopes	Very poor	(2)
PnA—Pierian stony sandy loam, 0 to 3 percent slopes	Very poor	(2)
PnE—Pierian stony sandy loam, 3 to 35 percent slopes	Very poor	(2)
PtF—Ptarmigan loam, 15 to 70 percent slopes	(2)	(2)
RaF—Rarick loam, 10 to 60 percent slopes	Fair	Fair
Rl—Rock land	Poor	Poor
Ro—Rock outcrop	Very poor	Very poor
Rs—Rock slides	(2)	(2)
SaF—Sanford fine sandy loam, 15 to 65 percent slopes	Fair	Very poor
ScE—Sawcreek sandy loam, 15 to 50 percent slopes	Fair	Poor
SdE—Schofield-Peeler gravelly sandy loams, 5 to 25 percent slopes	Fair	Poor
SdF—Schofield-Peeler gravelly sandy loams, 25 to 60 percent slopes	Fair	Poor
SeF—Schofield-Peeler very stony sandy loams, 25 to 60 percent slopes	Fair	Poor
Sh—Shale rock land	Poor	Poor
SmF—Stecum stony sandy loam, 15 to 70 percent slopes	Fair	Very poor
SoF—Stecum very stony sandy loam, 25 to 70 percent slopes	Fair	Very poor
Sr—Stony colluvial land	(2)	(2)

limitations, and hazards of the soils

Windthrow hazard [2]	Logging limitations [3]	Range herbage [4]	Hydrologic soil group [5]	Detention storage of water [6]	Erodibility classification [7]	Erosion hazard [8]
Severe	Very severe	Poor	A	Medium	II	Slight.
(10)	(10)	Fair	B	High	I	Moderate.
Moderate	Moderate	Fair	B	High	IV	High.
Moderate	Moderately severe.	Fair	B	High	IV	Very high.
(10)	(10)	Excellent	B	High	II	Moderate.
(10)	(10)	Fair	B	Medium	II	High.
(10)	(10)	Excellent	D	Medium	IV	Very high.
(10)	(10)	Fair	B	High	II	Slight.
(10)	(10)	Fair	B	High	II	Moderate.
(10)	(10)	Fair	B	High	III	Moderate.
(10)	(10)	Poor	C	Medium	IV	Very high.
(10)	(10)	Poor	D	High	I	Very slight.
(10)	(10)	Good	D	High	I	Very slight.
(10)	(10)	Fair	B	High	III	Moderate.
(10)	(10)	Fair	B	High	III	Moderate.
(10)	(10)	Fair	C	Medium	III	Moderate.
(10)	(10)	Fair	C	Low	III	High.
(10)	(10)	Fair	B	High	III	Moderate.
(10)	(10)	Poor	C	Low	III	High.
(10)	(10)	Poor	C	Medium	IV	High.
(10)	(10)	Fair	B	High	II	Moderate.
(10)	(10)	Fair	B	Medium	II	High.
Moderate	Moderately severe.	Good	B	High	II	Moderate.
Severe	Moderate	Fair	C	Medium	III	High.
(10)	(10)	Fair	C	Medium	III	Moderate.
(10)	(10)	Fair	C	Low	III	High.
Severe	Moderate	Fair	C	Medium	III	Moderate.
Severe	Moderately severe.	Fair	C	Low	III	High.
(10)	(10)	Excellent	B	High	II	Moderate.
Severe	Very severe	Very poor	D	Low	V	Very high.
Moderate	Moderate	Fair	B	Medium	III	Moderate.
Moderate	Moderately severe.	Poor	B	Medium	III	Moderate.
(10)	(10)	Excellent	C	Medium	IV	High.
Moderate	Slight	Good	B	Medium	II	Moderate.
Moderate	Moderately severe.	Good	B	Low	II	High.
(10)	(10)	Fair	B	Low	III	Moderate.
(10)	(10)	Good	B	Low	III	High.
Slight	Moderate	Poor	B	High	II	Slight.
Slight	Moderately severe.	Poor	B	High	II	Moderate.
Slight	Severe	Poor	B	High	II	Moderate.
(10)	(10)	Fair	C	Low	IV	High.
Severe	Moderate	Fair	C	Low	III	High.
Severe	Moderate	Fair	C	Low	III	High.
(10)	(10)	Fair	C	Medium	II	Slight.
(10)	(10)	Fair	C	Low	II	Moderate.
Slight	Moderate	Poor	A	Low	II	Moderate.
(10)	(10)	Poor	A	Low	II	Slight.
(10)	(10)	Poor	A	Low	II	Slight.
(10)	(10)	Poor	A	Low	II	Slight.
(10)	(10)	Poor	D	Medium	III	Slight.
Severe	Moderate	Fair	C	Medium	III	High.
Moderate	Very severe	Very poor	D	Low	V	Very high.
Moderate	Very severe	Very poor	D	Low	I	Slight.
Moderate	Very severe	(9)	A	High	I	Very slight.
Severe	Moderately severe.	Fair	C	Medium	IV	High.
(10)	(10)	Fair	B	High	IV	High.
Moderate	Moderate	Fair	B	Medium	III	Slight.
Moderate	Moderately severe.	Fair	B	Medium	III	Moderate.
Moderate	Severe	Poor	B	Medium	III	Moderate.
Severe	Very severe	Very poor	D	Low	V	Very high.
(10)	(10)	Fair	C	Medium	IV	High.
(10)	(10)	Fair	C	Medium	IV	High.
Moderate	Very severe	Poor	A	High	I	Slight.

TABLE 9.—*Estimated potential uses,*

Mapping unit	Suitability for [1]—	
	Lodgepole pine	Englemann spruce-subalpine fir
St—Stony rock land	(6)	(6)
SuE—Supervisor loam, 5 to 25 percent slopes	Fair	Very poor
SuF—Supervisor loam, 25 to 70 percent slopes	Fair	Very poor
TaB—Tabernash gravelly loam, 0 to 6 percent slopes	Fair	Poor
TdF—Tellman sandy loam, 5 to 45 percent slopes	Fair	Poor
TeE—Teoculli loam, 0 to 25 percent slopes	Very poor	Fair
TgE—Tex gravelly sandy loam, 5 to 25 percent slopes	Fair	Poor
TgF—Tex gravelly sandy loam, 25 to 60 percent slopes	Fair	Poor
ThE—Tex very stony sandy loam, 5 to 25 percent slopes	Fair	Poor
ThF—Tex very stony sandy loam, 25 to 60 percent slopes	Poor	Very poor
TlE—Tilton sandy loam, 5 to 25 percent slopes	Poor	Very poor
TlF—Tilton sandy loam, 25 to 45 percent slopes	Poor	Very poor
TnA—Tine sandy loam, 0 to 3 percent slopes	Very poor	Very poor
TnE—Tine sandy loam, 3 to 30 percent slopes	Very poor	Very poor
ToE—Tomichi sandy loam, 0 to 25 percent slopes	Fair	Very poor
ToF—Tomichi sandy loam, 25 to 60 percent slopes	Poor	Very poor
TpE—Tomichi stony sandy loam, 5 to 25 percent slopes	Fair	Very poor
TpF—Tomichi stony sandy loam, 25 to 60 percent slopes	Poor	Very poor
TrF—Tongue River loam, 5 to 60 percent slopes	Fair	Fair

[1] Rating of "fair" is equivalent to site class IV.

[2] Susceptibility to windthrow is based on soil characteristics. It does not take into consideration aspect, wind velocity, inherent characteristics of species, and other factors.

[3] Refers to limitations imposed by soil, slope gradients, and other factors involved in logging operations, primarily tractor logging systems and, to a lesser degree, jammer logging system.

[4] Ratings are based on Wyoming bunchgrass type. Species included are Idaho fescue, Muhlenbergia Montana, mountain brome (*Bromus marginatus*), Thurber fescue, ring muhly, and junegrass. Soils rated as "excellent" have a dominance of Thurber fescue.

[5] Refers to the runoff potential of soils. Hydrologic soil groupings are made according to Engineering Handbook, Hydrology, Section 4, Part I, Soil Conservation Service, USDA.

Soils rated "fair" for lodgepole pine include most of the soils presently supporting lodgepole pine. This rating is average for this species in the Taylor River Area. Soils rated "fair" for spruce-fir are mostly in a belt between 10,700 and 11,800 feet, but there are soils with either more precipitation or higher ground water that have this rating. In many places these soils are shallow and rocky and in a narrow band fringing the alpine area.

Soils rated "good" for lodgepole pine generally formed in limestone and Maroon conglomerate. These soils have better soil-moisture relationships, and timber growth is better. Soils rated "good" for spruce-fir occupy the Doctor Park area and the upper reaches of Cement and Brush Creeks. This area presently has a high proportion of Engelmann spruce, subalpine fir, and scattered stands of quaking aspen. Annual precipitation ranges from about 22 to over 30 inches. The soils are fertile and have good soil-moisture relationships.

Plant competition and brush encroachment is more serious on soils of higher fertility, on fine-textured soils, and on soils having favorable moisture conditions. Soils of this kind support many kinds of plants, such as weeds, grass, brush, and undesirable trees, and all of these plants are in competition for water and nutrients. Coarse-textured, droughty soils are suited to only a narrow range of species.

In the Taylor River Area, plant competition and brush encroachment are most severe on soils in alluvial-colluvial deposits along streams and drainageways and on lower mountain toe slopes where the soils are generally deeper and more fertile and receive additional transient moisture. Shallow, rocky soils support considerable brush, but trees are sparse in such areas, and competition is limited to relatively few species. On a broad basis, plant competition and brush encroachment are most severe in the Ashcroft-Limber-Tilton soil association area. Next in severity is the Bassel-Bucklon soil association area.

Plant competition and brush encroachment is of particular importance in replanted areas. Competition between tree seedlings and shallow-rooted plants causes many planting failures. This competion is severe over a relatively brief period, and under favorable conditions, which may be influenced by management, tree roots may reach greater depths where they are less influenced by competition.

Windthrow hazards are greater on some soils than on others due to soil characteristics that control tree root development and that affect tree stability in winds. Soils of the area have been evaluated according to the windthrow hazard that can be predicted from soil characteristics alone. Other factors affecting windthrow, such as wind velocity, topographic exposure, density and uniformity of stands, inherent character-

limitations, and hazards of the soils—Continued

Windthrow hazard [2]	Logging limitations [3]	Range herbage [4]	Hydrologic soil group [5]	Detention storage of water [6]	Erodibility classification [7]	Erosion hazard [8]
([10])	([10])	Fair	D	Medium	IV	Moderate.
([10])	([10])	Fair	C	Medium	IV	Moderate.
([10])	([10])	Fair	C	Low	IV	High.
Slight	Slight	Poor	B	High	III	Slight.
Slight	Moderately severe.	Fair	B	High	III	Moderate.
([10])	([10])	Good	B	High	II	Slight.
Slight	Moderate	Poor	B	High	II	Slight.
Slight	Moderately severe.	Poor	B	High	II	Moderate.
Slight	Severe	Poor	B	High	II	Slight.
Slight	Severe	Poor	B	High	II	Moderate.
([10])	([10])	Fair	B	High	III	Moderate.
([10])	([10])	Fair	B	High	III	High.
([10])	([10])	Fair	A	High	II	Slight.
([10])	([10])	Poor	A	High	II	Moderate.
Slight	Moderate	Poor	B	High	II	Slight.
Slight	Moderately severe.	Poor	B	High	II	Moderate.
Slight	Severe	Poor	B	High	II	Slight.
Slight	Severe	Poor	B	High	II	Moderate.
Severe	Severe	Fair	D	Low	IV	High.

[6] Refers to the capacity of soil and underlying material to store detention water for slow release through springs and seeps to help maintain stream flow.

[7] Refers to stability or instability of soils when subjected to raindrop impact and runoff. Classification is determined by profile characteristics of the soil and does not take into consideration climate, vegetation, man's activities, and other such environmental factors. The most stable soils are in class I, and the least stable are in class V.

[8] Refers to susceptibility to accelerated erosion when soil or vegetation is disturbed by fire or by the activity of man.

[9] Species does not grow on the soil or is totally unsuited.

[10] Soil produces no timber or no timber of commercial value.

istics of species, and topographically accelerated winds are not considered in the evaluation. Any soil characteristic that does not allow normal root development but that favors a "pancake" root system increases the hazard of windthrow. Factors that restrict tree root growth include bedrock at a shallow depth, slowly permeable soil layers such as claypans, high water level, or inadequate internal drainage.

Windthrow hazard of soils and land types is given in table 9, page 58. The ratings of "slight," "moderate," and "severe" are based only upon soil characteristics.

Soils having a "slight" windthrow hazard are deep and well-drained with no restrictive layers. For the most part, these soils formed in glacial moraines and outwash.

Soils with a "moderate" windthrow hazard include many that formed in granite, but also include some derived from limestone and Maroon conglomerate. The soils are mostly well-drained and have no restrictive soil layers, but depth to bedrock is extremely variable, and there are many places where the soils are shallow to bedrock.

Soils or land types having a "severe" windthrow hazard include those that formed in shale or interbedded sandstone and shale and from gneiss and schist. Soils that formed in shale or in sandstone and shale are generally shallow to bedrock or have fine-textured, slowly permeable soil layers that restrict tree root development. Soils that formed in gneiss and schist have slowly permeable layers. On sloping soils the schist bedrock tends to divert waters to the surface, and the soils become soft. The hazards are therefore increased during periods of high winds or in positions receiving greater wind velocities than usual.

Throughout the Area, soils along drainageways and lower toe slopes that receive additional moisture from higher areas following wet periods are very susceptible to windthrow.

Logging limitations, for the most part, implies the limitations imposed by soils and topography on equipment used in harvesting timber. Considered in making the ratings are not only the mechanical limitations imposed by slope gradient and other physical factors, but also the effects on forest soil resources. The effects of logging operations on the soil, on the remaining stand, and on regeneration vary with the logging system used and on the kind of soil. Logging limitations for the soils of the Area are listed in table 9, page 58.

There are many logging systems, but the following discussion is concerned mainly with tractor logging and, to a lesser degree, with the "jammer" system. Where slope and other physical factors are especially unfavorable, some cable-hauling method like the high-lead system is recommended. In some cases, it may be desirable, in the interest of good forest management, that the area not be logged due to its susceptibility to erosion.

In tractor logging, the kind of soil and the slope gradient are more significant than in cable-hauling

systems. Slope of 30 percent is considered the maximum for economical tractor operation in the survey area. Some important limitations are wet conditions; loose, sandy soils; areas that are highly dissected by the drainage system; and extremely stony or bouldery soils.

A logging classification must consider slope gradient, texture, stoniness, erosion hazard, susceptibility to landslides and landflows, and rate of recovery or regeneration. The erosion hazard is dependent on many things but includes texture; permeability; stability of soil aggregates; soil thickness; slope gradient, length, and aspect; organic matter content; and amount of forest litter. Onsite investigation reveals other factors in many places.

On the basis of the factors discussed, the soils and land types of the Area have been placed into five logging classes with limitation ratings of "slight," "moderate," "moderately severe," "severe," and "very severe." These limitations are defined in the following paragraphs.

Slight limitations.—Either tractor or cable-hauling systems can be used. Soils in this class have stable surface aggregates and are moderately permeable. Slope gradients are under 30 percent, and the erosion hazard is slight.

Moderate limitations.—There are moderate limitations for tractor systems and few limitations for properly conducted cable-hauling systems. Slope gradients are less than 30 percent. The erosion hazard is moderate. Gully erosion is more common than sheet erosion. Precautions need to be taken on skid trails and wherever logging operations cause soil disturbance. Surface soil aggregates are somewhat unstable, the soils are low in organic matter, forest understory is sparse, and forest litter is very thin.

Moderately severe limitations.—In general, tractor logging is not recommended on soils with this rating except where the erosion hazard is less severe; elsewhere some system of cable-hauling is recommended. In all cases, areas of soil disturbance require special attention to prevent accelerated erosion. Included in this class are moderately coarse textured soils with slope gradients over 30 percent and highly erodible, clayey soils that formed in shale and that have slopes of less than 30 percent. The erosion hazard is moderate to high. Soils that formed in shale are susceptible to landslides and land flows, so caution is necessary in road construction. In general, the forest understory is very sparse, forest litter is thin, and the soils have low organic-matter content.

Severe limitations.—Tractor logging is not recommended on soils with this rating and, in many cases, is impossible. A system of cable hauling is recommended, and special attention should be given to areas of soil disturbance. Included in this class are moderately coarse textured, very stony or bouldery soils, and very highly erodible soils on unstable materials. Slope gradients exceed 30 percent.

Very severe limitations.—It is recommended that there be no logging on soils with this rating. Existing timber should be left for protection on these areas. Miscellaneous land types such as Rock land, Rock outcrop, Rock slides, and Stony rock land make up this class. Within any of the logging classes, short slopes are more favorable than long slopes, and north aspects are more favorable than south aspects, from the standpoint of the erosion hazard.

Range

Most of the grassland in the Area is in the mountain bunchgrass and Wyoming bunchgrass zones. Above about 11,800 feet is the alpine zone. Below that is the subalpine zone, which is a transitional zone between the true alpine and mountain bunchgrass zones.

Within the alpine zone is the turf type, or dry type of range, and the meadow type of range. Very wet areas consist of Cryaquolls and Histosols (peat and muck) and Cryaquolls (alpine bog). Cryaquolls support primarily alpine willows.

The turf type supports many kinds of grasses, sedges, forbs, and low-growing shrubs. A variety of sedges, alpine dryad, geum, chickweed, oxytropis, and poas are common. Other species include club moss, sandwort, sheep fescue, potentilla, alpine willow, spike trisetum, stonecrop, and alpine clovers. The soil is generally barren over 10 to 30 percent of the surface except in wind-eroded areas, which may be completely barren.

The alpine meadow type is dominated by sedges, forbs, and willows. Golden avens (*Geum rossi*), bistorts, and alpine clovers are common forbs. Sedges, including kobresia, generally dominate. Tufted hairgrass is generally present, but grasses represent a small percentage of the total vegetation.

Taylor Park and Union Park represent the largest grassland areas within the Wyoming bunchgrass zone. In these park areas, plants cover 35 to 50 percent of the surface; the soil is barren over 20 to 35 percent of the surface; and litter covers 15 to 30 percent of the surface. The plant composition is 40 to 70 percent grasses or grasslike plants, 10 to 25 percent forbs, and 10 to 20 percent big sagebrush. Species in order of abundance are Idaho fescue, slimstem muhly, carex, big sagebrush, junegrass, forbs, and poa. Common forbs are chickweed, phlox, pussytoes, stonecrop, and potentilla. In some areas, Thurber fescue and Idaho fescue are the dominant species.

The dry meadow type of range within the mountain bunchgrass and Wyoming bunchgrass zones occupies small areas, but the total acreage is great. The principal species include shrubby cinquefoil, silver sagebrush, bluegrass, tufted hairgrass, redtop, meadow barley, juncus, dandelion, slender wheatgrass, sedges, and spike trisetum. There are also other grasses and a wide variety of forbs not mentioned.

The wet meadow type of range within this zone includes areas of peat and muck (Cryaquolls and Histosols). Willows cover most areas of muck, but areas of peat are devoid of willows. Species in these areas include sedges, knotweed, meadow barley, juncus, tufted hairgrass, brookgrass (*catabrosa aquatica*), buttercup, and bluegrass. Popcorn flower (*Plagiobothrys spp.*) occupies bare areas.

Suitability of soils for herbage production has been determined from field observations and by the ocular-

estimate-by-plot method to estimate production on certain soils. Suitability ratings used in this survey are relative to ratings of the other soils in the survey area. The suitability of each soil for herbage production is given in table 9, page 58.

The following suitability classes and total herbage yields for each class are estimated at air-dry weight of forage produced on soils in good condition under average growing conditions. A soil is in excellent condition if herbage yields are 2,000 pounds per acre per year or more, good if yields are 1,500 to 2,000 pounds per acre per year, fair if yields are 1,000 to 1,500 pounds per acre per year, poor if yields are 400 to 1,000 pounds per acre per year, and very poor if yields are 400 pounds per acre per year or less.

Excellent to good areas for herbage production include soils that formed in alluvium, in alluvial-colluvial deposits from limestone and Maroon conglomerate, and in limestone in the mountain bunchgrass zone. These are areas of either fertile soils or soils that receive additional moisture from higher areas. Alpine meadows frequently yield between 1,000 and 1,500 pounds of herbage per acre per year.

Fair to poor areas for herbage production include the grassland soils below 10,000 feet. The Taylor Park and Union Park areas are "frost pockets," where a combination of low temperatures and droughty soils inhibits plant growth. In these parks, however, are many areas of wet and dry meadows on which herbage production is high. Cattle tend to congregate in these areas, so there is considerable damage to vegetation due to trampling.

Very poor areas for herbage production include barren mountain peaks, cirques, rock talus, and other areas of miscellaneous land types.

Water

Water is one of the most important products of the Taylor River Area. In addition to its importance for irrigation and domestic uses, water is responsible for much of the recreational value of the Area. In this section, water is considered for its contribution to springs and stream flow rather than to plant growth.

The amount of water produced by an area is affected by topography, elevation, character of bedrock, depth of unconsolidated materials, drainage pattern, soils, vegetative cover, and other factors. Soils of the Area are rated according to their potential for sustained water yield. This refers to the capacity of the soil and the underlying unconsolidated material to absorb and store water for slow release to springs and streams.

The rate of runoff and the characteristics of the rainfall have an effect on water yield. Soils with slow infiltration rates at the surface, slowly permeable layers at shallow depths, or bedrock near the surface are subject to high runoff and therefore store very little detention water.

Information about runoff potential is essential to watershed planning, since runoff potential determines, to a large extent, the flooding hazard, the character and amount of flow of streams and springs, and the hazard of erosion resulting from rainwater or snowmelt. Soils of the Area have been rated according to the Soil Conservation Service engineering handbook for hydrology. The hydrologic soil groups into which different soils fall are shown in table 9, page 58. These groups indicate runoff potential and should not be confused with ratings for water yield. There are four hydrologic groups.

Group A is made up of soils having high infiltration rates even when thoroughly wetted. These soils are chiefly deep, well-drained to excessively drained sand and gravel. These soils have a high rate of water transmission and low runoff potential.

Group A includes mixed Alluvial land, Stony colluvial land, and areas of Rock slides. These miscellaneous land types, especially Rock slides and Stony colluvial land, are subject to little or no runoff. Rock slides consist of masses of fractured rocks with large voids. These rocks have accumulated at the bases of steep mountain slopes. In winter, ice and snow fill the voids. Due to the high elevation, this ice and snow melts slowly, and the meltwater contributes to springs and stream flow throughout much of the summer.

Group B is made up of soils having moderate infiltration rates when thoroughly wetted. These soils are chiefly moderately deep, moderately well drained to well drained soils of moderately fine to moderately coarse texture. These soils have a moderate rate of water transmission.

Group B includes sandy, deep soils with good internal drainage. Soils in this group are on deep glacial moraines and outwash, Maroon conglomerate, alluvial-colluvial foot slopes, or other deep soil material. In contrast to the soils in Group A, the soils in Group B do not have included material with large voids. The soils in Group B are at lower elevations than those of Group A, and winter precipitation does not persist for so long a time.

Group C is made up of soils having slow infiltration rates when thoroughly wetted. These soils are chiefly soils with a layer that impedes the downward movement of water or soils of moderately fine to fine texture and a slow infiltration rate. These soils have a slow rate of water transmission.

Group C includes upland soils that formed in sandstone, shale, gneiss, and schist and that either have a fine-textured subsoil or are relatively shallow to bedrock.

Group D is made up of soils having very slow infiltration rates when thoroughly wetted. These soils are chiefly clay soils with a high swelling potential, soils with a high permanent water table, soils with a claypan or a clay layer at or near the surface, and soils that are shallow over nearly impermeable material. These soils have a very slow rate of water transmission.

Group D includes soils that have clay layers at or near the surface, that are very shallow to bedrock, or that have extensive bedrock exposures. Cryaquolls and Histosols are included in this group because these soils are generally saturated and therefore do not absorb much additional water. Rock land and Rock outcrop are included in this group because, since much of the surface area is barren rock, runoff is very high.

Water behavior is related to storm characteristics. Most of the precipitation in the area falls as snow;

the frequent summer rains are of short duration and of medium intensity, so runoff is not great.

Concave areas and cirque basins are catchment areas for winter snow and summer rains and contribute to stream flow in late summer. Glacial moraines, made up of Tex, Matcher, and Tomichi soils, absorb much water because of the weakly developed drainage system, the "kettle hole" topography, and the coarse textures. Toe slopes are generally gentle, so runoff is not rapid and water enters the soil. Deep regoliths are common in these positions, so much detention water is stored.

In areas of granite, sandstone, and shale, there are many shallow soils and fine dendritic drainage patterns, so runoff into the drainage system is rapid. Areas of Maroon conglomerate, gneiss, and schist have a coarse dendritic drainage pattern, so these areas are not so rapidly drained. Detention storage ratings for the soils and land types are shown in table 9, page 58.

Hazards and Limitations

Erosion, landslides, and fire are the main hazards to use of the soils of the Taylor River Area. These hazards are described in the following paragraphs.

Erosion and landslides

Erosion is the wearing away of the soil by wind or water. Accelerated erosion occurs at a rate greater than normal for the soil. Generally, accelerated erosion is brought about by man's activities, although any occurrence that reduces or destroys the vegetal cover can accelerate erosion. In the alpine areas, there is some soil blowing, although most of the erosion in the survey area is due to the action of water. Accelerated erosion takes the form of sheet erosion, rill erosion, or gully erosion, and generally a combination of all three.

Landslides, or slips, occur most commonly in material of uniform particle size, particularly when it is underlain by comparatively impermeable soil material or bedrock.

The erodibility classification given in table 9 refers to soil characteristics and qualities that provide stability or instability when exposed to surface erosion by water. It does not consider climate, slope gradient, vegetative cover, or other environmental factors. It is determined by field tests and is a means of arriving at an erosion hazard, which takes into account all of the environmental factors. The soil erodibility index is indicated by Roman numerals as follows: very low, I; low, II; moderate, III; high, IV; and very high, V.

The forest technician will be more interested in the "erosion hazard" given for each soil in table 9. The estimates of erosion hazard are based on conditions in the Taylor River Area and include the amount and intensities of rainfall. They predict the hazard of erosion if the soil or vegetative cover should be seriously disturbed or destroyed by fire, timber cutting, overgrazing, trampling by livestock, or other causes. A discussion of the five erosion hazard classes follows.

Class 1—very slight.—This class is limited to nearly level muck, peat, and other poorly drained soils. There is little or no runoff from such soils due to their permeability and gentle relief. The high content of organic matter and the porous nature of the substratum quickly absorbs rain or snowmelt as well as runoff and transient water from higher areas. These areas serve as water catchment basins, and excess water leaves the soil as underground seepage rather than as surface runoff.

Areas with a very slight erosion hazard present few erosion control problems, but severe trampling by livestock is detrimental to the vegetative cover.

Class 2—slight.—This class consists mainly of Rock outcrop and soils over glacial outwash. This class is extensive and includes the high, rocky mountain peaks; steep canyon walls; most of Taylor Park; and Quartz Creek valley.

Rock outcrop, Rock slides, and Stony colluvial land have a slight erosion hazard for several reasons. More than 90 percent of the surface area of Rock outcrop consists of barren rock, so there is little soil to erode. Rock slides are devoid of vegetation, and the high content of coarse fragments greatly limits erosion. The slopes are very steep, so runoff is rapid and damages areas below.

In areas of glacial outwash, infiltration of water into the surface soil is moderately rapid, and the soils are permeable. Except in areas of peat and muck, which have a high water table, most of the soils are well drained to excessively drained.

Class 3—moderate.—This class is the most extensive in the Area and includes a wide variety of soils. Included are soils of the alpine zone, soils that formed in material weathered from granite, limestone, sandstone, valley filling sediment, and glacial moraine deposits. Most of the area is timbered, although much of it is grassland. The surface layer has a high infiltration rate, and the underlying material is permeable to water. With the exception of the Doct, Ptarmigan, and Mirror soils, bedrock is at a considerable depth. However, the upper layers of soils forming in glacial moraines are low in clay, so serious gullying could occur if the vegetative cover were destroyed, although coarse fragments on the surface and in the profile would inhibit sheet erosion. Much of the vegetation consists of lodgepole pine with a very sparse cover of understory plants, and in addition, the soils are low in organic matter. Destruction of the timber cover would be followed by serious erosion. In the alpine zone, the soils are comparatively shallow to bedrock, although the coarse fragments on the surface and the dense mat of roots in the surface layer would greatly retard accelerated erosion.

Some small areas are severely eroded, and there are deep gullies in some places. Most of the gullies have resulted from improperly constructed trails and from mining operations.

Class 4—high.—This class consists of soils developed in Maroon conglomerate, gneiss, schist, and sandstone with interbedded shale. Although intake of water into the surface soil is rapid and the soil material is permeable, the soils in this class do not have the water storage capacity of the soils in classes 1, 2, and 3. Depth to the underlying consolidated bedrock varies widely within short distances but ranges from 8 inches to 6 feet or more.

The Maroon conglomerate is relatively unstable, as

indicated by the numerous soil slips which have created catsteps, or terracelike, sloping benches. There are no recent slips, and practically all of the old ones are stabilized by grass or trees. However, the slips are evidence of an unstable landscape, and erosion would be severe if the vegetative cover were destroyed.

The erosion hazard is high for soils weathered from sandstone and shale due to the shallow depth to bedrock, associated low available water capacity, and the unstable nature of the shales.

Soils that formed in gneiss or schist vary widely in their susceptibility to erosion, depending upon the amount of schist in an area. Depending upon the angle of the bedding plane, the schist often deflects water to the surface, which may increase the erosion hazard or create wet spots.

Accelerated erosion ranges from very slight to moderate, and there are small areas of severely eroded soils. There are some deep gullies as a result of cattle trailing and poorly located and constructed trails.

Class 5—very high.—This class consists of soils derived mainly from shale or of Rock land. Shale areas are very unstable, and soil slips or landslides are common. Rock land is included in class 5 regardless of the rock type, even though 50 to 90 percent of the surface area is barren rock. If the vegetative cover were disturbed or destroyed, the 10 to 50 percent of surface area covered with soil would be highly susceptible to erosion. The runoff from the bare rocks would be concentrated on the intervening soils. This, combined with excessively steep slopes, would cause severe erosion.

Fire

The effects of fire on the chemical, physical, and biological properties of soils depend mainly upon the soil, climate, intensity of the fire, plant species, and other factors. Some effects of fire include accelerated erosion due to the loss of the organic matter that helps to stabilize the soil and the loss of the vegetation that intercepts and thereby decreases the impact of raindrops. Soil temperatures are greater due to the loss of the insulating effects of vegetation and to the increased heat absorption by the blackened surface, all of which affect plant succession.

One of the immediate effects of fire is the crusting of the ashes following the first rain. For this reason, emergency aerial seeding of grasses or other plants for soil protection must be done as soon as possible.

The erosion hazard of the soil varies depending upon its erodibility and fertility level. For example, Judy soils have a moderate erosion hazard and a high fertility level, so revegetation would be comparatively rapid. The Tongue River soils, on the other hand, have a very high erosion hazard and medium fertility, so damage from fire on this soil could be great since erosion would be rapid and revegetation difficult.

Burning increases the amount of calcium, potassium, and phosphorus in the soil. However, fire markedly decreases the soil nitrogen supply, so nitrogen fertilization is necessary with grass seedings.

Recreational Development

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation (fig. 14). In table 10, selected soil characteristics and use potentials that are important when planning recreational developments are rated for some soils in the Area. Soils with dominant slope gradients of over 25

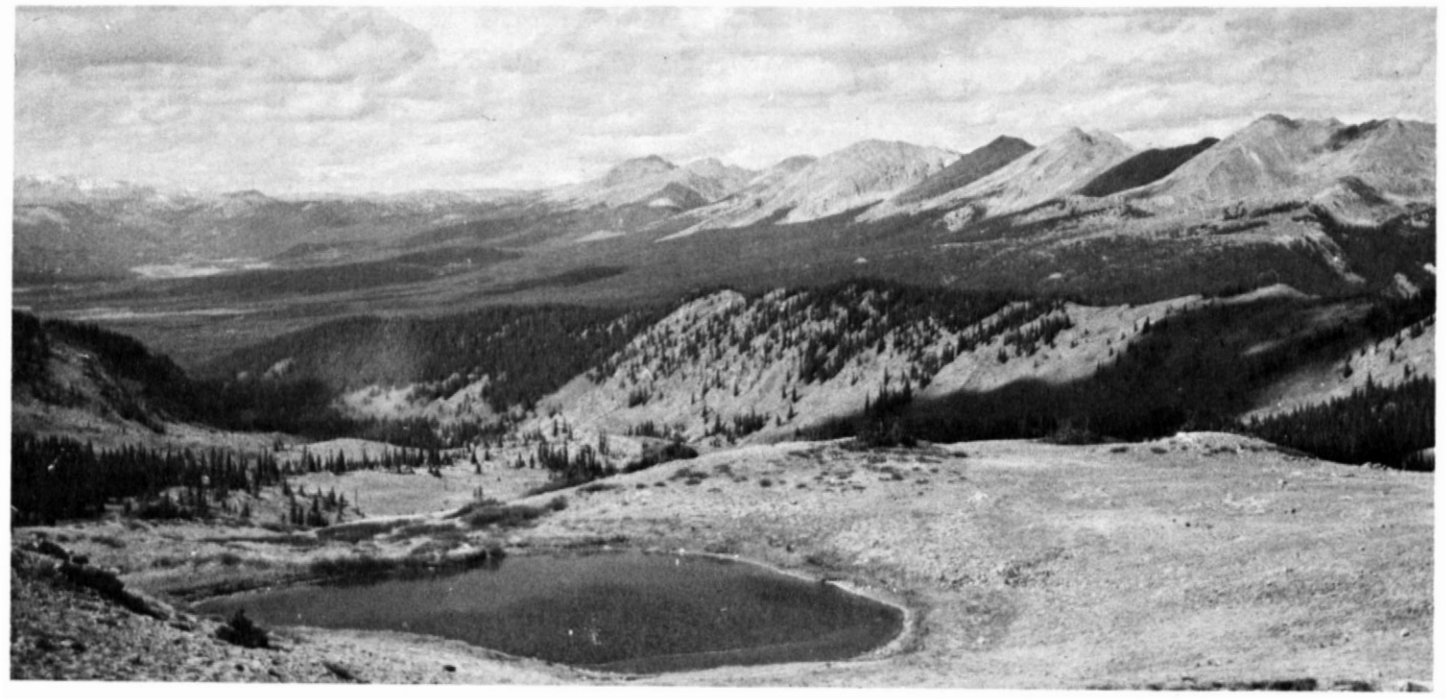

***Figure 14.*—View from Cottonwood Pass.**

TABLE 10.—*Interpretations of the soils for recreational development*

[Soils that have minimum slopes of 25 percent or more are not listed. Also, some very stony or very shallow soils are not included]

Mapping units	Erosion hazard	Soil trafficability	Soil compactability	Septic tank absorption fields	Main limitations
Ad—Alluvial land	Slight	Poor	Poor	Not suited	High water table.
AsE—Ashcroft sandy loam, 5 to 25 percent slopes.	High	Fair	Good	Suited	Erosion hazard, slope.
BaE—Bassel sandy loam, 0 to 25 percent slopes.	Moderate	Poor	Good	Suited	Subsoil stones, slope.
CaA—Cabin sandy loam, 0 to 3 percent slopes.	Slight	Fair	Good	Suited.	
CaE—Cabin sandy loam, 3 to 25 percent slopes.	Moderate	Fair	Good	Suited	Slope.
ChE—Charlos sandy loam, 0 to 25 percent slopes.	Moderate	Fair	Good	Suited	Slope.
ClE2—Charlos sandy clay loam, 5 to 25 percent slopes, eroded.	Very high	Fair	Poor	Suited	Erosion hazard, slope.
Cs—Cryaquolls and Histosols	Slight	Very poor	Very poor	Not suited	High water table, organic surface layer.
DnF—Dinnen sandy loam, 2 to 60 percent slopes.[1]	Moderate	Fair	Good	Suited	Slope.
DsF—Dinnen stony sandy loam, 5 to 60 percent slopes.[1]	Moderate	Fair	Fair	Suited	Surface stones, slope.
EmF—Emerald sandy clay loam, 5 to 45 percent slopes.[1]	Moderate	Poor	Fair	Questionable	Slope, moderately slow permeability.
GoE—Gothic fine sandy loam, 5 to 40 percent slopes.[1]	High	Poor	Good	Not suited	Slow permeability.
HeF—Hierro loam, 5 to 45 percent slopes [1]	Moderate	Poor	Good	Suited	Slope.
JuE—Judy silty clay loam, 5 to 25 percent slopes.	Moderate	Poor	Poor	Not suited	Depth to bedrock.
KeE—Kebler sandy loam, 5 to 25 percent slopes.	Moderate	Fair	Fair	Not suited	Depth to bedrock.
LaF—Lamphier loam, 5 to 45 percent slopes.[1]	Moderate	Poor	Fair	Suited.	
LeE—Leal gravelly loamy sand, 5 to 25 percent slopes.	Moderate	Very poor	Poor	Suited	Slope.
LlF—Leaps silty clay loam, 5 to 45 percent slopes.[1]	High	Poor	Poor	Not suited	Very slow permeability.
LmE—Limber gravelly loam, 5 to 25 percent slopes.	Moderate	Fair	Good	Not suited	Depth to bedrock.
LuE—Lucky gravelly sandy loam, 5 to 25 percent slopes.	Moderate	Good	Good	Not suited	Depth to bedrock.
MaE—Matcher stony sandy loam, 5 to 25 percent slopes.	Slight	Fair	Fair	Suited	Stones.
McF—Matcher very stony sandy loam, 5 to 45 percent slopes.[1]	Slight	Poor	Poor	Suited	Stones.
MhF—Mayoworth loam, 15 to 60 percent slopes.[1]	High	Poor	Good	Questionable	Depth to bedrock.
MnE—McIntyre loam, 5 to 25 percent slopes.	Moderate	Poor	Fair	Not suited	Depth to bedrock.
MyE—Mysten loamy fine sand, 0 to 25 percent slopes.	Moderate	Good	Good	Suited [2]	Loose sands.
PeA—Pierian sandy loam, 0 to 3 percent slopes.	Slight	Fair	Good	Suited [2].	
PnA—Pierian stony sandy loam, 0 to 3. percent slopes.	Slight	Fair	Fair	Suited [2]	Surface stones.
PnE—Pierian stony sandy loam, 3 to 35 percent slopes.[1]	Slight	Fair	Fair	Suited [2]	Surface stones.
ScE—Sawcreek sandy loam, 15 to 50 percent slopes.[1]	High	Fair	Good	Not suited	Depth to bedrock.
SdE—Schofield-Peeler gravelly sandy loams, 5 to 25 percent slopes.	Slight	Fair	Fair	Not suited	Depth to bedrock.
SuE—Supervisor loam, 5 to 25 percent slopes.	Moderate	Poor	Good	Not suited	Depth to bedrock.
TaB—Tabernash gravelly loam, 0 to 6 percent slopes.	Slight	Good	Fair	Suited.	
TdF—Tellman sandy loam, 5 to 45 percent slopes.[1]	Moderate	Fair	Fair	Suited.	
TeE—Teoculli loam, 0 to 25 percent slopes	Slight	Poor	Good	Good.	
TgE—Tex gravelly sandy loam, 5 to 25 percent slopes.	Slight		Fair	Suited.	
TlE—Tilton sandy loam, 5 to 25 percent slopes.	Moderate	Good	Good	Suited.	

TABLE 10.—*Interpretations of the soils for recreational development*—Continued

Mapping units	Erosion hazard	Soil trafficability	Soil compactability	Septic tank absorption fields	Main limitations
TnA—Tine sandy loam, 0 to 3 percent slopes.	Slight	Fair	Fair	Suited.	
TnE—Tine sandy loam, 3 to 30 percent slopes.[1]	Moderate	Fair	Fair	Suited.	
ToE—Tomichi sandy loam, 0 to 25 percent slopes.	Moderate	Fair	Fair	Suited.	
TpE—Tomichi stony sandy loam, 5 to 25 percent slopes.	Moderate	Fair	Fair	Suited	Surface stones.
TrF—Tongue River loam, 5 to 60 percent slopes.[1]	High	Fair	Fair	Not suited	Depth to bedrock.

[1] Ratings apply only to the acreage where slope is less than 25 percent.
[2] The underlying material is a poor filter, and there is a possibility of contaminating nearby water supplies.

percent and very stony or very shallow soils are not considered for recreation developments and are not rated. Actual slope gradient should be determined at the site of any proposed recreational development. Slopes of more than 10 percent can limit some development.

Erosion hazard is the inherent susceptibility of a soil to particle detachment and transport by rainfall and runoff when the soil has been denuded, as by fire or activities of man. Soil properties that affect particle detachability are soil structure, texture, organic-matter content, and permeability. Runoff and transport are affected by slope and amount of coarse fragments. Classes of erosion hazard are slight, moderate, high, and very high. Most soils are subject to water erosion, but coarse textured soils are subject to soil blowing in exposed areas.

Soil trafficability reflects the capacity of a soil to support moving vehicles. This is based upon the load-supporting capacity of the soil. The AASHTO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. A *good* rating means soil properties generally are favorable for vehicular use. *Fair* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Poor* means soil properties are so unfavorable and so difficult to correct or overcome that special design or intensive maintenance is required. *Very poor* means one or more soil properties are so unfavorable that overcoming the limitation is difficult, costly, and generally impractical.

Soil compactability is the potential of a soil to become dense by means of foot traffic. Though the supporting power of a soil increases with density, its permeability is drastically reduced and runoff and erosion are increased. Properties that can influence the potential of the soil for compactability are soil texture, amount and shape of coarse fragments, amount and size of pores and roots, and organic matter content. A *good* rating means soil properties generally are favorable to foot traffic without damage. *Fair* means that some soil properties are unfavorable, and some change can result from foot traffic. *Poor* means soil properties are unfavorable, and damage can result from foot traffic. *Very poor* means that some soil properties are unfavorable, and damage will result from foot traffic.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material between depths of 18 inches and 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs. Soils rated "suitable" have 4 feet or more of permeable material over bedrock or 6 feet or more over the water table. Permeability is moderate to very rapid (more than 0.6 inch per hour). Soils rated "questionable" have less than 4 feet of permeable material over bedrock, or 4 to 6 feet over the seasonal water table. Very few soils that are otherwise suitable are affected by a high water table. Permeability ranges from moderately slow to moderate (0.2 to 2.0 inches per hour). Soils rated "not suited" have slow to moderately slow permeability (less than 0.6 inch per hour), are three feet thick or less over bedrock, or are subject to ponding.

Soils with profile characteristics and slopes suitable for occupancy sites are not extensive in the areas that attract the most recreationists. The most suitable soils include the soils in the Cabin, Charlos, Dinnen, Pierian, Tabernash, Tomichi, and Tine series. These soils are in narrow, elongated areas along the Taylor River, Spring Creek, Quartz Creek, and more extensively in the vicinity of Taylor Reservoir. Many of these areas are already developed or are in treeless areas that do not appeal to recreationists.

Aspect has not been considered in rating the soils. At these high elevations, where days are apt to be cold, consideration of sunny versus shaded aspects is important.

Native plants that can be used as barriers to conceal unsightly views, control foot traffic, and protect eroding footpaths or compacted campgrounds include wild rose, prostrate juniper, and Fendler ceanothus.

Native species that can be used for landscaping to enhance the beauty of recreational developments include lodgepole pine, Engelmann spruce, Douglas-fir,

and quaking aspen. Ponderosa pine may be used on south exposures below 9,000 feet. Alpine fir is suitable for northerly exposures above 9,000 feet. Shrubs that can be used for landscaping include Rocky Mountain maple, serviceberry, chokecherry, snowberry, bitterbrush, shrubby cinquefoil, Oregon-grape, elderberry, russet buffaloberry, and rabbitbrush. In moist areas, dogwood, bog birch, willows, and alder can be used for landscaping.

The Taylor Park area presents a problem in landscaping, since the species that will grow in this frost pocket are very limited. For moist areas, bog birch, shrubby cinquefoil, and willows are suitable. Wild rose and snowberry may grow on the drier sites. Although sagebrush is seldom, or never, used for landscaping, it is one of the few species that might be suitable for borders. Silver sagebrush grows in moist areas, and fringed sage, in dry areas.

Wildlife Habitat

The McIntyre-Kebler-Sanford soil association provides the best potential habitat for sage grouse, mourning dove, and songbirds. There is adequate food and cover for these birds. Food is plentiful for deer, but cover is lacking.

The Bassel-Bucklon, Ashcroft-Limber-Tilton, and Schofield-Tex-Stecum soil associations have good cover for deer and elk, but the Ashcroft-Limber-Tilton soil association has soils that produce more food. The Tex and Schofield soils provide good cover, but understory vegetation is sparse. It is mainly kinnikinnick, prostrate juniper, and lichens. The sparsity of grasses on the Tex and Schofield soils particularly affects the food supply for elk, since this is the main item of their diet.

The Mirror-Haverly-Vasquez and Rock land-Rock outcrop-Rock slides soil associations provide summer grazing for elk and habitat for ptarmigan. Practically all of the Taylor River Area is at too high an elevation to be winter range for either deer or elk.

Streams in the Teoculli-Cabin-Pierian soil association provide excellent game fishing.

Refer to table 11 for the relative productivity of the soils for food and cover for selected wildlife species. A listing of the most important food and cover plants

TABLE 11.—*Relative productivity of the soils for wildlife food and cover*

[Absence of a rating indicates that the soil is outside the range or does not provide habitat for that game species. See the section "Wildlife Habitat" for the food and cover plants used by each wildlife species]

Soil series and land types	Mule deer		Elk		Blue and Franklin grouse		Sage grouse		Ptarmigan	
	Food	Cover	Food	Cover	Food	Cover	Food	Cover	Food	Cover
Alluvial land	Good	Good	Good	Fair	Good	Good	Good	Good	Good	Good.
Almont			Good	Fair					Good	Good.
Ashcroft	Fair	Good	Fair	Good	Fair	Good				
Bassel	Good	Poor	Good	Poor	Poor	Poor	Fair	Good		
Bucklon	Good	Poor	Good	Poor	Poor	Poor	Fair	Fair		
Cabin	Good	Poor	Good	Poor	Poor	Poor	Good	Good		
Charlos	Good	Poor	Good	Poor	Poor	Poor	Good	Good		
Cryaquolls			Good	Good					Good	Good.
Cryaquolls and Histosols.	Good	Good	Good	Good	Fair	Good	Poor	Poor		
Dinnen	Good	Poor	Good	Poor	Poor	Poor	Good	Good		
Doct			Good	Poor					Good	Good.
Emerald	Fair	Poor	Fair	Poor	Fair	Poor	Good	Fair		
Eyre	Fair	Poor	Fair	Poor	Fair	Poor	Good	Good		
Gothic	Good	Poor	Good	Poor	Fair	Poor	Good	Good		
Haverly-Vasquez.			Good	Poor			Good	Good		
Hierro	Fair	Poor	Fair	Poor	Fair	Poor	Good	Good		
Jenkins	Fair	Good	Fair	Good	Fair	Good	Poor	Poor		
Judy	Good	Poor	Good	Poor	Fair	Poor	Good	Good		
Kebler	Poor	Good	Poor	Good	Fair	Good	Poor	Poor		
Lamphier	Good	Poor	Good	Poor	Fair	Poor	Fair	Fair		
Landslides and Gullied land.	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor		
Leal	Fair	Good	Poor	Good	Fair	Good	Poor	Poor		
Leaps	Good	Poor	Good	Poor	Fair	Poor	Fair	Good		
Limber	Good	Good	Good	Good	Good	Good				
Lucky	Good	Poor	Good	Poor	Fair	Poor	Good	Good		
Matcher	Poor	Good	Poor	Good	Fair	Good	Poor	Poor		
Mayoworth	Fair	Poor	Fair	Poor	Fair	Poor	Good	Good		
McIntyre	Good	Fair	Good	Fair	Poor	Fair	Fair	Fair		
Mirror			Good	Poor	Poor	Poor			Good	Good.
Mysten	Fair	Fair	Fair	Fair	Poor	Fair	Poor	Poor		
Pierian	Fair	Poor	Fair	Poor	Fair	Poor	Good	Good		
Ptarmigan			Fair	Poor					Fair	Good.
Rarick	Fair	Good	Fair	Good	Fair	Good	Poor	Poor		

TABLE 11.—*Relative productivity of the soils for wildlife food and cover*—Continued

Soil series and land types	Mule deer		Elk		Blue and Franklin grouse		Sage grouse		Ptarmigan	
	Food	Cover	Food	Cover	Food	Cover	Food	Cover	Food	Cover
Rock land	Fair	Fair	Fair	Fair	Fair	Good	Poor	Poor	Fair	Fair.
Rock outcrop	Poor	Fair	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Poor.
Rock slides	Poor	Poor	Poor	Poor	Poor	Poor	-----	-----	Poor	Poor.
Sanford	Poor	Good	Poor	Good	Poor	Good	Poor	Poor	Poor	Poor.
Sawcreek	Good	Poor	Good	Poor	Good	Fair	Fair	Poor	Fair	Poor.
Schofield-Peeler.	Fair	Good	Fair	Good	Fair	Good	Poor	Poor	-----	
Shale rock land.	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	-----	
Stecum	Good	Poor	Good	Poor	Fair	Poor	Good	Good	-----	
Stony colluvial land.	Poor	Poor	Fair	Poor	Poor	Poor	Fair	Fair	-----	
Stony rock land.	Poor	Poor	Fair	Poor	Poor	Poor	-----	-----	Fair	Good.
Supervisor	Fair	Poor	Fair	Poor	Fair	Poor	Good	Good	-----	
Tabernash	Fair	Good	Fair	Good	Fair	Good	Poor	Poor	-----	
Tellman	Poor	Good	Poor	Good	Poor	Good	Poor	Poor	-----	
Teoculli	Good	Poor	Good	Poor	Fair	Poor	Fair	Fair	-----	
Tex	Fair	Good	Poor	Good	Poor	Good	Poor	Poor	-----	
Tilton	Good	Poor	Good	Poor	Fair	Poor	Good	Good	-----	
Tine	Good	Poor	Good	Poor	Fair	Poor	Good	Good	-----	
Tomichi	Good	Poor	Good	Poor	Fair	Poor	Good	Good	-----	
Tongue River.	Good	Poor	Fair	Good	Fair	Good	Poor	Poor	-----	

follows. Game birds supplement their summer diet with insects, but it would be impractical to list all plant species consumed.

Mule deer.—Food: grasses, forbs, bitterbrush, serviceberry, aspen, chokecherry, big sagebrush, and juniper. Cover: conifers, aspen, and juniper. Generally, mule deer do not winter in the Taylor River Area.

Elk.—Food: grasses, sedges, forbs, bitterbrush, and willow. Cover: conifers, aspen, and willow. Generally, elk do not winter in the Taylor River Area.

Blue and Franklin grouse.—Summer food: fruits. Winter food: fir needles, buds, catkins, and plant tips. Cover: conifers, aspen, and willow.

Sage grouse.—Summer food: big sagebrush, dandelion, and rabbitbrush. Winter food: big sagebrush. Cover: big sagebrush, tree fringes, shrubs, and weeds.

Ptarmigan.—Summer food: herbs, fruits, and berries. Winter food: buds and terminal twigs of alder, willow, and alpine fir. Cover: alpine willow, Krummholz, grasses, and sedges.

Engineering

The primary uses of a soil from an engineering standpoint are to support structures of various kinds or to be a construction material from which the structure itself is built. Soil survey maps and soil interpretations for engineering purposes can be used to make preliminary estimates of the engineering properties of soils in general planning for engineering projects. A delineated area of soil on a map is not a uniform material throughout its extent in any dimension. Engineering interpretations are generalized and should be used primarily in planning more detailed field investigations to determine the characteristics of the soil material in place at the site of the proposed engineering work. See table 12 for estimated soil properties significant in engineering and table 13 for interpretations of engineering properties of the soils.

Table 12 shows the AASHTO and Unified engineering classifications of the soils. The engineering appraisals are based on these classifications and on field appraisals. Table 13 is to be used as a guide in determining routes and not for design purposes.

The Unified System of soil classification (*2*) is based on the identification of soils according to particle size, plasticity, and liquid limit. In the Unified System, SW and SP are clean sands. SM and SC are sands with nonplastic or plastic fines. GW and GP are clean gravels, and GM and GC are gravelly soils with nonplastic or plastic fines. ML and CL are nonplastic or plastic, fine-grained material with a low liquid limit, and MH and CH are primarily nonplastic or plastic, fine-grained materials with a high liquid limit. Soils may be on the borderline between two classifications, in which case a joint classification symbol is used, for example, CL–ML.

The AASHTO classification (*1*) is based on the field performance of soils used in highway construction. The grouping of soils of about the same general load-carrying capacity and service together resulted in twelve basic groups and subgroups—A–1 through A–7. The best soils for road subgrades are classified as A–1, the next best A–2, etc., with the poorest soils classed as A–7.

The classifications under "Unified" in table 12, are based on visual and manual procedures described in "Method for classification of soils for engineering purposes" (*2*). Classifications under "AASHTO" in table 12, are based upon the generalized relationship of Unified and AASHTO classifications and for USDA texture-AASHTO relationships.

TABLE 12.—*Estimated soil properties significant in engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table. The symbol > means more than; the symbol < means less than]

Soil series and map symbols	Depth from surface [1]	USDA texture	Classification		Permeability	Shrink-swell potential
			AASHTO	Unified		
	Inches				*Inches per hour*	
Alluvial land: Ad Too variable to be rated.	0–60					
Almont: AmF	0–8	Silt loam	A–4	SM	0.6–2.0	Low.
	8–60	Stony silty clay loam	A–6	CL	0.6–2.0	Moderate.
Ashcroft: AsE, AsF	0–26	Sandy loam and gravelly sandy loam.	A–4	SM	2.0–6.0	Low.
	26–48	Gravelly sand	A–1	SP	>6.0	Low.
	48	Bedrock.				
Bassel: BaE, BaF	0–12	Sandy loam	A–4	SM	2.0–6.0	Low.
	12–22	Very stony sandy clay loam	A–2	SC	0.6–2.0	Moderate.
	22–60	Very stony loamy sand	A–2	SM	>6.0	Low.
Bucklon: BuF	0–13	Silt loam	A–5	ML	0.6–2.0	Moderate.
	13–18	Silty clay loam	A–7	MH	0.06–0.2	High.
	18	Bedrock.				
Cabin: CaA, CaE	0–8	Sandy loam	A–4	SM	2.0–6.0	Low.
	8–32	Gravelly sandy clay loam	A–2	SC	0.6–2.0	Moderate.
	32–60	Very cobbly loamy sand	A–1	GW	>6.0	Low.
Charlos: ChE, ClE2	0–7	Sandy loam	A–2	SM	2.0–6.0	Low.
	7–20	Gravelly clay loam	A–6	CL	0.6–2.0	Moderate.
	20–50	Gravelly sandy loam	A–2	SM	>6.0	Low.
Cryaquolls: Cr	0–30	Loamy fine sand or fine sandy loam.	A–2 or A–4	SM	2.0–6.0	Low.
	30	Bedrock.				
Cryaquolls and Histosols: Cs	0–14	Peat and mucky silt loam	A–8	PT	0.6–2.0	Low.
	14	Variable.				
Dinnen: DnF, DsF	0–18	Sandy loam	A–4	SM	2.0–6.0	Low.
	18–60	Coarse sandy loam	A–2	SM	>6.0	Low.
Doct: DtE, DtF	0–9	Silt loam	A–4	ML	0.6–2.0	Low.
	9–30	Gravelly silty clay loam	A–6	GC	0.06–0.2	Moderate.
	30	Bedrock.				
Emerald: EmF	0–21	Sandy clay loam	A–6	SC	0.6–2.0	Moderate.
	21–45	Stony clay loam	A–6	CL	0.2–0.6	Moderate.
Eyre: EyF	0–8	Sandy loam	A–4	SM	2.0–6.0	Low.
	8–16	Very stony fine sandy loam	A–4	SM	2.0–6.0	Low.
	16	Bedrock.				
Gothic: GoE	0–5	Fine sandy loam	A–4	SM	0.6–2.0	Low.
	5–48	Clay loam	A–6	CL	0.06–0.2	High.
	48–70	Gravelly sandy clay loam	A–6 or A–2	SC	0.6–2.0	Moderate.
*Haverly: HaE, HaF For Vasquez parts, see Vasquez series.	0–6	Fine sandy loam	A–4	SM	0.6–2.0	Low.
	6–30	Stony loamy fine sand	A–1	SM	2.0–6.0	Low.
	30	Bedrock.				
Hierro: HeF	0–10	Loam and silt loam	A–4	ML	0.6–2.0	Low.
	10–29	Sandy clay loam	A–6	CL	0.2–0.6	Moderate.
	29–40	Loam	A–4	ML	0.6–2.0	Low.
Jenkins: JeF	0–18	Gravelly loam	A–4	ML	0.6–2.0	Low.
	18–28	Channery sandy loam	A–2	SC	2.0–6.0	Low.
	28	Bedrock.				
Judy: JuE, JuF	0–23	Silty clay loam	A–7	CH	0.06–0.2	High.
	23	Bedrock.				

TABLE 12.—*Estimated soil properties significant in engineering*—Continued

Soil series and map symbols	Depth from surface [1]	USDA texture	Classification		Permeability	Shrink-swell potential
			AASHTO	Unified		
	Inches				*Inches per hour*	
Kebler: KeE, KeF	0–13	Sandy loam	A–2 or A–4	SM	2.0–6.0	Low.
	13–24	Very stony fine sandy loam	A–2	SM	2.0–6.0	
	24	Bedrock.				
Lamphier: LaF	0–16	Loam	A–4	ML	0.6–2.0	Low.
	16–31	Clay loam	A–6	CL	0.2–0.6	Moderate.
	31–60	Loam	A–4	ML	0.6–2.0	Low.
Landslides and Gullied land: Ld	0–60	Silty clay	A–7	CH	<0.06	High.
Leal: LeE, LeF	0–4	Gravelly loamy coarse sand	A–1	GM	>6.0	Low.
	4–41	Gravelly sandy loam	A–2	GM	2.0–6.0	Low.
	41–60	Gravelly loamy coarse sand	A–1	GM	>6.0	Low.
Leaps: LlF	0–60	Silty clay loam	A–6	CL	<0.06	High.
Limber: LmE, LmF	0–2	Gravelly loam	A–4	ML	2.0–6.0	Low.
	2–8	Gravelly clay loam	A–6	GC	0.6–2.0	Moderate.
	8–34	Gravelly loam	A–4	GM	2.0–6.0	Low.
	34	Bedrock.				
Lucky: LuE, LuF	0–13	Gravelly sandy loam	A–2	SM	2.0–6.0	Low.
	13–37	Gravelly sandy clay loam	A–6	CL	0.6–2.0	Moderate.
	37	Bedrock.				
Matcher: MaE, MaF, McF	0–18	Stony sandy loam	A–2	GM	2.0–6.0	Low.
	18–22	Very stony coarse loamy sand	A–1	SP or SW	>6.0	Low.
	22–60	Very stony sand	A–1	GW	>6.0	Low.
Mayoworth: MhF	0–5	Loam	A–4	ML	0.6–2.0	Low.
	5–30	Clay loam	A–6	CL	0.2–0.6	Moderate.
	30	Bedrock.				
McIntyre: MnE, MnF	0–12	Loam	A–4	SM	0.6–2.0	Low.
	12–30	Very fine sandy loam	A–4	ML	0.6–2.0	Low.
	30	Bedrock.				
Mirror: MrE, MrF	0–6	Gravelly sandy loam	A–2	SM	0.6–2.0	Low.
	6–30	Very gravelly sandy loam	A–1	GM	>6.0	Low.
	30	Bedrock.				
Mysten: MyE	0–6	Loamy fine sand	A–2	SM	>6.0	Low.
	6–60	Gravelly loamy coarse sand	A–1	GW–GM	>6.0	Low.
Peeler	0–36	Gravelly sandy loam	A–2	SM	2.0–6.0	Low.
Mapped only in complex with Schofield soils.	36–60	Gravelly sandy clay loam	A–2	GC	0.6–2.0	Moderate.
Pierian: PeA, PnA, PnE	0–8	Stony sandy loam	A–2	GM	2.0–6.0	Low.
	8–60	Very stony loamy sand	A–1	GP–GM	>6.0	Low.
Ptarmigan: PtF	0–7	Loam	A–4	ML	0.6–2.0	Low.
	7–26	Loam	A–4	ML	0.6–2.0	Low.
	26	Bedrock.				
Rarick: RaF	0–14	Gravelly loam and loam	A–4	ML	2.0–6.0	Low.
	14–21	Gravelly sandy loam	A–2	SM	2.0–6.0	Low.
	21	Bedrock.				
Rockland: Rl. Too variable to be rated.						
Rock outcrop: Ro. Too variable to be rated.						
Rock slides: Rs. Too variable to be rated.						

TABLE 12.—*Estimated soil properties significant in engineering*—Continued

Soil series and map symbols	Depth from surface [1]	USDA texture	Classification		Permeability	Shrink-swell potential
			AASHTO	Unified		
	Inches				*Inches per hour*	
Sanford: SaF	0–13	Fine sandy loam	A–4	ML	2.0–6.0	Low.
	13–30	Stratified sandy loam, loam and clay loam.	A–4	ML	0.6–2.0	Moderate.
	30	Bedrock.				
Sawcreek: ScE	0–13	Sandy loam	A–2	SM	2.0–6.0	Low.
	13–30	Sandy loam	A–4 or A–2	SM	2.0–6.0	Low.
	30	Bedrock.				
*Schofield: SdE, SdF, SeF	0–16	Gravelly sandy loam	A–2	SM	2.0–6.0	Low.
For Peeler parts, see Peeler series.	16–32	Gravelly sandy clay loam	A–2 or A–6	GC	0.6–2.0	Moderate.
	32	Bedrock.				
Shale rock land: Sh			A–7	CH	<0.06	High.
Stecum: SmF, SoF	0–24	Stony sandy loam	A–2	SM or GM	2.0–6.0	Low.
	24	Bedrock.				
Stony colluvial land: Sr	0–24	Extremely stony loamy coarse sand.	A–1	GP	>6.0	Low.
Stony rock land: St. Too variable to be rated.						
Supervisor: SuE, SuF	0–14	Loam	A–4	ML	2.0–6.0	Low.
	14–36	Stony loam	A–4	ML	2.0–6.0	Low.
	36	Bedrock.				
Tabernash: TaB	0–8	Gravelly sandy loam	A–2	SM	2.0–6.0	Low.
	8–22	Gravelly clay loam	A–6	CL	0.6–2.0	Moderate.
	22–60	Gravelly coarse sand	A–1	SP	>6.0	Low.
Tellman: TdF	0–8	Sandy loam	A–2	SM	2.0–6.0	Low.
	8–24	Clay loam	A–6	CL	0.2–0.6	Moderate.
	24–60	Fine sand	A–1	SM	>6.0	Low.
Teoculli: TeE	0–10	Loam	A–4	ML	0.6–2.0	Low.
	10–40	Very fine sandy loam	A–4	SM or ML	2.0–6.0	Low.
Tex: TgE, TgF, ThE, ThF	0–45	Gravelly coarse sandy loam	A–2	SM	6.0–20.0	Low.
	45–60	Gravelly loamy sand	A–1	SM or SP	6.0–20.0	Low.
Tilton: TlE, TlF	0–24	Sandy loam	A–2	SM	2.0–6.0	Low.
	24–60	Sandy clay loam	A–6	SC	0.6–2.0	Moderate.
Tine: TnA, TnE	0–5	Sandy loam	A–4	SM	2.0–6.0	Low.
	5–13	Gravelly sandy loam	A–2	SM	2.0–6.0	Low.
	13–60	Sand, gravel, cobbles	A–1	GP	>6.0	Low.
Tomichi: ToE, ToF, TpE, TpF	0–8	Sandy loam	A–2	SM	2.0–6.0	Low.
	8–60	Coarse sand	A–1	SP	>6.0	Low.
Tongue River: TrF	0–7	Loam	A–4	ML	0.6–2.0	Low.
	7–18	Channery clay loam	A–6	CL	0.6–2.0	Moderate.
	18–30	Very channery loam	A–4	ML	0.6–2.0	Low.
	30	Bedrock.				
Vasquez	0–8	Loam	A–4	ML	0.6–2.0	Low.
Mapped only in complex with Haverly soils.	8–28	Stony loamy fine sand	A–2	SM	>6.0	Low.
	28–60	Gravelly loamy sand	A–1	SM or SP	>6.0	Low.
	60	Bedrock.				

[1] Horizons without significant differences in physical properties have been combined.

Estimated engineering properties

Several estimated soil properties significant in engineering are given in table 12. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 12.

Soil texture is described in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary of this soil survey.

Permeability is the quality of a soil that enables it to transmit water or air. It is estimated on the basis of characteristics observed in the field, particularly structure and texture. The estimates in table 12 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Engineering interpretations

The estimated interpretations in table 13 are based on the estimated engineering properties of soils as recorded in table 12, on test data for soils in this survey area and in others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Taylor River Area, Colorado. In tables 9, 10, and 11, ratings are used to summarize value for, or suitability of, the soils for various purposes, but not for waterways, ponds, reservoirs, and embankments, and dikes or levees. For these particular uses, table 13 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil suitability and values are indicated by the ratings good, fair, poor, and very poor. *Good* means soil properties are generally favorable for the rated use, or in other words, limitations are minor and easily overcome. *Fair* means some soil properties are unfavorable but can be overcome or modified by special planning and design. *Poor* means soil properties are so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is required. *Very poor* means one or more soil properties are so unfavorable for a particular use that overcoming the limitations is difficult and costly and commonly not practical for the rated use.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as in preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 13 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, and neither do they indicate quality of the deposit.

Foundation material, as rated in table 9, supports a structure not more than two stories high on footings placed in undisturbed soil. The features that affect the rating of a soil for use as foundation material are those that relate to capacity to support load and to resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

The value of soils when used as a base course directly under bituminous and unsurfaced roads are rated in table 13. These soils are expected to carry automobile traffic during non-snow periods. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of bituminous roads are load-supporting capacity and stability of the base and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material and the shrink-swell potential indicate traffic-supporting capacity. Wetness, frost action, and flooding affect stability of the material. Depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Soil properties that most affect design and construction of unsurfaced roads are also load-supporting capacity and stability, and the workability and quantity of cut and fill material available. Most cuts and fills are, however, realtively shallow, except when they cross slopes. Frost action also does not pose as great a hazard as it does to a bituminous surfaced road.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is a function of their perme-

TABLE 13.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. fully the instructions for referring to other series

Soil series and map symbols	Suitability as source of—			Foundation material
	Topsoil	Sand	Gravel	
Alluvial land: Ad. Too variable to be rated.				
Almont: AmF	Poor	Unsuitable	Unsuitable	Poor: high water table
Ashcroft: AsE, AsF	Fair	Good	Fair	Good
Bassel: BaE, BaF	Fair	Fair	Unsuitable	Good
Bucklon: BuF	Fair	Unsuitable	Unsuitable	Poor: low strength; high shrink-swell potential.
Cabin: CaA, CaE	Fair	Fair	Unsuitable	Moderate: moderate shrink-swell potential.
Charlos: ChE, ClE2	Fair	Poor	Unsuitable	Good
Cryaquolls: Cr	Poor	Unsuitable	Unsuitable	Poor: high water table
Cryaquolls and Histosols: Cs	Fair	Unsuitable	Unsuitable	Poor: high water table; high organic matter content.
Dinnen: DnF, DsF	Good	Poor	Unsuitable	Good
Doct: DtE, DtF	Fair	Unsuitable	Unsuitable	Poor: bedrock at a depth of about 30 inches.
Emerald: EmF	Fair	Unsuitable	Unsuitable	Fair: moderate shrink-swell potential.
Eyre: EyF	Poor	Unsuitable	Unsuitable	Poor: very stony; bedrock at a depth of about 16 inches.
Gothic: GoE	Fair	Unsuitable	Unsuitable	Poor: high shrink-swell potential; low strength.
*Haverly: HaE, HaF For Vasquez parts, see Vasquez series.	Poor	Unsuitable	Unsuitable	Fair: high water table
Hierro: HeF	Fair	Unsuitable	Unsuitable	Fair: low strength
Jenkins: JeF	Poor	Unsuitable	Unsuitable	Poor: bedrock at a depth of about 28 inches.

engineering properties of the soils

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care-
that appear in the first column of this table]

Values for roads		Soil features affecting—			
Base course directly under bituminous	Unsurfaced	Dikes or levees	Ponds		Waterways
			Reservoir area	Embankment	
Very poor	Very poor	Moderate shrink-swell potential.	Favorable	Moderate shrink-swell potential.	10 to 70 percent slopes; vegetation is difficult to establish.
Poor. Good between depths of 26 and 48 inches.	Fair	Rapid permeability; bedrock at a depth of about 48 inches; piping hazard.	Excessive seepage	Rapid permeability	Droughty; highly erodible; 5 to 60 percent slopes.
Poor. Good between depths of 22 and 60 inches.	Poor	Rapid permeability	Excessive seepage	Rapid permeability	0 to 60 percent slopes.
Very poor	Poor	High shrink-swell potential; low strength.	Shale bedrock at a depth of about 18 inches.	High shrink-swell potential; low strength.	Highly erodible; 15 to 75 percent slopes.
Poor. Good between depths of 32 and 60 inches.	Fair	Rapid permeability	Excessive seepage	Rapid permeability	Vegetation is difficult to establish [1]; 0 to 25 percent slopes.
Fair. Good between depths of 20 and 50 inches.	Fair	Rapid permeability; piping hazard.	Excessive seepage	Rapid permeability	0 to 25 percent slopes.
Very poor	Very poor	Bedrock at a depth of about 30 inches.	Bedrock at a depth of about 30 inches.	Bedrock at a depth of about 30 inches.	High water table.
Very poor	Very poor	Wetness; organic surface material.	Excessive seepage in late summer.	Organic surface material.	High organic matter content; high water table.
Poor	Fair	Rapid permeability; piping hazard.	Excessive seepage	Rapid permeability; piping hazard.	Droughty; 2 to 60 percent slopes.
Very poor	Poor	Bedrock at a depth of about 30 inches.	Bedrock at a depth of about 30 inches.	Bedrock at a depth of about 30 inches.	Vegetation is difficult to establish [1]; 10 to 70 percent slopes.
Very poor	Poor	Moderate shrink-swell potential; low strength.		Stony; low strength	5 to 45 percent slopes.
Poor	Fair	Bedrock at a depth of about 16 inches.	Excessive seepage; bedrock at a depth of about 16 inches.	Very stony; bedrock at a depth of about 16 inches.	Droughty; 15 to 70 percent slopes.
Very poor	Poor	Low strength; high shrink-swell potential.	Favorable	Low strength; high shrink-swell potential.	Erodible; 5 to 40 percent slopes.
Poor	Fair	Wetness; bedrock at a depth of about 30 inches.	Excessive seepage; bedrock at a depth of about 30 inches.	Stony; bedrock at a depth of about 30 inches.	Intermittently wet; vegetation is difficult to establish; 5 to 70 percent slopes.
Very poor	Poor	Low strength	Favorable	Low strength	5 to 45 percent slopes.
Very poor	Poor	Bedrock at a depth of about 28 inches.	Excessive seepage; bedrock at a depth of about 28 inches.	Bedrock at a depth of about 28 inches.	Low fertility; 15 to 60 percent slopes.

TABLE 13.—*Interpretations of*

Soil series and map symbols	Suitability as source of—			Foundation material
	Topsoil	Sand	Gravel	
Judy: JuE, JuF	Fair	Unsuitable	Unsuitable	Poor: high shrink-swell potential; bedrock at a depth of about 23 inches.
Kebler: KeE, KeF	Fair	Unsuitable	Unsuitable	Poor: bedrock at a depth of about 24 inches.
Lamphier: LaF	Good	Unsuitable	Unsuitable	Fair: moderate shrink-swell potential; low strength.
Landslides and Gullied land: Ld	Poor	Unsuitable	Unsuitable	Poor: high shrink-swell potential; erodible.
Leal: LeE, LeF	Poor	Poor	Poor	Good
Leaps: LlF	Poor	Unsuitable	Unsuitable	Poor: high shrink-swell potential; low strength.
Limber: LmE, LmF	Poor	Unsuitable	Unsuitable	Fair: bedrock at a depth of about 34 inches.
Lucky: LuE, LuF	Fair	Unsuitable	Unsuitable	Fair: bedrock at a depth of about 37 inches.
Matcher: MaE, MaF, McF	Poor	Poor	Poor	Good
Mayoworth: MhF	Fair	Unsuitable	Unsuitable	Poor: bedrock at a depth of about 30 inches.
McIntyre: MnE, MnF	Fair	Unsuitable	Unsuitable	Fair: bedrock at a depth of about 30 inches.
Mirror: MrE, MrF	Fair	Unsuitable	Unsuitable	Fair: bedrock at a depth of about 30 inches.
Mysten: MyE	Poor	Fair	Unsuitable to fair.	Good
Peeler Mapped only in complex with Schofied soils.	Poor	Unsuitable	Unsuitable	Good
Pierian: PeA, PnA, PnE	Poor	Poor	Fair	Good: high stone content
Ptarmigan: PtF	Good	Unsuitable	Unsuitable	Fair: bedrock at a depth of about 26 inches.
Rarick: RaF	Poor	Unsuitable	Unsuitable	Poor: bedrock at a depth of about 21 inches.

engineering properties of the soils—Continued

Values for roads		Soil features affecting—			
Base course directly under bituminous	Unsurfaced	Dikes or levees	Ponds		Waterways
			Reservoir area	Embankment	
Very poor	Poor	Bedrock at a depth of about 23 inches; low strength; high shrink-swell potential.	Bedrock at a depth of about 23 inches.	High shrink-swell potential; low strength; bedrock at a depth of about 23 inches.	Moderately erodible; 5 to 60 percent slopes.
Fair	Fair	Bedrock at a depth of about 24 inches.	Excessive seepage; bedrock at a depth of about 24 inches.	Bedrock at a depth of about 24 inches.	Low available water capacity; 5 to 60 percent slopes.
Very poor	Poor	Hard to compact; low strength.	Favorable	Hard to compact; low strength.	5 to 45 percent slopes.
Very poor	Very poor	Low strength; hard to compact; high shrink-swell potential.	Favorable	High shrink-swell potential; hard to compact.	Highly erodible; vegetation is difficult to establish.
Good	Very poor	Rapid permeability; piping hazard.	Excessive seepage	Rapid permeability; piping hazard.	Low fertility; 5 to 60 percent slopes.
Very poor	Poor	High shrink-swell potential; low strength.	Favorable	High shrink-swell potential; low strength.	Highly erodible; 5 to 45 percent slopes.
Very poor	Poor	Bedrock at a depth of about 34 inches.	Bedrock at a depth of about 34 inches.	Gravelly and stony; high permeability; bedrock at a depth of about 34 inches.	5 to 70 percent slopes.
Fair	Good	Bedrock at a depth of about 37 inches.	Bedrock at a depth of about 37 inches.	Moderate shrink-swell potential; bedrock at a depth of about 37 inches.	5 to 65 percent slopes.
Fair: very stony below a depth of about 16 inches.	Fair	Rapid permeability	Rapid permeability	Very stony; rapid permeability.	Low available water capacity; very stony; 5 to 60 percent slopes.
Very poor	Poor	Bedrock at a depth of about 30 inches.	Bedrock at a depth of about 30 inches.	Bedrock at a depth of about 30 inches.	15 to 60 percent slopes.
Very poor	Poor	Bedrock at a depth of about 30 inches.	Bedrock at a depth of about 30 inches.	Bedrock at a depth of about 30 inches.	5 to 65 percent slopes.
Fair	Good	Bedrock at a depth of about 30 inches.	Excessive seepage; bedrock at a depth of about 30 inches.	Very gravelly and stony; rapid permeability.	Vegetation is difficult to establish; 10 to 70 percent slopes.
Fair	Good	Rapid permeability	Excessive seepage	Rapid permeability	Low available water capacity.
Fair	Good	Piping hazard	Excessive seepage	Piping hazard	5 to 60 percent slopes.
Fair	Fair	Rapid permeability	Excessive seepage	Very stony; rapid permeability.	Very stony; low available water capacity.
Very poor	Poor	Bedrock at a depth of about 26 inches; piping hazard.	Bedrock at a depth of about 26 inches.	Piping hazard	Vegetation is difficult to establish [1]; 15 to 70 percent slopes.
Very poor	Fair	Bedrock at a depth of about 21 inches; rapid permeability.	Excessive seepage; bedrock at a depth of about 21 inches.	Very permeable; bedrock at a depth of about 21 inches.	10 to 60 percent slopes.

TABLE 13.—*Interpretations of*

Soil series and map symbols	Suitability as source of—			Foundation material
	Topsoil	Sand	Gravel	
Rock land: Rl. Too variable to be rated.				
Rock outcrop: Ro. Too variable to be rated.				
Rock slides: Rs. Too variable to be rated.				
Sanford: SaF	Fair	Unsuitable	Unsuitable	Poor: bedrock at a depth of about 24 inches.
Sawcreek: ScE	Good	Unsuitable	Unsuitable	Fair: bedrock at a depth of about 30 inches.
*Schofield: SdE, SdF, SeF. For Peeler parts, see Peeler series.	Fair	Unsuitable	Unsuitable	Fair: bedrock at a depth of about 32 inches.
Shale rock land: Sh	Unsuitable	Unsuitable	Unsuitable	Poor: highly unstable; high shrink-swell potential.
Stecum: SmF, SoF	Poor	Unsuitable	Unsuitable	Fair: bedrock at a depth of about 24 inches.
Stony colluvial land: Sr	Unsuitable	Unsuitable	Unsuitable	Fair: high stone content
Stony rock land: St. Too variable to be rated.				
Supervisor: SuE, SuF	Fair	Unsuitable	Unsuitable	Fair: bedrock at a depth of about 36 inches.
Tabernash: TaB	Fair	Good	Poor	Good
Tellman: TdF	Fair	Poor	Unsuitable	Fair: good below a depth of 2 feet.
Teoculli: TeE	Good	Unsuitable	Unsuitable	Fair: low strength
Tex: TgE, TgF, ThE, ThF	Poor	Fair	Poor	Good
Tilton: TlE, TlF	Good	Unsuitable	Unsuitable	Fair: moderate shrink-swell potential; low strength.
Tine: TnA, TnE	Poor	Fair	Fair	Good
Tomichi: ToE, ToF, TpE, TpF	Fair	Good	Unsuitable	Good
Tongue River: TrF	Fair	Unsuitable	Unsuitable	Fair: low strength
Vasquez. Mapped only in complex with Haverly soils.	Fair	Fair	Fair	Poor: high water table

[1] Vegetation is not easily established on any soils at these elevations; however, it is particularly difficult on these soils.

engineering properties of the soils—Continued

Values for roads		Soil features affecting—			
Base course directly under bituminous	Unsurfaced	Dikes or levees	Ponds		Waterways
			Reservoir area	Embankment	
Very poor	Fair	Bedrock at a depth of about 24 inches.	Bedrock at a depth of about 24 inches.	Bedrock at a depth of about 24 inches.	15 to 65 percent slopes.
Fair	Fair	Bedrock at a depth of about 30 inches.	Excessive seepage; bedrock at a depth of about 30 inches.	Bedrock at a depth of about 30 inches.	15 to 50 percent slopes.
Fair	Good	Bedrock at a depth of about 32 inches.	Bedrock at a depth of about 32 inches.	Bedrock at a depth of about 32 inches.	5 to 60 percent slopes.
Very poor	Very poor	High shrink-swell potential; low strength.	Very shallow to bedrock.	High shrink-swell potential; low strength.	Very low available water capacity; highly erodible.
Fair	Fair	Bedrock at a depth of about 24 inches.	Excessive seepage; bedrock at a depth of about 24 inches.	Stony; bedrock at a depth of about 24 inches.	Low available water capacity; 15 to 70 percent slopes.
Very poor	Very poor	Very stony; rapid permeability.	Excessive seepage	Very stony; high permeability.	Stony; low available water capacity; 60 to 70 percent slopes.
Very poor	Poor	Bedrock at a depth of about 36 inches.	Excessive seepage; bedrock at a depth of about 36 inches.	Bedrock at a depth of about 36 inches.	Moderate available water capacity; 5 to 70 percent slopes.
Fair	Good	Rapid permeability	Excessive seepage	Rapid permeability	Vegetation is difficult to establish [1]; 0 to 6 percent slopes.
Fair	Fair	Rapid permeability	Excessive seepage	Rapid permeability	Vegetation is difficult to establish [1]; 5 to 45 percent slopes.
Very poor	Poor	Low strength	Favorable	Low strength	0 to 25 percent slopes.
Fair	Good	Rapid permeability	Excessive seepage	Rapid permeability	Low available water capacity; 5 to 60 percent slopes.
Fair	Good	Low strength	Favorable	Low strength	5 to 45 percent slopes.
Fair	Fair	Rapid permeability	Excessive seepage	Rapid permeability	Low available water capacity; 0 to 30 percent slopes.
Fair	Fair	Rapid permeability	Excessive seepage	Rapid permeability	Low available water capacity; 0 to 60 percent slopes.
Very poor	Fair	Bedrock at a depth of about 30 inches.	Bedrock at a depth of about 30 inches.	Bedrock at a depth of about 30 inches.	Highly erodible; 5 to 60 percent slopes.
Very poor	Poor	Rapid permeability	Excessive seepage in summer.	Rapid permeability	5 to 70 percent slopes.

ability and depth to fractured or permeable bedrock or other permeable material.

Embankments and dikes or levees require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among unfavorable factors.

Waterways require soil material resistant to erosion. This soil must also be capable of being seeded and able to support sod. A high content of organic matter and high available water capacity are desirable soil features. Steep slopes, high erosion hazard, presence of stones, and low available water capacity are among unfavorable factors.

Capability Groups

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. Soils are placed in classes I through VIII on the basis of increasing limitations for cultivated crops. For a more complete explanation of the capability classification, see Agriculture Handbook No. 210, "Land Capability Classification."

The land types Landslides and Gullied land, Rock land, Rock outcrop, Rock slides, Shale rock land, Stony colluvial land, and Stony rock land are in capability class VIII. These land types have limitations that restrict their use to recreation, wildlife, water supply, or esthetic purposes. Management should be directed at increasing benefits from wildlife, watershed protection, increased water yield, or recreation. All other mapping units in the Area are in either class VI or class VII. Since they have severe or very severe limitations that make them unsuitable for cultivated crops, their use is restricted largely to grazing, timber production, recreation, wildlife, and water production. A small part of the Taylor River Area is in irrigated meadows, but climatic limitations alone prevent normal tillage of cultivated crops.

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Glossary

Acidity. See Reaction.

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; its exposure.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Bedrock. The solid rock underlying soils or that is exposed at the surface.

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 is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Coarse-textured soils. Sand, loamy sand, sandy loam, and fine sandy loam. As a textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder of individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation

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. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low available water capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling in the deeper parts of the profile.

Erodibility, soil. Stability or instability of soils when subjected to surface erosion by water or wind.

Erosion. The wearing away of the land surface by wind (sandblast), 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 of the soil are favorable.

Fine-textured soils. Clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay, and clay.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

Gleyed horizon. One that has formed due to intense reduction of iron during soil development or due to stagnant water, and is marked by base colors that approach neutral, with or without mottles. Although gleying is commonly associated with wetness, especially in the presence of organic matter, wetness by itself is not a criterion of gleying.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Internal drainage. Refers to movement of water through the soil profile. Relative terms for exposing internal drainage are very rapid, rapid, medium, slow, very slow, and none.

Leaching, soil. Removal of materials in solution by percolating water.

Medium-textured soil. Loam, very fine sandy loam, silt loam, and silt.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension (*9*).

Nutrients, plant. The elements taken in by the plant, essential to its growth, and used by it in the elaboration of its food and tissue. These include nitrogen, phosphorus, calcium, potassium, magnesium, sulphur, iron, manganese, copper, boron, zinc, and perhaps others obtained from the soil; and carbon, hydrogen, and oxygen, obtained largely from the air and water.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability, soil. The quality of the soil that enables it to transmit water or air. Terms used to describe permeability and their numerical equivalents are: very slow (< 0.06 inch per hour); slow (0.06–0.2 inch per hour); moderately slow (0.2–0.6 inch per hour); moderate (0.6–2.0 inches per hour); moderately rapid (2.0–6.0 inches per hour); rapid (6.0–20.0 inches per hour); and very rapid (> 20.0 inches per hour).

Phase, soil. A subdivision of a soil, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil series, for example, may be divided into phases because of difference in slope, stoniness, thickness, or some other characteristic that affects its management but not its behavior in the natural landscape.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degree of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter

from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

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 or aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

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