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Department of
Agriculture



Natural
Resources
Conservation
Service

In cooperation with
United States
Department of
Interior, Bureau of Indian
Affairs and
Bureau of Land
Management;
National Park Service and
the Arizona Agricultural
Experiment Station

Soil Survey of Pima County, Arizona, Eastern Part



How to Use This Soil Survey

General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

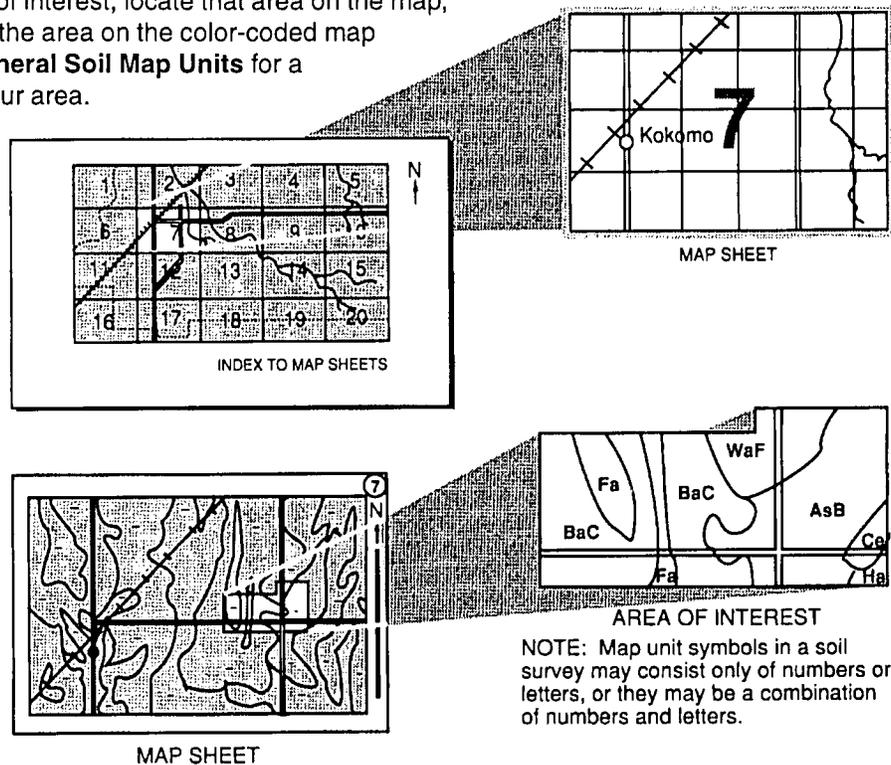
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet and turn to that sheet.

Locate your area of interest on the map sheet. Note the map units symbols that are in that area. Turn to the **Contents**, which lists the map units by symbol and name and shows the page where each map unit is described.

The **Contents** shows which table has data on a specific land use for each detailed soil map unit. Also see the **Contents** for sections of this publication that may address your specific needs.



This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1984. Soil names and descriptions were approved in 1993. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1984. This survey was made cooperatively by the Natural Resources Conservation Service and the Arizona Agricultural Experiment Station. The survey is part of the technical assistance furnished to the Elroy, Pima, Redington, and Winkelman Natural Resources Conservation Districts and the Tohono O'Odham Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

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Cover: Golden Gate Mountain, scene of many movie and television westerns, near Tucson. Typical area of Pinaleno very cobbly sandy loam, 1 to 8 percent slopes, is in the foreground.

Additional information about the Nation's natural resources is available on the Natural Resources Conservation Service homepage on the World Wide Web. The address is <http://www.nrcs.usda.gov>.

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Foreword

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

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

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. The information in this report is intended to identify soil properties that are used in making various land use or land treatment decisions. Statements made in this report are intended to help the land users identify and reduce the effects of soil limitations that affect various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Great differences in soil properties can occur within short distances. Some soils are subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey soils are poorly suited to use as septic tank absorption fields.

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

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Soil Survey of Pima County, Arizona, Eastern Part

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Fieldwork by Merlyn L. Richardson, Christopher C. Cochran, Steven J. Levine, and Dale E. Orrell.

United States Department of Agriculture, Natural Resources Conservation Service
in cooperation with
the Arizona Agricultural Experiment Station.

Introduction

Pima County, Arizona, Eastern Part, is in the south-central part of Arizona. It has an area of 1,900,000 acres, or about 2,968 square miles. It is bordered on the north by Pinal County, on the east by Graham and Cochise Counties, on the south by Santa Cruz County and Mexico, and on the west by the Tohono O'odham Nation (fig. 1). Portions of the eastern part of Pima County, Arizona not included in this report are areas of the Coronado National Forest and areas previously published in the Soil Survey of Tucson and Avra Valley Area, Arizona (1972) and the Soil Survey of Santa Cruz and Parts of Cochise and Pima Counties, Arizona (1979).

In 1980, the population of the area was about 500,000. Tucson, the second largest city in Arizona, had a population of 331,506. By 1990, the population of the city of Tucson had increased to 406,506, making it the 33rd largest city in the U.S.

An older survey, "Soil Survey of the Tucson Area, Arizona," was published in 1931 (Youngs, 1931). This earlier survey covers a part of the present survey. The present survey, however, updates the earlier survey and provides additional information and larger maps that show the soils in greater detail.

Descriptions, names and delineations of the soils in this soil survey do not fully agree with those on

soil maps for adjacent survey areas. Differences are the result of better knowledge of soils, modifications in series concepts, intensity of mapping, or the extent of soils within the survey.

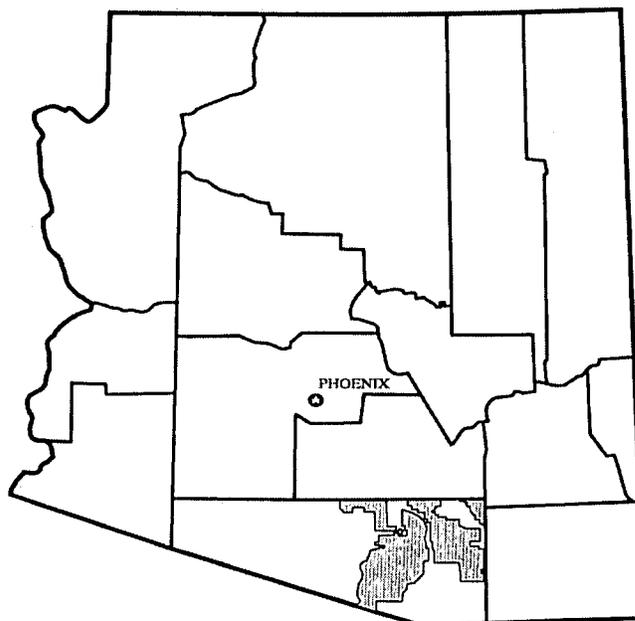


Figure 1.—Location of Pima County, Eastern Part in Arizona.

General Nature of the Survey Area

This section gives general information about the survey area. It describes settlement and development, transportation, and climate.

Settlement and Development

Evidence of the earliest Indian inhabitants within the survey area, Hohokam, can be dated to about 450 A.D (fig. 2). These people were farmers who grew corn, beans, and squash and supplemented their diets with wild game and native fruits, nuts and roots. Archaeologists have been able to document the presence of Hohokam villages through 1200 A.D. No one is sure what happened to these prehistoric people after that time, but some archaeologists have suggested that they were the forebears of the historic Pima Indians (flood plain farmers) and Papago Indians (gatherers)

In the late 1600's, Spanish missionaries became the first Anglos to settle the area. Tucson was founded on August 20, 1775 by "a red-headed,



Figure 2.—Petroglyphs made by early Indian inhabitants etched onto andesitic tuff in an area of Anklam-Cellar-Rock outcrop complex, 15 to 55 percent slopes.

hyperactive Irishman" named Don Hugo O'Connor. The name Tucson is believed to have been derived from the Pima Indian word *schookson* or *stjukson*, which translates as "at the foot of the black hill or mountain," referring to either Tumamoc Hill or Sentinel Peak (known locally as "A Mountain") (Sonnichsen, 1982).

Ranchers, soldiers, and trappers soon followed the missionaries. Tucson and the surrounding area were under Spanish control until the outbreak of the Mexican War in 1846. On December 17, 1846, Mexican people in the area had their first encounter with "Yanquis" when Lieutenant Colonel Philip St. George Cooke led a battalion through Tucson on their way to California. The encounters increased after gold was discovered in California. The Gadsden Purchase in 1853 brought the area into U.S. possession (Sonnichsen, 1982).

With the coming of the Americans, great changes started to take place in transportation, trade, and politics. In 1860, the population of Tucson totalled 623 people. Ninety years later, the population had grown to 45,454 people. During the next 10 years, the population quadrupled to 212,892. Because of the mild winters and improved transportation, Tucson and the surrounding area has been growing at an annual rate of about 10,000 people since 1950 (Sonnichsen, 1982).

Tucson is one of the largest communities in the United States solely dependent on ground water. The competition for this water supply for irrigation of farmland and the ever-increasing population has resulted in a gradual elimination of agriculture from the area. In the 1940's, a project was envisioned that would keep agriculture alive in Arizona. Titled the Central Arizona Project (CAP), this 330-mile concrete canal carries water from the Colorado River to Tucson. The CAP's completion may not ensure a steady supply of irrigation water as was first envisioned, but it will provide a needed supplement to the area's declining water table.

Transportation

Transportation in the eastern part of Pima County, Arizona, is supported by interstate highways, railroads, and airports. Interstate Highways 10 and 19, U.S. Highway 89, and State Routes 83, 86, and 286 criss-cross the area, with Tucson serving as the central hub. Several state and county roads also provide important transportation links to smaller towns and villages. Amtrak and Southern Pacific

Transportation Co. provide rail passenger and rail freight service respectively. Avra Valley Airport in Marana, Ryan Field west of Tucson, and Tucson International Airport provide the area with private and commercial air service.

Climate

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

Summers are hot and winters cool in eastern Pima County. Winter days are fairly warm, although the temperature drops below freezing most nights each winter. Rainfall is scant in most months, but is heaviest in summer, when scattered thunderstorms develop in the moist air which occasionally sweeps inland from the Gulf of Mexico. Snow cover in winter is not persistent and is generally confined to higher elevations.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Palisade, Sasabe, and Tucson, Arizona, for the period 1951 to 1978. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperatures at Palisade, Sasabe, and Tucson are 35, 50, and 52 degrees F. respectively. The average daily minimum temperature is 37 degrees at Palisade, 49 degrees at Sasabe, and 54 degrees at Tucson. The lowest temperature on record, which occurred at Palisade on March 2, 1971, is -6 degrees. In summer, the average temperature is 64 degrees at Palisade, 79 degrees at Sasabe, and 84 degrees at Tucson. The average daily maximum temperature is about 60 degrees at Palisade, 79 degrees at Sasabe, and 82 degrees at Tucson. The highest recorded temperature, which occurred at Tucson on June 25, 1970, is 111 degrees.

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

The total annual precipitation is 31 inches at Palisade, 17 inches at Sasabe, and 11 inches at Tucson. Of this, 50 to 60 percent usually falls in April through September, which includes the growing season for most crops. The heaviest 1-day rainfall during the period of record was 6.51 inches recorded

at Palisade on December 10, 1978. Thunderstorms occur on about 40 days each year, and most occur in summer.

The average seasonal snowfall is 77 inches at Palisade and a little less than 2 inches at Sasabe and Tucson. The greatest snow depth at any one time during the period of record was 86 inches at Palisade and 5 inches at both Sasabe and Tucson. On the average, 68 days of the year have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 25 percent. Humidity is higher at night, and the average at dawn is about 50 percent. The sun shines 90 percent of the time possible in summer and 80 percent in winter. The prevailing wind is from the southeast. Average windspeed is highest, 9 miles per hour, in spring.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area are in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the

boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions,

and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

The adjoining Tucson-Avra Valley Area, Arizona, soil survey and Santa Cruz and Parts of Cochise and Pima Counties, Arizona, soil survey are of such age that classification and mapping concepts have changed, and the most practical join has been made.

The Pinal County, Arizona, Western Part soil survey does not fully agree as to named components in the mapping units or joining of soil boundaries. However, use and management is essentially the same for most soils in the two areas (soils of such extent so as to be named in one soil survey area are of minor extent in the adjoining area and are considered inclusions of similar soils). The field office technical guides in these areas will be updated by Technical Soil Services as needed.

General Soil Map Units

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

Typically, it consists of one or more major soils or miscellaneous areas and some minor soils or miscellaneous areas. It is named for the major soils or miscellaneous areas. The components of one map unit can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

Soils on basin floors, stream terraces, flood plains, and alluvial fans

This group consists of 3 map units. It makes up about 11 percent of the survey area.

1. Vecont

Very warm, very deep, well drained, nearly level, fine textured soils; on basin floors

This map unit is on basin floors. Slopes range from 0 to 1 percent. Elevation is 1,650 to 1,800 feet. The mean annual air temperature is 70 to 72 degrees F, and the mean annual precipitation is 8 to 10 inches. The frost-free period is 250 to 300 days.

This unit makes up 1 percent of the survey area. It is about 65 percent Vecont soils and 35 percent minor soils.

Vecont soils are on basin floors. These soils are very deep and well drained. They formed in mixed alluvium. These soils are fine textured. These soils have an occasional flooding hazard.

The minor soils of this map unit are Mohall, Denure, and Pahaka soils. Mohall soils are moderately fine textured soils on fan terraces and basin floors. Denure soils are moderately coarse textured soils on fan terraces. Pahaka soils are moderately coarse over moderately fine textured soils on fan terraces.

This unit is mainly used for rangeland. Some of it is abandoned cropland.

This unit's main management concerns are slow permeability and the hazards of flooding and water erosion.

2. Glendale-Arizo-Hantz

Warm, very deep, well drained and excessively drained, nearly level, moderately fine, very gravelly coarse and fine textured soils; on stream terraces, flood plains, and alluvial fans

This map unit is on stream terraces, flood plains, and alluvial fans. Slopes range from 0 to 3 percent. Elevation is 2,000 to 3,600 feet. The mean annual air temperature is 64 to 70 degrees F, and the mean annual precipitation is 10 to 12 inches. The frost-free period is 220 to 280 days.

This unit makes up 6 percent of the survey area. It is about 21 percent Glendale soils, 20 percent Arizo soils, and 15 percent Hantz soils. Minor soils make up about 44 percent of this map unit.

Glendale and similar soils are on stream terraces. These soils are very deep and well drained. They formed in mixed alluvium. These soils are moderately fine textured. These soils have a rare flooding hazard.

Arizo and similar soils are on flood plains. These soils are very deep and excessively drained. They formed in mixed alluvium. These soils are very

gravelly coarse textured. These soils have a frequent flooding hazard.

Hantz and similar soils are on flood plains and alluvial fans. These soils are very deep and well drained. They formed in mixed alluvium. These soils are fine textured. These soils have an occasional flooding hazard.

The minor soils of this map unit are Anthony soils. Anthony soils are moderately coarse textured soils on alluvial fans and flood plains.

This unit is mainly used for rangeland and irrigated cropland, but it is also used for recreational areas and urban development.

The main management concerns on this unit are moderately slow permeability and the hazards of flooding and wind erosion on the Glendale soils; seepage, sandy textures, and the hazard of flooding on the Arizo soils; and high shrink-swell, slow permeability, and the hazard of flooding on the Hantz soils.

3. Comoro-Riveroad-Keysto

Warm, very deep, well drained, nearly level to strongly sloping, moderately coarse, moderately fine and extremely gravelly medium textured soils; on flood plains and stream terraces

This map unit is on stream terraces and flood plains. Slopes range from 0 to 8 percent. Elevation is 2,400 to 4,600 feet. The mean annual air temperature is 59 to 66 degrees F, and the mean annual precipitation is 12 to 16 inches. The frost-free period is 180 to 230 days.

This unit makes up 4 percent of the survey area. It is about 53 percent Comoro and similar soils, 19 percent Riveroad soils, and 15 percent Keysto soils. Minor soils make up about 13 percent of this map unit.

Comoro and similar soils are on flood plains. These soils are very deep and well drained. They formed in mixed alluvium. These soils are moderately coarse textured. They have a rare flooding hazard.

Riveroad soils are on flood plains. These soils are very deep and well drained. They formed in mixed alluvium. These soils are moderately fine textured. These soils have a rare flooding hazard.

Keysto soils are on stream terraces. These soils are very deep and well drained. They formed in mixed alluvium. These soils are extremely gravelly medium textured. These soils have none to rare flooding hazard.

The minor soils of this map unit are the Guest

soils that are fine textured soils on swales, flood plains, and drainageways.

This unit is mainly used for rangeland, but it is also used for irrigated cropland, recreational areas and urban development.

This unit's main management concerns are droughtiness and the hazard of flooding on the Comoro soils; the hazard of flooding and shrink-swell potential on the Riveroad soils; and seepage, content of rock fragments, and the hazard of flooding on the Keysto soils.

Soils on basin floors and fan terraces

This group consists of 2 map units. It makes up about 21 percent of the survey area.

4. Mohall-Denure-Pahaka

Very warm, very deep, well drained and somewhat excessively drained, nearly level to gently sloping, moderately fine, gravelly moderately coarse and moderately coarse over moderately fine textured soils; on basin floors and fan terraces

This map unit is on fan terraces and basin floors. Slopes range from 0 to 5 percent. Elevation is 1,650 to 2,200 feet. The mean annual air temperature is 70 to 72 degrees F, and the mean annual precipitation is 8 to 10 inches. The frost-free period is 250 to 300 days.

This unit makes up 2 percent of the survey area. It is about 39 percent Mohall soils, 13 percent Denure soils, and 8 percent Pahaka soils. Minor soils make up about 40 percent of this map unit.

Mohall soils are on fan terraces and basin floors. These soils are very deep and well drained. They formed in mixed alluvium. These soils are moderately fine textured. These soils have no flooding hazard.

Denure soils are on fan terraces. These soils are very deep and somewhat excessively drained. They formed in mixed alluvium. These soils are gravelly moderately coarse textured. These soils have no flooding hazard.

Pahaka soils are on fan terraces. These soils are very deep and well drained. They formed in mixed alluvium. These soils are moderately coarse over moderately fine textured. These soils have no flooding hazard.

The minor soils of this map unit are Trix and Dateland soils. Trix soils are medium over moderately fine textured soils on alluvial fans. Dateland soils are medium textured soils on fan terraces.

This unit is mainly used for rangeland.

This unit's main management concerns are droughtiness, the hazard of wind erosion, seepage, and piping.

5. Hayhook-Mohave-Tubac

Warm, very deep, well drained, nearly level to strongly sloping, gravelly moderately coarse, moderately fine and fine textured soils; on fan terraces and basin floors

This map unit is on fan terraces and basin floors. Slopes range from 0 to 8 percent. Elevation is 2,200 to 3,600 feet. The mean annual air temperature is 64 to 70 degrees F, and the mean annual precipitation is 10 to 12 inches. The frost-free period is 220 to 280 days.

This unit makes up 19 percent of the survey area. It is about 35 percent Hayhook and similar soils, 17 percent Mohave and similar soils, and 13 percent Tubac soils. Minor soils make up about 35 percent of this map unit.

Hayhook and similar soils are on fan terraces. These soils are very deep and well drained. They formed in alluvium from granite. These soils are gravelly moderately coarse textured. They have no flooding hazard.

Mohave and similar soils are on fan terraces. These soils are very deep and well drained. They formed in mixed alluvium. These soils are moderately fine textured. They have no flooding hazard.

Tubac soils are on basin floors and fan terraces. These soils are very deep and well drained. They formed in mixed alluvium. These soils are fine textured. These soils have no flooding hazard.

The minor soils of this map unit are Yaqui soils and Urban land. Yaqui soils are moderately coarse over moderately fine textured soils on alluvial fans.

This unit is mainly used for rangeland and urban development, but it is also used for irrigated cropland.

This unit's main management concerns are shrink-swell potential, moderately slow permeability, and droughtiness for the Mohave soils; the hazard of wind erosion and seepage for the Hayhook soils; and slow permeability and shrink-swell potential for the Tubac soils.

Soils on fan terraces, relict fan terraces, and hills

This group consists of 3 map units. It makes up about 35 percent of the survey area.

6. Pinamt-Momoli

Very warm, very deep, well drained and somewhat excessively drained, nearly level to strongly sloping, extremely gravelly moderately fine and very gravelly moderately coarse textured soils; on fan terraces

This map unit is on fan terraces. Slopes range from 1 to 10 percent. Elevation is 1,800 to 2,200 feet. The mean annual air temperature is 70 to 72 degrees F, and the mean annual precipitation is 8 to 10 inches. The frost-free period is 250 to 300 days.

This unit makes up 0.5 percent of the survey area. It is about 40 percent Pinamt soils and 25 percent Momoli soils. Minor soils make up about 35 percent of this map unit.

Pinamt soils are on fan terraces. These soils are very deep and well drained. They formed in mixed alluvium. These soils are extremely gravelly moderately fine textured.

Momoli soils are on fan terraces. These soils are very deep and somewhat excessively drained. They formed in mixed alluvium. These soils are very gravelly moderately coarse textured.

The minor soils of this map unit are fine textured soils on fan terraces.

This unit is mainly used for rangeland.

This unit's main management concerns are content of rock fragments, droughtiness, and seepage on the Pinamt and Momoli soils.

7. Pinaleno-Stagecoach-Cave

Warm, very deep and very shallow and shallow to a hardpan, well drained, nearly level to steep, extremely cobbly moderately fine, very gravelly medium, and gravelly moderately coarse textured soils; on fan terraces and relict fan terraces

This map unit is on fan terraces and relict fan terraces. Slopes range from 0 to 35 percent. Elevation is 1,800 to 3,600 feet. The mean annual air temperature is 64 to 70 degrees F, and the mean annual precipitation is 10 to 12 inches. The frost-free period is 220 to 280 days.

This unit makes up 14 percent of the survey area. It is about 42 percent Pinaleno and similar soils, 19 percent Stagecoach and similar soils, and 8 percent Cave and similar soils. Minor soils make up about 31 percent of this map unit.

Pinaleno and similar soils are on fan terraces. These soils are very deep and well drained. They

formed in mixed alluvium. These soils are extremely cobbly moderately fine textured.

Stagecoach and similar soils are on fan terraces. These soils are very deep and well drained. They formed in mixed alluvium. These soils are very gravelly medium textured.

Cave and similar soils are on relict fan terraces. These soils are very shallow and shallow to a hardpan and well drained. They formed in mixed alluvium. These soils are gravelly moderately coarse textured.

The minor soils of this map unit are Nahda, Palos Verdes, and Sahuarita soils and Urban land. Nahda soils are very gravelly fine textured soils on fan terraces. Palos Verdes soils are moderately fine textured soils on relict fan terraces. Sahuarita soils are moderately coarse over moderately fine textured soils on fan terraces.

This unit is mainly used for rangeland and urban development, but it is also used for recreational areas.

This unit's main management concerns are content of rock fragments, droughtiness, and moderately slow permeability for the Pinaleno soils; the hazards of wind and water erosion, dustiness, and content of rock fragments for the Stagecoach soils; and shallow depth to a hardpan, seepage, and dustiness for the Cave soils.

8. Whitehouse-Caralampi-Tombstone

Warm, very deep, well drained, nearly level to steep, fine, extremely gravelly moderately fine, and extremely gravelly medium textured soils; on fan terraces and hills

This map unit is on fan terraces and hills. Slopes range from 1 to 50 percent. Elevation is 3,100 to 5,200 feet. The mean annual air temperature is 59 to 66 degrees F, and the mean annual precipitation is 12 to 16 inches. The frost-free period is 180 to 230 days.

This unit makes up 20.5 percent of the survey area. It is about 30 percent Whitehouse and similar soils, 22 percent Caralampi and similar soils, and 19 percent Tombstone and similar soils. Minor soils make up about 29 percent of this map unit.

Whitehouse and similar soils are on fan terraces. These soils are very deep and well drained. They formed in mixed alluvium. These soils are fine textured.

Caralampi and similar soils are on fan terraces and hills. These soils are very deep and well drained.

They formed in mixed alluvium. These soils are extremely gravelly moderately fine textured.

Tombstone and similar soils are on fan terraces. These soils are very deep and well drained. They formed in mixed alluvium and colluvium. These soils are extremely gravelly medium textured.

The minor soils of this map unit are Altar, Arivaca, Diaspar, and Kimrose family soils. Altar soils are very gravelly medium textured soils on fan terraces. Arivaca soils are fine textured soils on relict fan terraces. Diaspar soils are moderately coarse textured soils on fan terraces. Kimrose family soils are extremely gravelly medium textured soils on hills.

This unit is mainly used for rangeland, but it is also used for recreational areas and urban development.

This unit's main management concerns are slow permeability, shrink-swell potential, and the hazard of wind erosion for the Whitehouse soils; moderately slow permeability, content of rock fragments, and droughtiness for the Caralampi soils; and seepage and content of rock fragments for the Tombstone soils.

Soils on pediments, hills, and mountains

This group consists of 3 map units. It makes up about 32 percent of the survey area.

9. Anklam-Pantano-Cellar

Warm, very shallow and shallow, well drained and somewhat excessively drained, gently sloping to very steep, very gravelly moderately fine and medium and extremely gravelly moderately coarse textured soils; on pediments, hills, and mountains

This map unit is on pediments, hills, and mountains. Slopes range from 5 to 65 percent. Elevation is 2,200 to 4,000 feet. The mean annual air temperature is 64 to 70 degrees F, and the mean annual precipitation is 10 to 12 inches. The frost-free period is 220 to 280 days.

This unit makes up 11 percent of the survey area. It is about 35 percent Anklam and similar soils, 17 percent Pantano and similar soils, and 14 percent Cellar and similar soils. Minor soils make up about 34 percent of this map unit.

Anklam and similar soils are on hills and mountains. These soils are shallow and well drained. They formed in alluvium and colluvium from volcanic rocks. These soils are very gravelly moderately fine textured.

Pantano and similar soils are on pediments, hills, and mountains. These soils are shallow and well drained. They formed in mixed alluvium and colluvium. These soils are very gravelly medium textured.

Cellar and similar soils are on pediments, hills, and mountains. These soils are very shallow and shallow and somewhat excessively drained. They formed in alluvium and colluvium from granite and gneiss. These soils are extremely gravelly moderately coarse textured.

The minor soils of this map unit are Lehman soils. Lehman soils are fine textured soils on pediments and hills.

This unit is mainly used for rangeland, but it is also used for recreational areas, urban development, and wildlife habitat.

This unit's main management concerns are depth to bedrock, droughtiness, slope, and content of rock fragments for the Anklam, Pantano, and Cellar soils.

10. Deloro-Lampshire-Rock Outcrop

Warm, very shallow and shallow, well drained, nearly level to very steep, extremely channery fine and very gravelly medium textured soils and Rock outcrop; on pediments, hills, and mountains

This map unit is on pediments, hills, and mountains. Slopes range from 1 to 65 percent. Elevation is 3,300 to 5,500 feet. The mean annual air temperature is 59 to 66 degrees F, and the mean annual precipitation is 12 to 16 inches. The frost-free period is 180 to 230 days.

This unit makes up 19 percent of the survey area. It is about 36 percent Deloro and similar soils, 19 percent Lampshire and similar soils, and 10 percent Rock outcrop. Minor soils make up about 35 percent of this map unit.

Deloro and similar soils are on pediments, hills, and mountains. These soils are shallow and well drained. They formed in mixed alluvium and colluvium. These soils are extremely channery fine textured.

Lampshire and similar soils are on pediments, hills, and mountains. These soils are very shallow and shallow and well drained. They formed in mixed alluvium and colluvium. These soils are very gravelly medium textured.

Rock outcrop consists of exposed areas of granite, gneiss, rhyolite, tuff, schist, basalt, and limestone.

The minor soils of this map unit are Andrada, Mabray, and Oracle soils. Andrada soils are extremely gravelly medium textured soils on hills and pediments. Mabray soils are very gravelly medium textured soils on mountains. Oracle soils are moderately fine textured soils on pediments and hills.

This unit is mainly used for rangeland, but it is also used for recreational areas and wildlife habitat.

This unit's main limitations are depth to bedrock, content of rock fragments, and slope for the Deloro and Lampshire soils.

11. Cortaro-Spudrock-Rock Outcrop

Cool, shallow and moderately deep, well drained, moderately steep to very steep, very gravelly and very channery moderately coarse textured soils and Rock outcrop; on hills and mountains

This map unit is on hills and mountains. Slopes range from 15 to 65 percent. Elevation is 5,400 to 8,670 feet. The mean annual air temperature is 45 to 57 degrees F, and the mean annual precipitation is 16 to 30 inches. The frost-free period is 140 to 180 days.

This unit makes up 2 percent of the survey area. It is about 39 percent Cortaro and similar soils, 30 percent Spudrock soils, and 17 percent Rock outcrop. Minor soils make up about 14 percent of this map unit.

Cortaro and similar soils are on hills and mountains. These soils are shallow and well drained. They formed in alluvium and colluvium from granite, gneiss, and schist. These soils are very gravelly moderately coarse textured.

Spudrock soils are on hills and mountains. These soils are moderately deep and well drained. They formed in alluvium and colluvium from granite, gneiss, and schist. These soils are very channery moderately coarse textured.

Rock outcrop consists of exposed areas of granite, gneiss, and schist.

The minor soils of this map unit are Lemmon soils. Lemmon soils are fine textured soils on hills and mountains.

This unit is mainly used for woodland, but it is also used for recreational areas and wildlife habitat.

This unit's main management concerns are depth to bedrock, seepage, slope, and content of rock fragments for the Cortaro and Spudrock soils.

Miscellaneous

This group consists of 1 map unit. It makes up about 1 percent of the survey area.

12. Pits, dumps

Open pit mines, mine waste rock dumps, mine tailing impoundments, and mine support facilities

This map unit is on hills and mountains. This map unit is characterized by deep, steep-sided pits, and extensive flat-topped dumps with steep scarps on the ends and sides. Slopes range from 0 to 100 percent. Elevation is 2,300 to 4,000 feet. The mean annual air temperature is 63 to 70 degrees F, and the mean annual precipitation is 10 to 16 inches. The frost-free period is 220 to 280 days.

This unit makes up 1 percent of the survey area. It is about 45 percent Pits and 45 percent Dumps. Minor soils make up about 10 percent of this map unit.

Open pit mines are as much as 1,500 feet deep and a mile in diameter at the top. Waste rock and ore are removed by large trucks and conveyor belts. Extremely stony waste rock is piled adjacent to the pits.

Dumps extend a mile or more from the pits. The tailing impoundments are built up by a series of dikes that are raised as the tailing impoundments accumulate from the treated copper ore. The tailings consist of pulverized rock and have a texture of silt loam. The mine tailing dumps appear as huge benches that are nearly level on top. The ends and sides of these benches are very steep and rise as much as 300 feet above the surrounding area.

The minor soils of this map unit are Anklam and Pantano soils. Anklam soils are very gravelly moderately fine textured soils on pediments, hills, and mountains. Pantano soils are very gravelly moderately coarse textured soils on pediments, hills, and mountains.

This unit is used for mining of copper and molybdenum. A few areas are used for urban development.

This unit's main management concerns are dustiness, droughtiness, slope, and the hazards of wind and water erosion.

Detailed Soil Map Units

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

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough

observations to identify all of the kinds of soil on the landscape.

The presence of included areas in a map unit in no way diminishes the usefulness or accuracy of soil data. The objectives of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

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

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

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

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into soil phases. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Glendale silt loam, 0 to 3 percent slopes, is a phase of the Glendale series.

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

A soil complex consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat

similar in all areas. Pinaleno-Stagecoach complex, 5 to 16 percent slopes, is an example.

A soil association is made up of two or more geographically associated soils that are shown as one unit on the maps. Because of present or anticipated soil uses in the survey area, it was not considered practical or necessary to map the soils separately. The pattern and relative proportion of the soils are somewhat similar. Deloro-Schrap association, 1 to 8 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Riveroad and Comoro soils, 0 to 2 percent slopes, is an undifferentiated group in this survey area.

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

This survey includes miscellaneous areas. Such areas have little or no soil material and support little or no vegetation. Pits, dumps are an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil descriptions

1—Altar-Sasabe complex, 1 to 8 percent slopes.

This map unit is on shallowly incised, gently sloping fan terraces. Elevation is 3,000 to 3,600 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost free period is 180 to 230 days.

This unit is 50 percent Altar gravelly sandy loam

and 30 percent Sasabe sandy loam. The Altar soils are on toeslopes of fan terraces that have gradients of 2 to 8 percent, and the Sasabe soils are on slightly concave fan terraces that have gradients of 1 to 3 percent. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Diaspar and Bernardino soils intermingled with the Altar and Sasabe soils, and Comoro and Keysto soils on stream terraces along drainageways. Included areas make up about 20 percent of the total acreage.

The Altar soil is very deep and well drained. It formed in alluvium derived dominantly from granite and schist. Typically, the surface is covered by 25 to 35 percent gravel and cobble. The surface layer is yellowish brown gravelly sandy loam about 2 inches thick. The upper 15 inches of the subsoil is brown to dark brown very gravelly sandy clay loam. The lower 22 inches is brown very cobbly sandy loam. The substratum to a depth of 60 inches or more is light brown extremely gravelly loamy sand. These soils generally are noneffervescent in the upper 30 inches or more. In places, the substratum is redder and has more clay than is typical. In some areas, the surface layer is very cobbly sandy loam.

Permeability of the Altar soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

The Sasabe soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 10 to 15 percent gravel and a few cobble. The surface layer is strong brown sandy loam about 5 inches thick. The upper 17 inches of the subsoil is yellowish red and red clay loam and clay. The lower 38 inches is yellowish red gravelly clay loam, gravelly sandy clay loam and very gravelly sandy clay loam. In some pedons, a hardpan that is cemented with lime and silica is below a depth of 40 inches.

Permeability of the Sasabe soil is slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is moderately high. In the vicinity of the San Pedro River, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

This unit is used for rangeland.

The potential plant community on this unit is

mainly grama grasses, curlymesquite, cane bluestem, and false mesquite. The present vegetation in most areas is mainly grama grasses, mesquite, false-mesquite, threeawn, and snakeweed.

This unit is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem. Competition from woody plants must be reduced before an effective cover of perennial grass can be maintained. It responds well to good grazing management practices and is potentially one of the best upland range sites in the survey area. Controlled burning is effective in controlling poisonous half-shrubs such as snakeweed and burroweed on this unit. Other suitable range management practices, such as fencing, livestock watering developments, and range seeding can help to improve grazing distribution and the range condition.

This unit is well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Altar soil is in capability subclass VI, and the Sasabe soil is in capability subclass VIe. The Altar soil is in the Sandy Loam Upland, 12-16" p.z. range site, and the Sasabe soil is in the Loamy Upland, 12-16" p.z. range site.

2—Anklam-Cellar-Rock outcrop complex, 15 to 55 percent slopes.

This map unit is on steep hills and mountains. Elevation is 2,400 to 4,000 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 40 percent Anklam extremely gravelly sandy loam that has slope gradients of 25 to 50 percent, 25 percent Cellar extremely gravelly sandy loam that has slope gradients of 15 to 55 percent, and 20 percent Rock outcrop. Also in this unit is about 10 percent Lajitas and Pantano soils. The soils and the areas of Rock outcrop are intricately intermingled; however, a higher percentage of Rock outcrop is in areas near the hilltops and mountaintops.

Included in this unit are small areas of Mohave, Stagecoach, Palos Verdes, and Pinaleno soils on fan terraces, Chimenea soils on small areas underlain by granite, and Delthorny and Lehman soils on hills. Also included are small areas of Arizo soils in and along drainageways. Included areas make up about 15 percent of the total acreage.

The Anklam soil is shallow and well drained. It formed in alluvium and colluvium derived dominantly from fractured rhyolite, andesite, tuff agglomerate,

schist, and shale. Typically, the surface is covered by 55 to 65 percent gravel, cobble, and stones. The surface layer is brown extremely gravelly sandy loam about 2 inches thick. The subsoil is reddish brown and red very gravelly clay loam 11 inches thick. Fractured weathered bedrock that has clay in the fractures is at a depth of 13 inches. These soils generally are noncalcareous throughout. Depth to bedrock ranges from 10 to 20 inches. In some areas, the surface layer is very gravelly sandy clay loam or very cobbly sandy loam.

Permeability of the Anklam soil is moderately slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

The Cellar soil is very shallow and shallow and somewhat excessively drained. It formed in alluvium and colluvium derived dominantly from granite and gneiss. Typically, the light yellowish brown and brown extremely gravelly sandy loam soil is about 10 inches deep over granite.

Permeability of the Cellar soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 4 to 20 inches. Runoff is very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

Rock outcrop consists of exposed areas of rhyolite, basalt, and andesitic tuff. It is on ledges and a few pinnacles. The soils and the areas of Rock outcrop are intricately intermingled; however, a higher percentage of Rock outcrop is in areas near the hilltops and mountaintops (fig. 3).

This unit is used mainly for rangeland. It is also used for recreational areas, and a few areas are used as homesites.

The potential plant community on this unit is mainly Arizona cottontop, false-mesquite, slender grama, and bush muhly. The present vegetation in most areas is mainly paloverde, cacti, whitethorn, and triangle bursage.

This unit produces forage for year-round use by livestock. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution. Grazing management, including fencing, livestock watering developments, and constructing trails to permit more animals to graze in smaller areas for shorter periods of time, helps to overcome the grazing distribution problems.

This unit is poorly suited to recreational development. Slope limits the use of areas of this unit

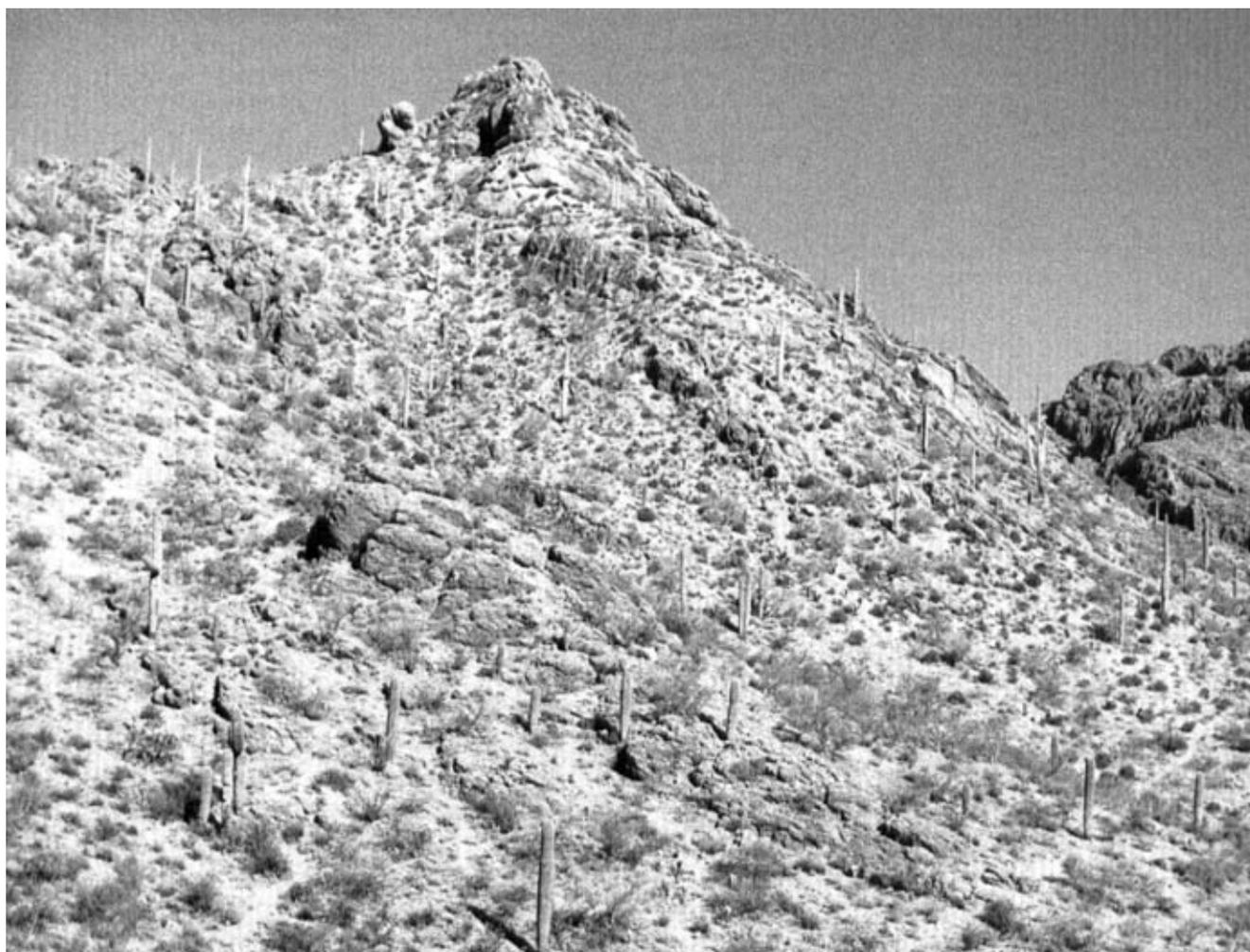


Figure 3.—Anklam soils and Rock outcrop in a typical area of Anklam-Cellar-Rock outcrop complex, 15 to 55 percent slopes.

mainly to a few paths and trails, which should extend across the slope.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Anklam and Cellar soils are in capability subclass VIIe and in the Shallow Hills, 10-13" p.z. range site. Rock outcrop is not assigned a range site and is in capability class VIII.

3—Anthony fine sandy loam, 0 to 3 percent slopes.

This very deep, well drained soil is on nearly level flood plains. It formed in mixed alluvium. Elevation is 2,200 to 3,600 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

Typically, the surface layer is light yellowish brown fine sandy loam about 5 inches thick. The subsurface layer is stratified yellowish brown very fine sandy loam and loamy sand 11 inches thick. The upper 7 inches of the substratum is light yellowish brown gravelly loamy sand, the next 28 inches is yellowish brown sandy loam, and the lower part to a depth of 60 inches or more is yellowish brown gravelly loamy coarse sand. These soils are calcareous throughout. In some areas, the surface layer is gravelly loam or very fine sandy loam.

Included in this unit are small areas of Hayhook and Sahuarita soils on fan terraces above Anthony soils and Glendale soils on stream terraces below Anthony soils. Also included are small areas of Yaqui soils on alluvial fans and Arizo soils on flood plains and riverwash in channel bottoms. Included areas make up about 15 percent of the total acreage.

Permeability of the Anthony soil is moderately

rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. This soil is subject to rare flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks. Runoff is generally slow except where concentrated in shallow rills and gullies. The hazard of water erosion is slight, but some drainageways are entrenched and channelled. Headcutting and deposition may occur following heavy summer thunderstorms or winter storms. The hazard of wind erosion is moderately high. In the vicinity of the San Pedro River, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

Most areas of this unit are used for rangeland. A few areas are used for homesites and urban development. Some areas are used for irrigated cropland.

The potential plant community on this unit is mainly bush muhly, desert globemallow, Arizona cottontop, and dropseeds. The present vegetation in most areas is mainly creosotebush, mesquite, blue paloverde, and triangle bursage.

This soil is easily traversed by livestock. It produces a limited amount of forage for year-round use. Forage production, consisting of annual forbs and grasses, can be very high in years when precipitation in winter and spring is good. Grazing management should be focused on improving forage production. Other suitable range management practices, such as fencing and livestock watering developments, can help to improve grazing distribution.

This unit is suited to irrigated crops. It is limited mainly by seasonal flooding and hazard of wind erosion. The risk of flooding can be reduced by the use of levees, dikes, and diversions. Because of the moderately rapid permeability of the soil in this unit, the length of runs should be properly designed. Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting, and increases the water intake rate. Crop residue left on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Wind erosion can be controlled by keeping the soil rough and cloddy when it is not protected by vegetation.

If this unit is used for homesites, the main limitations are flooding and the hazard of wind erosion in disturbed areas. The area around the Tanque Verde Creek and the Sabino Creek may experience high water tables. This will affect septic

tank leach fields and buildings with or without basements.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is well suited to irrigated grain and seed crops and irrigated domestic grasses and legumes for wildlife.

This soil is in capability subclasses IIe, irrigated, and VIIs, nonirrigated, and in the Sandy Bottom, 10-13" p.z. range site.

4—Arivaca very cobbly loam, 2 to 15 percent slopes.

This moderately deep and well drained soil is on undulating to rolling relict fan terraces at the base of volcanic hills. It formed in alluvium derived dominantly from basalt conglomerate and tuff. Elevation is 3,400 to 4,600 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

Typically, the surface is covered by 20 percent gravel and 30 percent cobble. The surface layer is reddish brown very cobbly loam about 1 inch thick. The subsurface layer is dark reddish gray gravelly clay loam 3 inches thick. The subsoil is reddish brown gravelly clay loam, clay, and cobbly clay 17 inches thick. At 21 inches is unweathered porphyritic tuff. Depth to bedrock ranges from 20 to 40 inches. In some areas, the surface layer is very gravelly fine sandy loam. The surface layer is stony or very stony in a few areas.

Included in this unit are small areas of Bernardino, Kimrose family, Nolam, and White House soils. Also included are small areas of basalt Rock outcrop. Included areas make up about 15 percent of the total acreage.

Permeability of the Arivaca soil is slow. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

This unit is used for rangeland.

The potential plant community on this unit is mainly tobosa, curlymesquite, sideoats grama, and wolfberry. The present vegetation in most areas is mainly broom snakeweed, mesquite, catclaw acacia, curlymesquite, and annuals.

This soil is easily traversed by livestock. It produces forage for year-round use. Surface cobble and stones may reduce grazing on this soil by livestock. Tobosa, the dominant species, is unpalatable when cured. Grazing management,

including use of fencing and livestock watering developments, helps to improve grazing distribution and helps to keep the tobosa species usable. Other suitable range management practices, such as controlled burning and brush management, can help to improve the range condition.

This unit is moderately well suited to desertic herbaceous plants and well suited to desertic shrubs and trees for wildlife.

The Arivaca soil is in capability subclass VI and in the Clay Loam Upland, 12-16" p.z. range site.

5—Arizo-Riverwash complex, 0 to 3 percent slopes.

This map unit is on nearly level flood plains (fig. 4). Elevation is 2,000 to 3,000 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air

temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 50 percent Arizo gravelly loamy sand and 20 percent Riverwash. Arizo soils and Riverwash occupy bar and channel flood plain physiography. Arizo soils are on higher-lying bars, and Riverwash is in the channel bottoms.

Included in this unit are small areas of nearly vertical scarps that have Glendale and Anthony soils on flood plains and stream terraces above Arizo soils. Included areas make up about 30 percent of the total acreage.

The Arizo soil is very deep and excessively drained. It formed in mixed alluvium. Typically, the surface layer is yellowish brown gravelly loamy sand about 18 inches thick. The lower part to a depth of 60 inches or more is light yellowish brown very gravelly loamy sand. These soils are moderately alkaline and



Figure 4.—Area of Arizo-Riverwash complex, 0 to 3 percent slopes, bounded by Rock outcrop.

calcareous throughout. In some areas, the substratum has less gravel and cobble than is typical. In places, the soil has less lime in the upper part than is typical.

Permeability of the Arizo soil is very rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow except during convective thunderstorms in the summer and frontal storms in the winter when runoff from higher positions causes flash flooding. Hazard of water erosion is very high during flash floods. This soil is subject to frequent but brief periods of flooding in both the summer and winter seasons. The hazard of wind erosion is moderately high.

Riverwash consists of unstablized and stratified layers of sand, silt, and gravel. It is so frequently flooded, reworked, and sorted that it supports little if any vegetation.

Most areas of this unit are used for rangeland. A few areas are used for homesites, urban development, irrigated cropland, and recreational areas. A few areas are used as a source of sand and gravel. Some areas are used as sites for sanitary landfills.

The potential plant community on the Arizo soil is mainly bush muhly, blue paloverde, mesquite, catclaw acacia, burrobrush, and desert willow. The present vegetation in most areas is mainly burrobrush, mesquite, blue paloverde, Johnsongrass, and catclaw acacia.

The availability of water and the diversity of vegetation, which includes an abundance of streamside plants, encourage a constant grazing pressure. Livestock prefer this unit because of the availability of shade, easy access, and seasonal water from local flooding. It produces forage for year-round use. This unit is susceptible to erosion when the protective plant cover is depleted by overgrazing. Fencing can help to control grazing distribution and thereby help to maintain adequate plant cover. When properly managed this unit can produce an abundance of browse and perennial grass forage on the streambanks and protected flood plain areas. Planting shoots, rhizomes, and cuttings of forage species helps stabilize streambanks and channels. Using brush management to control burrobrush and batamote helps to improve the range condition. Other suitable range management practices, such as livestock watering developments and grade stabilization structures, can help to improve grazing distribution and the range condition.

This unit is moderately suited to recreational development. It is limited mainly by frequent flooding

and sand. Recreational pursuits are primarily horseback riding and driving off-road vehicles.

This unit is poorly suited to homesites or urban development. Population growth has resulted in increased construction of homes on this unit. The main limitations are frequent flooding and very low cutbank stability.

If areas within this unit are used for septic tank absorption fields or sanitary landfills, the main limitations are flooding and seepage. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Special engineering and design are needed to protect landfill areas from flooding and preventing the ground water contamination.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is poorly suited to irrigated grain and seed crops and irrigated domestic grasses and legumes for wildlife.

The Arizo soil is in capability subclass IVw, irrigated, and VIw, nonirrigated, and in the Sandy Bottom, 10-13" p.z. range site. Riverwash is not assigned a range site and is in capability class VIII.

6—Bernardino-Tombstone association, 5 to 16 percent slopes.

This map unit is on rolling fan terraces. Elevation is 3,500 to 5,000 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 50 percent Bernardino gravelly sandy clay loam and 25 percent Tombstone very gravelly loam. Bernardino soils are on fan terrace crests and shoulders on slopes of 5 to 10 percent, and Tombstone soils are on fan terrace ends and backslopes on slopes of 5 to 16 percent.

Included in this unit are small areas of Kimrose family soils on relict fan terraces, Guest soils on flood plains, Riveroad and Comoro soils on stream terraces along drainageways, Nolam soils intermingled with Tombstone soils on fan terrace shoulders, and White House soils on nearly level to slightly concave fan terrace crests. Included areas make up about 25 percent of the total acreage.

The Bernardino soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 20 to 35 percent gravel and a few cobble. The surface layer is reddish brown gravelly sandy

clay loam about 2 inches thick. The upper 13 inches of the subsoil is reddish brown clay and clay loam. The lower 26 inches is light brown and pink loam. The substratum to a depth of 60 inches or more is white loam. In places, these soils are effervescent to the surface. Many soft masses of lime are in the lower part of the subsoil and in the substratum.

Permeability of this Bernardino soil is slow to a depth of 15 inches and moderate below this depth. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is slight.

The Tombstone soil is very deep and well drained. It formed in mixed alluvium and colluvium. Typically, the surface is covered by 50 to 65 percent gravel and scattered cobble. The surface layer is grayish brown and dark grayish brown very gravelly loam about 13 inches thick. The next layer to a depth of 60 inches or more is a white and light gray extremely gravelly loam. These soils are calcareous throughout. Many soft masses of lime are in the subsoil and substratum. In some areas, the surface layer is thinner and lighter in color.

Permeability of the Tombstone soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

Most areas of this unit are used for rangeland. A few areas are used for homesites.

The potential plant community on the Bernardino soil is mainly sideoats grama, curlymesquite, and black grama. The potential plant community on the Tombstone soil is mainly black grama, sideoats grama, hairy grama, and slim tridens. The present vegetation in most areas is mainly grama grasses, snakeweed, mesquite, and curlymesquite.

This unit is easily traversed by livestock. It provides forage for year-round use. The vegetation on the Bernardino soil is preferred by livestock. Brush encroachment is a serious problem on this soil. Grazing management, including use of fencing and livestock watering developments, helps to improve grazing distribution. Other suitable range management practices, such as range seeding and brush management, can help to improve the range condition.

If this unit is used for homesite development, the main limitations are the potential for shrinking and swelling and slow permeability on the Bernardino soil. Slope is the main limitation on the Tombstone soil. If buildings are constructed on the Bernardino soil, properly designing foundations and footings and

diverting runoff away from buildings help to prevent structural damage caused by shrinking and swelling. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential. Erosion is a hazard in the steeper areas. Only the part of the site that is used for construction should be disturbed. Excavation for houses and access roads, in places, exposes material that is highly susceptible to wind erosion. Deep cuts needed to provide level building sites can expose underlying material that is high in content of lime. Plants native to the area are most suitable for landscaping. Lawn grasses, shrubs, and ornamental trees that tolerate excessive amounts of lime should be selected.

If the Bernardino soil is used for septic tank absorption fields, slow permeability is the main limitation. Absorption lines should be placed below the slowly permeable layer. Increasing the size of the absorption area helps to compensate for the slow permeability. Slope is a concern in installing septic tank absorption fields. Absorption lines should be installed on the contour.

This unit is moderately well suited to desertic herbaceous plants and well suited to shrubs and trees for wildlife.

Bernardino soil is in the Loamy Upland, 12-16" p.z. range site, and the Tombstone soil is in the Limy Slopes, 12-16" p.z. range site.

7—Bernardino-White House complex, 1 to 15 percent slopes.

This map unit is on undulating to rolling fan terraces. Elevation is 3,500 to 5,000 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 40 percent Bernardino gravelly sandy clay loam that has slope gradients of 1 to 15 percent and 40 percent White House gravelly loam that has slope gradients of 1 to 8 percent. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Tombstone and Nalam soils on fan terrace ends, Guest soils on flood plains, and Riveroad and Comoro soils on stream terraces along drainageways. Included areas make up about 20 percent of the total acreage.

The Bernardino soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 20 to 35 percent gravel and a few cobble. The surface layer is reddish brown gravelly sandy clay loam about 2 inches thick. The upper 13 inches

of the subsoil is reddish brown clay and clay loam. The lower 26 inches is pink and light brown loam. The substratum to a depth of 60 inches or more is white loam. In places, these soils are effervescent to the surface. Many soft masses of lime are in the lower part of the subsoil and in the substratum.

Permeability of this Bernardino soil is slow to a depth of 15 inches and moderate below this depth. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is slight.

The White House soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 25 to 35 percent gravel and scattered cobble. The surface layer is reddish brown gravelly loam about 1 inch thick. The subsurface layer is dark reddish gray clay loam, 2 inches thick. The subsoil is dark reddish brown to red clay 33 inches thick. The substratum to a depth of 60 inches or more is yellowish red sandy clay loam. These soils generally are noneffervescent in the upper 20 inches or more. In some areas, the surface layer is very gravelly sandy loam.

Permeability of the White House soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is slight.

Most areas of this unit are used for rangeland. A few areas are used for homesites.

The potential plant community on this unit is mainly sideoats grama, cane bluestem, and black grama. The present vegetation in most areas is mainly grama grasses, mesquite, snakeweed, false-mesquite, and curlymesquite.

This unit is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a problem in some areas; however, brush management is not required to maintain an effective plant cover. Because of slow permeability and medium runoff, this unit responds slowly to good grazing management if the perennial grass cover is depleted. Controlled burning is effective in controlling poisonous half-shrubs such as burroweed and snakeweed on this unit. Other suitable range management practices, such as fencing, livestock watering developments, range seeding, and implementing planned grazing systems, can help to improve grazing distribution and the range condition.

If this unit is used for homesite development, the main limitations are the potential for shrinking and swelling of the subsoil and slope. The effects of shrinking and swelling can be minimized by using

proper engineering designs and by backfilling with material that has low shrink-swell potential. Buildings and roads should be designed to offset the limited ability of the soils in this unit to support a load. Erosion is a hazard in the steeper areas. Only the part of the site that is used for construction should be disturbed. Preserving the existing plant cover during construction helps to control erosion.

If this unit is used for septic tank absorption fields, the main limitations are slow permeability and slope. The limitation of slow permeability can be overcome by removing the soil in the absorption field and then backfilling with more permeable material and by enlarging the absorption field. Installing aerating or holding tanks or using separate absorption fields for kitchen and laundry waste and for toilet water are alternate methods of waste disposal. Slope is a concern in installing septic tank absorption fields. Absorption lines should be installed on the contour.

This unit is moderately well suited to desertic herbaceous plants and well suited to desertic shrubs and trees for wildlife.

This map unit is in capability subclass VI. Both soils in this unit are in the Loamy Upland, 12-16" p.z. range site.

8—Bucklebar-Sahuarita complex, 0 to 3 percent slopes.

This map unit is on nearly level intermediate and low fan terraces incised by narrow drainageways. Elevation is 2,200 to 3,300 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 45 percent Bucklebar sandy loam and 30 percent Sahuarita very gravelly fine sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Yaqui soils on alluvial fans, Hayhook soils on fan terraces, and Tubac soils on basin floors. Also included are small areas of Arizo soils in and along drainageways. Included areas make up about 25 percent of the total acreage.

The Bucklebar soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface layer and upper part of the subsoil is strong brown sandy loam about 9 inches thick. The subsoil is reddish brown loam 28 inches thick. The lower part of the subsoil to a depth of 60 inches or more is strong brown loam. These soils generally are noneffervescent in the upper 30 inches or more. In

some areas, the surface layer is thicker and darker than is typical.

Permeability of the Bucklebar soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The surface layer is erodible, but the subsoil resists erosion and forms the sides and bottoms of shallow gullies or rills. The hazard of wind erosion is moderately high.

The Sahuarita soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 35 to 55 percent gravel. The surface layer is light yellowish brown very gravelly fine sandy loam about 3 inches thick. The subsoil is light yellowish brown fine sandy loam 25 inches thick. The next layer is a buried subsoil of brown loam 17 inches thick and brown very gravelly sandy clay loam 15 or more inches thick. Common fine lime filaments are in the buried subsoil. These soils are calcareous throughout. Depth to the buried subsoil ranges from 20 to 40 inches. In some areas, the surface layer is fine sandy loam.

Permeability of the Sahuarita soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff generally is slow, but the included soils in and near drainageways are subject to rare seasonal periods of flooding because of run-on from adjacent uplands. Runoff is rapid in the many shallow rills and the few deep gullies. The hazard of water erosion is slight. The hazard of wind erosion is very slight.

This unit is used mainly for rangeland. It is also used for homesite development.

The potential plant community on this unit is mainly Arizona cottontop, plains bristlegrass, bush muhly, and grama grasses. The present vegetation in most areas is mainly paloverde, mesquite, burroweed, and triangle bursage.

This unit is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem on much of this unit. The competition from woody plants must be reduced before this unit will respond to grazing management. Other suitable range management practices, such as fencing, livestock watering developments, and range seeding, can help to improve grazing distribution and the range condition.

This unit is moderately well suited to homesite development. The main limitations are the hazard of wind erosion and moderate shrink-swell potential in the Bucklebar soil. Revegetating disturbed areas around construction sites as soon as possible helps to control wind erosion. Plants native to the area are most suitable for landscaping. The effects of

shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Bucklebar soil is in capability subclass VIIc. The Sahuarita soil is in capability subclass VIIs. This unit is in the Sandy Loam Upland, 10-13" p.z. range site.

9—Caralampi very gravelly sandy loam, 5 to 15 percent slopes.

This very deep well drained soil is on rolling fan terraces. It formed in mixed alluvium. Elevation is 3,100 to 5,000 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

Typically, the surface is covered by 40 to 65 percent gravel and cobble. The surface layer is dark brown very gravelly sandy loam about 1 inch thick. The subsoil is reddish brown very gravelly clay loam and extremely gravelly sandy clay loam 27 inches thick. The substratum to a depth of 60 inches or more is light reddish brown and yellowish red extremely gravelly sandy loam. These soils generally are noneffervescent in the upper 30 inches or more. In some areas, the surface layer is very cobbly sandy loam.

Included in this unit are small areas of Nalam and White House soils. Included areas make up about 10 percent of the total acreage.

Permeability of the Caralampi soil is moderately slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight. In the vicinity of Cienega Creek north of Interstate 10 and along Marsh Station Road, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

Most areas of this unit are used for rangeland. A few areas are used for homesite and recreational areas.

The potential plant community on this unit is mainly sideoats grama, sprucetop grama, cane bluestem, and false-mesquite. The present vegetation in most areas is mainly mesquite, curlymesquite, snakeweed, and false-mesquite.

This soil is easily traversed by livestock. It

produces forage for year-round use. Brush encroachment is a problem in some areas; however, brush management is not required to maintain an effective plant cover. Because of moderately slow permeability and rapid runoff, this soil responds slowly to good grazing management if the perennial grass cover is depleted. Controlled burning is effective in controlling poisonous half-shrubs such as burroweed and snakeweed on this soil. Other suitable range management practices, such as fencing, livestock watering developments, range seeding, and implementing planned grazing systems, can help to improve grazing distribution and the range condition.

If this unit is used for septic tank absorption fields, the main limitations are slope and moderately slow permeability. Steepness of slope limits the distribution of effluent, which may surface at points downslope. Placing absorption lines on the contour slows the movement of effluent through the drains and promotes dispersion throughout the absorption field. Absorption lines should be placed below the moderately slowly permeable layer. Increasing the size of the absorption area also helps to compensate for the moderately slow permeability.

This unit is moderately well suited to desertic herbaceous plants and well suited to desertic shrubs and trees for wildlife.

This map unit is in capability subclass VI. This soil is in the Loamy Upland 12-16" p.z. range site.

10—Caralampi extremely gravelly sandy loam, 15 to 45 percent slopes.

This very deep well drained soil is on moderately steep and steep hills. It formed in mixed alluvium. Elevation is 3,200 to 5,000 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

Typically, the surface is covered by 40 to 65 percent gravel and cobble. The surface layer is dark brown extremely gravelly sandy loam about 1 inch thick. The subsoil is reddish brown very gravelly clay loam and extremely gravelly sandy clay loam 27 inches thick. The substratum to a depth of 60 inches or more is light reddish brown and yellowish red extremely gravelly sandy loam. These soils generally are noneffervescent in the upper 30 inches or more. In some areas, the surface layer is very cobbly sandy loam.

Included in this unit are small areas of Tombstone and Nolam soils on steep fan terrace backslopes, White House soils on narrow fan terrace crests, and Riveroad, Keysto and Comoro soils on stream

terraces along narrow drainageways. Included areas make up about 15 percent of the total acreage.

Permeability of the Caralampi soil is moderately slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium to rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

This unit is used for rangeland.

The potential plant community on this unit is mainly sideoats grama, sprucetop grama, cane bluestem, and false-mesquite. The present vegetation in most areas is mainly mesquite, sideoats grama, curlymesquite, snakeweed, and false-mesquite.

This soil is easily traversed by livestock. It produces forage for year-round use. Steepness of slope limits access and results in poor grazing distribution. Brush encroachment is a problem in some areas; however, brush management is not required to maintain an effective plant cover. Because of rapid runoff, this soil responds slowly to good grazing management if the perennial grass cover is depleted. Controlled burning is effective in controlling poisonous half-shrubs such as burroweed and snakeweed on this soil. Other suitable range management practices, such as fencing, livestock watering developments, range seeding, and implementing planned grazing systems, can help to improve grazing distribution and the range condition.

This unit is moderately well suited to desertic herbaceous plants and well suited to desertic shrubs and trees for wildlife.

This map unit is in capability subclass VIIe. This soil is in the Loamy Hills, 12-16" p.z. range site.

11—Cave soils and Urban land, 0 to 8 percent slopes.

This map unit is on nearly level and gently sloping relict fan terraces. Elevation is 2,300 to 3,200 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit has no regular pattern. Every delineation has at least one of the major components and may have both. Each of the components, however, need not be in every delineation. The percentage varies from one area to another.

Included in this unit are small areas of Yaqui soils on lower alluvial fans, Arizo soils on flood plains and Delnorte soils on relict fan terraces, and Mohave, Stagecoach, and Sahuarita soils on fan terraces.

The Cave soil is very shallow and shallow to a lime-cemented hardpan and well drained. It formed in mixed alluvium. Typically, the surface layer is light

brown gravelly fine sandy loam about 4 inches thick. The next layer is a pinkish white gravelly fine sandy loam 3 inches thick. A white indurated lime hardpan (caliche) is at a depth of 7 inches. Under the hardpan from 20 to 60 inches is pale brown gravelly loamy sand. Depth to the hardpan (caliche) ranges from 4 to 20 inches. These soils are calcareous throughout.

Permeability of the Cave soil is moderate. Available water capacity is very low. Effective rooting depth is 4 to 20 inches. Runoff is medium to rapid, and the hazard of water erosion is slight. The hazard of wind erosion is slight.

Urban land consists of areas of soil so altered by construction or obscured by structures and pavement that identification of the soil is difficult or impossible. Most of the Urban land is located in the city of Tucson. In general, the underlying and interspersed soil material has many of the characteristics of the associated soils in this unit.

Most areas of this unit are used for urban development. A few areas are used for rangeland.

The potential plant community on this unit is mainly bush muhly, creosotebush, fluffgrass, and slim tridens. The present vegetation in most areas is mainly creosotebush, range ratany, ocotillo, and fluffgrass.

Included soils in drainageways on this unit produce most of the forage for use by livestock. Grazing management should be focused on improving forage production in these drainageways. Other suitable range management practices, such as fencing and livestock watering developments, can help to improve grazing distribution.

If this unit is used for urban development, the main limitations are depth to hardpan (caliche). Excavation for building sites is limited by the caliche. Heavy machinery is needed for leveling or making shallow excavations for utilities. Sandy and gravelly material below the caliche is subject to caving or slumping if excavations are deep. It is difficult to establish vegetation in areas where the surface layer has been removed, exposing the caliche. In these areas, it is commonly necessary to backfill with several inches of good topsoil. If deep-rooted shrubs and trees are grown, it generally is necessary to excavate pits through the caliche into more suitable and permeable material and to backfill with good soil material and organic matter. Lawn grasses, shrubs, and ornamental trees that tolerate excessive amounts of lime should be selected.

The suitability of the soil for septic tank absorption fields can be improved by ripping the caliche to increase permeability. Because of this restrictive

layer, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VII. The Cave soil is in the Limy Upland, 10-13" p.z. range site.

12—Cellar-Lampshire-Rock outcrop complex, 15 to 60 percent slopes.

This map unit is on moderately steep to steep slopes of hills and mountains. Elevation is 3,400 to 4,000 feet. The mean annual precipitation is 10 to 16 inches, the mean annual air temperature is 57 to 66 degrees F, and the frost-free period is 180 to 280 days.

This unit is 35 percent Cellar very gravelly sandy loam, 30 percent Lampshire very gravelly sandy loam, and 25 percent Rock outcrop. The Cellar soils are on the drier south slopes, and the Lampshire soils are on the wetter north slopes of hills and mountains that have gradients of 15 to 60 percent.

Included in this unit are areas of Pantak soils that have 18 to 35 percent clay, soils that have slopes of less than 15 percent, Chiricahua soils that have greater than 35 percent clay, and soils that have less than 35 percent coarse fragments. Included areas make up about 10 percent of the total acreage.

The Cellar soil is very shallow and shallow and somewhat excessively drained. It formed in alluvium and colluvium from granite. Typically, the brown to dark brown very gravelly sandy loam soil is about 10 inches deep over granite.

Permeability of the Cellar soil is moderately rapid. Effective rooting depth is 6 to 20 inches. Depth to unweathered bedrock is 6 to 20 inches. Available water capacity is very low. Runoff is very rapid. The hazard of water erosion is moderate to severe, and the hazard of wind erosion is very slight.

The Lampshire soil is very shallow and shallow well drained. It formed in alluvium and colluvium from igneous and metamorphic rocks. Typically, the surface layer is very dark grayish brown gravelly sandy loam 2 inches thick. The next layer is very dark gray very gravelly sandy loam 6 inches thick. At 8 inches is unweathered granite.

Permeability of the Lampshire soil is moderate. Effective rooting depth is 4 to 20 inches. Depth to

unweathered bedrock is 4 to 20 inches. Available water-holding capacity is very low. Runoff is very rapid. The hazard of water erosion is moderate to severe, and the hazard of wind erosion is very slight.

Rock outcrop consists of barren rock that occurs as ledges, massive boulder piles, and nearly vertical cliffs of granite, gneiss, and metamorphic and igneous rock. The higher percentage of Rock outcrop is in areas near the hilltops and mountaintops.

This unit is used for rangeland and wildlife habitat.

The potential plant community for the Cellar soil is slender grama, jojoba, paloverde, ocotillo, bush muhly, and janusia. The present vegetation in most areas is mainly mesquite, slender grama, jojoba, paloverde, ocotillo, bush muhly, and janusia.

The potential plant community for the Lampshire soil is sideoats, black grama, hairy grama, slender grama, and sprucetop grama, shrubby buckwheat, and sotol. The present vegetation in most areas is mainly mesquite, sideoats grama, black grama, hairy grama, slender grama, and sprucetop grama, shrubby buckwheat, and sotol.

Potential vegetation is dominated by desert shrubs. Important perennial forage potentially includes bush muhly, slim tridens and big galleta. The majority of perennial forage is provided by seasonally available browse. Production on this site is limited by shallow soils. Livestock movement is hindered by steep cobbly slopes. Proper grazing distribution is difficult on these soils because of steep slopes and the unavailability of water. Overgrazing reduces the plant cover and increases the rate of erosion.

Encourage uniform grazing on these soils by fencing and developing permanent water. Improve distribution and utilization by concentrating a high number of livestock on the area for a short period of time. Stocker-type cattle will utilize forage on steep slopes to a greater degree than cows with calves. Concentrate management on included soils in drainageways where the majority of forage is produced. Control erosion and promote forage production with proper utilization. Provide periodic rest during the growing season to maintain plant vigor and production.

This unit is well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VIIe, nonirrigated. The Cellar and Lampshire soils are in the Granitic Hills, 12-16" p.z. range site.

13—Cellar-Lehmans complex, 5 to 25 percent slopes.

This map unit is on gently sloping to moderately steep hills and pediments. Elevation is 2,200 to 4,000 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 40 percent Cellar extremely gravelly sandy loam and 25 percent Lehmans gravelly sandy clay loam. Also in this unit is about 10 percent Rock outcrop. Cellar soils are on the steeper areas that have gradients of 15 to 25 percent, and Lehmans soils are on less sloping saddles that have gradients of 5 to 15 percent. The Rock outcrop occurs as ledges and boulder piles scattered throughout the unit.

Included in this unit are small areas of Chimenea soils on granite pediments and Tubac, Pinaleno, Stagecoach, and Palos Verdes soils on fan terraces. Also included are small areas of Arizo soils in and along narrow drainageways. Included areas make up about 25 percent of the total acreage.

The Cellar soil is very shallow and shallow and somewhat excessively drained. It formed in alluvium and colluvium derived dominantly from granite and gneiss. Typically, the surface is covered by 50 to 65 percent gravel, cobble, and a few stones. The light yellowish brown and brown extremely gravelly sandy loam soil is about 10 inches deep over granite. Depth to bedrock ranges from 4 to 20 inches. In some areas, the surface layer is very cobbly or stony sandy loam.

Permeability of the Cellar soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 4 to 20 inches. Runoff is very rapid, and the hazard of water erosion is moderate. The hazard of wind erosion is very slight.

The Lehmans soil is shallow and well drained. It formed in mixed alluvium and colluvium. Typically, the surface is covered by 30 percent gravel. The surface layer is reddish brown gravelly sandy clay loam 5 inches thick. The subsoil is reddish brown clay 8 inches thick. Granite is at a depth of 13 inches. These soils generally are not calcareous. Depth to bedrock ranges from 10 to 20 inches. In places, the soil is more acid than typical. In some areas, the surface layer is very gravelly loam or extremely cobbly clay loam.

Permeability of the Lehmans soil is slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is medium to rapid, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

This unit is used mainly for rangeland. A few areas are used for homesite and recreational areas.

The potential plant community on the Cellar soil is mainly bush muhly, Arizona cottontop, slim tridens, and littleleaf paloverde. The potential plant community on the Lehmans soil is jojoba, curlymesquite, and tobosa. The present vegetation in most areas is paloverde, cacti, threeawn, and tobosa.

This unit produces forage for year-round use by livestock. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution on the Cellar soil. Grazing pressure is concentrated on the areas of the Lehmans soil where slopes are more gentle. Grazing management, including use of fencing, livestock watering developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time, improves grazing distribution and the range condition.

If this unit is used for recreational development, the main limitations are depth to bedrock, gravel and cobble on the surface, and slope. Less sloping areas of this unit can be used as campsites, picnic areas, and playgrounds. Paths and trails should be constructed on the contour where possible.

If the Cellar soil is used for homesite development, the main limitations are depth to bedrock and slope. If the Lehmans soil is used for homesite development, the main limitations are depth to bedrock and shrink-swell potential. Excavation for buildings and roads is limited by very shallow and shallow depth to bedrock. Because removal of the bedrock to a suitable depth is costly, consider construction methods that do not involve excavation of the bedrock. Access roads should be designed to control surface runoff and help stabilize cut slopes. The effects of shrinking and swelling can be minimized by using proper engineering designs and backfilling with material that has low shrink-swell potential.

Septic tank absorption fields may not function properly because of the shallow and very shallow depth to bedrock. Consider the use of holding tanks or absorption beds.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Cellar soil is in capability subclass VII_s and in the Shallow Hills, 10-13" p.z. range site. The

Lehmans soil is in capability subclass VII_s and in the Shallow Upland, 10-13" p.z. range site.

14—Cellar-Rock outcrop complex, 30 to 65 percent slopes.

This map unit is on steep and very steep hills at the base of very steep mountains. Elevation is 2,500 to 3,700 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 60 percent Cellar extremely gravelly sandy loam and 20 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Anklam, Chimenea, and Pinaleno soils. Included areas make up 20 percent of the total acreage.

The Cellar soil is very shallow and shallow and somewhat excessively drained. It formed in gravelly alluvium and colluvium derived dominantly from granite and gneiss. Typically, the surface is covered by 50 to 65 percent gravel, cobble, and a few stones. The light yellowish brown and brown extremely gravelly sandy loam soil is about 10 inches deep over granite. Depth to bedrock ranges from 4 to 20 inches. In some areas, the surface layer is very cobbly or very stony sandy loam.

Permeability of the Cellar soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 4 to 20 inches. Runoff is very rapid, and the hazard of water erosion is severe. The hazard of wind erosion is very slight.

Rock outcrop consists of exposures of barren rock that occur as ledges, massive boulder piles, and nearly vertical cliffs of gneiss and granite. The soil and the areas of Rock outcrop are intricately intermingled.

This unit is used mainly for recreational areas. A few areas are used for rangeland.

The potential plant community on the Cellar soil is mainly bush muhly, Arizona cottontop, slim tridens, and club moss. The present vegetation in most areas is paloverde, brittlebush, triangle bursage, and threeawn.

This unit produces forage for year-round use by livestock. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution. Grazing management, including fencing, livestock watering developments, and construction of trails to permit more animals

to graze in smaller areas for shorter periods of time, minimizes grazing distribution problems.

This unit is poorly suited to recreational development. Slope and depth to bedrock limits the use of areas of this unit mainly to a few paths and trails.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Cellar soil is in capability subclass VIIe and in the Shallow Hills, 10-13" p.z. range site. Rock outcrop is in capability class VIII and is not assigned a range site.

15—Chimenea-Cellar-Rock outcrop complex, 15 to 50 percent slopes.

This map unit is on moderately steep and steep hills. Elevation is 2,400 to 4,000 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 40 percent Chimenea very gravelly fine sandy loam that has gradients of 15 to 30 percent, 20 percent Cellar extremely gravelly sandy loam that has gradients of 15 to 50 percent, and 15 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Anklam soils on saddles and Pinaleno, Stagecoach and Palos Verdes soils on fan terraces. Also included are small areas of Arizo soils in and along drainageways. Included areas make up about 25 percent of the total acreage.

The Chimenea soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from granite. Typically, the surface is covered by 45 percent subrounded fine gravel. The surface layer is brown very gravelly fine sandy loam 2 inches thick. The subsoil is reddish brown gravelly sandy clay loam 13 inches thick. Weathered granite (grus) is at a depth of 15 inches. Depth to bedrock ranges from 6 to 20 inches. These soils are generally noncalcareous throughout. In some areas, the surface layer is very cobbly, very stony, or very bouldery sandy loam.

Permeability of the Chimenea soil is moderate. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is very rapid, and the hazard of water erosion

is moderate. The hazard of wind erosion is very slight.

The Cellar soil is very shallow and shallow and somewhat excessively drained. It formed in alluvium and colluvium derived dominantly from granite and gneiss. Typically, the surface is covered by 50 to 65 percent gravel, cobble, and a few stones. The light yellowish brown and brown extremely gravelly sandy loam soil is about 10 inches deep over granite. Depth to bedrock ranges from 4 to 20 inches. In some areas, the surface layer is very cobbly or very stony sandy loam.

Permeability of the Cellar soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 4 to 20 inches. Runoff is very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

Rock outcrop consists of exposures of barren rock that occur as ledges, massive boulder piles, and nearly vertical cliffs of gneiss and granite. The soil and the areas of Rock outcrop are intricately intermingled; however, a higher percentage of Rock outcrop is in areas near the hilltops and mountaintops.

This unit is used mainly for rangeland. A few areas are used for recreation.

The potential plant community on the Chimenea soil is mainly bush muhly, Arizona cottontop, slender grama, and white brittlebush. The potential plant community on the Cellar soil is mainly bush muhly, Arizona cottontop, slim tridens, and littleleaf paloverde. The present vegetation in most areas is paloverde, cacti, bush muhly, and triangle bursage.

This unit produces forage for year-round use by livestock. Steepness of slope, rocky surfaces and areas of Rock outcrop limit access and result in poor grazing distribution. Grazing management, including fencing, livestock watering developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time, minimizes grazing distribution problems.

This unit is poorly suited to recreational development. Slope and depth to bedrock limits the use of areas of this unit mainly to a few paths and trails.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Chimenea soil is in capability subclass VIIs, and the Cellar soil is in capability subclass VIIe. Both soils are in the Shallow Hills, 10-13" p.z. range site. Rock outcrop is in capability class VIII and is not assigned a range site.

16—Chimenea very gravelly fine sandy loam, 5 to 15 percent slopes.

This very shallow and shallow, well drained soil is on strongly sloping pediments. It formed in alluvium and colluvium derived dominantly from granite. Elevation is 2,200 to 3,800 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

Typically, the surface is covered by 45 percent subrounded fine gravel. The surface layer is brown very gravelly fine sandy loam 2 inches thick. The subsoil is reddish brown gravelly sandy clay loam 13 inches thick. Weathered granite (grus) is at a depth of 15 inches. Depth to bedrock ranges from 6 to 20 inches. In some areas, the surface layer is thicker and darker than is typical.

Included in this unit are small areas of Tubac, Palos Verdes, and Pinaleno soils on fan terraces and Lehman's soils on pediment footslopes. Also included are small areas of Arizo soils in drainageways. Included areas make up about 25 percent of the total acreage.

Permeability of the Chimenea soil is moderate. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is medium to rapid, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

Most areas of this unit are used for rangeland. A few areas are used for homesites and urban development.

The potential plant community on this unit is mainly bush muhly, Arizona cottontop, littleleaf paloverde, and triangle bursage. The present vegetation in most areas is mainly triangle bursage, paloverde, brittlebush, cacti, and bush muhly.

This soil is easily traversed by livestock. It produces year-round browse. Livestock prefer this soil to adjacent hills and mountains. Grazing management, including use of fencing and livestock watering developments to control grazing use, can help to improve the range condition.

If this unit is used for homesites or urban development the main limitations are slope and depth to bedrock. Cuts needed to provide essentially level building sites can expose bedrock. Heavy machinery is needed for leveling or making shallow excavations for utilities. Erosion is a hazard in the steeper areas. Only the part of the site that is used for construction should be disturbed. Preserving the existing plant cover during construction helps to control erosion.

Depth to bedrock and slope limits this soil's use for sanitary facilities. Septic tank absorption systems require special design and installation to prevent surfacing of effluent.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VII. This soil is in the Shallow Upland, 10-13" p.z. range site.

17—Chiricahua-Lampshire complex, 5 to 15 percent slopes.

This map unit is on rolling, low, granitic hills and pediments. Elevation is 3,500 to 5,100 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 50 percent Chiricahua very gravelly fine sandy loam and 20 percent Lampshire very gravelly loam. Also in this unit is about 10 percent Rock outcrop. Chiricahua soils are on gently sloping saddles, and Lampshire soils are on moderately steep shoulders and backslopes. The Rock outcrop occurs as ledges and boulder piles scattered throughout the unit.

Included in this unit are small areas of Deloro, Oracle, and Romero soils on hills and mountains and Caralampi soils on fan terraces. Also included are small areas of Keysto and Comoro soils on stream terraces along drainageways. Included areas make up 20 percent of the total acreage.

The Chiricahua soil is shallow and well drained. It formed in mixed alluvium and colluvium. Typically, the surface is covered by 45 percent gravel and cobble. The surface layer is strong brown very gravelly fine sandy loam 1 inch thick. The subsoil is brown clay and gravelly clay 15 inches thick. Fractured bedrock that has clay in the fractures is at a depth of 16 to 23 inches. Unweathered granite is at 23 inches. These soils generally are not calcareous. Depth to bedrock ranges from 10 to 20 inches. In places, bedrock is deeper than typical. In some areas, the surface layer is very cobbly loam or sandy loam.

Permeability of the Chiricahua soil is slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches; however, roots and water may be in fractures to a depth of 60 or more inches. Runoff is medium to rapid, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

The Lampshire soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from granite and gneiss. Typically,

the surface is covered by 50 to 65 percent gravel, cobble, and a few stones. The brown very gravelly loam soil is about 10 inches deep over granite. Depth to bedrock ranges from 7 to 12 inches. In some areas, the surface layer is very cobbly or very stony sandy loam.

Permeability of the Lampshire soil is moderate. Available water capacity is very low. Effective rooting depth is 7 to 12 inches. Runoff is medium to rapid, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

This unit is used mainly for rangeland.

The potential plant community on this unit is mainly sideoats grama, hairy grama, black grama, curlymesquite, and sprucetop grama. The present vegetation in most areas is mesquite, prickly pear, curlymesquite, and false-mesquite.

This unit is easily traversed by livestock. It produces forage for year-round use. Livestock prefer this unit to adjacent hills and mountains. Grazing management, including use of fencing and livestock water developments to control grazing use, can help improve the range condition. Other suitable range management practices, such as brush management and range seeding, can help improve range condition.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

Both of the soils in this map unit are in capability subclass VI_s and the Shallow Upland, 12-16" p.z. range site.

18—Combate gravelly loamy coarse sand, 2 to 8 percent slopes.

This very deep well drained soil is on gently sloping alluvial fans at the base of granitic mountains. It formed in alluvium derived dominantly from granite. Elevation is 2,900 to 4,600 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

Typically, the surface layer is brown gravelly loamy coarse sand 1 inch thick. The subsurface is dark grayish brown gravelly loamy coarse sand 14 inches thick. The substratum to a depth of 60 inches or more is brown to dark brown and yellowish brown gravelly coarse sandy loam.

Included in this unit are small areas of Keysto, Comoro, and Diaspar soils. Included areas make up about 15 percent of the total acreage.

Permeability of the Combate soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 or more inches. Runoff is medium,

and the hazard of water erosion is slight. The hazard of wind erosion is moderately high.

This unit is used mainly for rangeland.

The potential plant community on this unit is mainly Arizona cottontop, Rothrock grama, sideoats grama, and black grama. The present vegetation in most areas is soaptree yucca, desert hackberry, Arizona cottontop, mesquite, and burroweed.

This unit is easily traversed by livestock. It produces forage for year-round use. Brush encroachment can be a serious problem. However, the soil responds well to good grazing management practices and is one of the best upland range sites in the survey area. Controlled burning is effective in controlling poisonous half-shrubs such as snakeweed and burroweed on this unit. Other suitable range management practices such as fencing, livestock watering developments, and range seeding can help improve grazing distribution and the range condition.

This unit is moderately well suited to desertic herbaceous plants and well suited to desertic shrubs and trees for wildlife.

The Combate soil is in capability subclass VI_s and in the Sandy Loam (Deep), 12-16" p.z. range site.

19—Comoro sandy loam, 0 to 2 percent slopes.

This very deep and well drained soil is on nearly level flood plains. It formed in mixed alluvium. Elevation is 2,600 to 3,800 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

Typically, the surface layer is very dark grayish brown sandy loam about 4 inches thick. The subsurface layer is very dark grayish brown sandy loam 33 inches thick. The substratum to a depth of 60 inches or more is brown to dark brown fine sandy loam. In some areas, the surface layer is lighter in color than is typical.

Included in this unit are small areas of riverwash in drainageways and Riveroad and Keysto soils on stream terraces. Included areas make up about 20 percent of the total acreage.

Permeability of the Comoro soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. This map unit is subject to rare flooding. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderately high.

This unit is used mainly for rangeland. A few areas are used for urban development, recreational areas, irrigated cropland, hay, and pasture.

The potential plant community on this unit is mainly Arizona cottontop, threeawn, sideoats grama, and spike dropseed. The present vegetation in most areas is mesquite, burroweed, and threeawn.

This unit is easily traversed by livestock. It produces forage for year-round use. Brush encroachment can be a serious problem. Changes in perennial grass cover are obvious in wet versus dry years because of the low water-holding capacity of the soil; however, the soil responds well to good grazing management practices. Controlled burning is effective in controlling poisonous half-shrubs such as snakeweed and burroweed on this unit. Other suitable range management practices, such as fencing, livestock watering developments and range seeding, can help improve grazing distribution and the range condition.

This unit is moderately well suited to irrigated crops. It is limited mainly by brief periods of flooding and low water-holding capacities. The risk of flooding can be reduced by the use of dikes, levees, and diversions. Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop grown. To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. For the efficient application and removal of irrigation water, leveling is needed in sloping areas. Use of pipe, ditch lining, or drop structures in irrigation ditches facilitates irrigation and reduces ditch erosion. Crop residue left on or near the surface helps conserve moisture, maintain tilth and control erosion. The organic matter content can be maintained and improved by using all crop residue, plowing under cover crops, and using a suitable rotation. Crops respond to nitrogen and phosphorus fertilizer.

The Comoro soil is well suited to hay and pasture land. The main limitation is droughtiness. Irrigation water can be applied by the sprinkler or surface irrigation methods. Leveling helps to insure the uniform application of water. Fertilizer is needed to insure optimum growth of grasses and legumes.

If this unit is used for urban development, the main limitations are flooding in unprotected areas, unstable cutbanks, and the hazard of wind erosion in disturbed areas. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Roads and streets should be located above the expected flood level. Shallow excavation for utilities or foundations need adequate shoring or backsloping

to prevent slumping. Revegetating disturbed areas around construction sites as soon as possible helps to control wind erosion.

This unit is well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is moderately well suited to irrigated grain and seed crops and irrigated domestic grasses and legumes for wildlife.

The Comoro soil is in capability subclass IIs, irrigated, and VIIs, nonirrigated. This unit is in the Sandy Bottom, 12-16" p.z. range site.

20—Cortaro-Rock outcrop-Faraway complex, 15 to 45 percent slopes.

This map unit is on moderately steep and steep granitic and gneissic hills and mountains. Elevation is 5,400 to 6,200 feet but may range as low as 4,600 feet on north-facing slopes. The mean annual precipitation is 16 to 20 inches, the mean annual air temperature is 55 to 57 degrees F, and the frost-free period is 160 to 180 days.

This unit is 40 percent Cortaro extremely gravelly sandy loam, 20 percent Rock outcrop, and 15 percent Faraway extremely gravelly sandy loam.

Included in this unit are small areas of Pantak, Lampshire, Deloro, Oracle, and Romero soils at lower elevations or on south-facing slopes. Also included are small areas of Far, Lemmon, and Spudrock soils at higher elevations or on north-facing slopes. Included areas make up about 25 percent of the total acreage.

The Cortaro soil is shallow and well drained. It formed in alluvium and colluvium derived dominantly from granite, gneiss, and schist. Typically, the surface is covered by 50 to 65 percent gravel and cobble and 10 to 15 percent stones. The surface layer is brown extremely gravelly sandy loam about 3 inches thick. The substratum is pale brown very gravelly sandy loam 9 inches thick over unweathered gneiss. Depth to bedrock ranges from 12 to 20 inches. In some areas, the surface layer is very cobbly or stony sandy loam.

Permeability of the Cortaro soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 12 to 20 inches. Roots and water may be in fractures to a depth of 60 inches or more. Runoff is very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

Rock outcrop consists of exposures of barren rock that occur as ledges, massive boulder piles, and nearly vertical cliffs of gneiss, granite, quartz monzonite, and schist that are extremely resistant to

weathering. The soil and the areas of Rock outcrop are intricately intermingled; however, a higher percentage of Rock outcrop is in areas near the hilltops and mountaintops.

The Faraway soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from granite, gneiss, and similar rock. Typically, the surface is covered by 65 percent gravel, cobble, and a few stones. Typically, the Faraway soil is very dark grayish brown extremely gravelly sandy loam about 8 inches deep over unweathered gneiss. Depth to bedrock ranges from 5 to 20 inches. In some areas, the surface layer is very cobbly loam.

Permeability of the Faraway soil is moderate. Available water capacity is very low. Effective rooting depth is 5 to 20 inches. Runoff is very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

This unit is used mainly for rangeland. It is also used for recreation.

The potential plant community on the Cortaro and Faraway soils is mainly sideoats grama, Texas bluestem, plains lovegrass, bullgrass, and scattered Emory, Mexican blue, and Arizona white oaks. The present vegetation in most areas is mainly Arizona white oak, Mexican pinyon, alligator juniper, manzanita, and Emory oak that has an understory of silktassel, datil yucca, shrubby buckwheat, and perennial grasses.

This unit produces forage for year-round use. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution. Fencing, livestock watering developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time help to overcome the grazing distribution problems. Controlled burning help to improve grazing distribution and the range condition.

This unit is poorly suited to recreational development. Less sloping areas of the unit can be used as campsites, picnic areas, and playgrounds. Paths and trails should be constructed on the contour where possible. The areas of Rock outcrop provide nesting areas for birds of prey.

This unit is poorly suited to wild herbaceous plants, hardwood, and coniferous trees for wildlife. It is moderately well suited to shrubs and vines.

The Cortaro soil is in capability subclass VIIe and in the Granitic Hills, 16-20" p.z. range site. Rock outcrop is not assigned range site and is in capability class VIII. The Faraway soil is in capability subclass VIIe and in the Granitic Hills, 16-20" p.z. range site.

21—Dateland-Denure association, 1 to 3 percent slopes.

This map unit is on nearly level fan terraces. Elevation is 1,700 to 2,000 feet. The mean annual precipitation is 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

This unit is 50 percent Dateland fine sandy loam and 35 percent Denure gravelly sandy loam. The Dateland soils are on the lower end of the fan terraces that have slopes of 1 to 2 percent. The Denure soils are on the upper end of the fan terraces that have slopes of 1 to 3 percent.

Included in this unit are areas of soils that contain more than 35 percent gravel and cobble, soils that are sandy and gravelly in drainageways that flood, soils that have gravelly subhorizons, soils that receive extra runoff water, Pahaka soils that have sandy loam surface textures to moderate depths over sand clay loam textures, Dateland soils that have sandy loam surface textures, and soils that are calcareous throughout. Included areas make up about 15 percent of the total acreage.

The Dateland soil is very deep and well drained. It formed in mixed fan alluvium. Typically, the surface layer and upper part of the subsoil is yellowish brown fine sandy loam 7 inches thick. The subsoil is light yellowish brown and light brown loam 23 inches thick. The next layer is light brown silt loam 22 inches thick. The substratum to a depth of 60 inches or more is brown loam. These soils generally have less than 10 percent calcium carbonate throughout.

Permeability of the Dateland soil is moderate. Available water capacity is moderate. Runoff is slow. The hazard of water erosion is slight, and the hazard of wind erosion is moderately high.

The Denure soil is very deep and somewhat excessively drained. It formed in mixed alluvium. Typically, the surface is light yellowish brown gravelly sandy loam 2 inches thick. The subsoil is strong brown gravelly sandy loam 15 inches thick. The substratum is reddish yellow very gravelly sandy loam 24 inches thick over a buried subsoil of yellowish red very gravelly sandy loam. These soils generally have less than 15 percent calcium carbonate throughout.

Permeability of the Denure soil is moderately rapid. Available water capacity is low. Runoff is slow. The hazard of water erosion is slight, and the hazard of wind erosion is moderately high. Salinity is none to very slight.

This unit is used for rangeland.

The potential plant community on this unit is mainly creosotebush, white bursage, bush muhly, annual grasses, and forbs. The present vegetation in most areas is mainly creosotebush, mesquite, annual grasses, and forbs.

This unit is easily traversed by livestock. Production of forage for livestock grazing is limited by low rainfall. Forage production, consisting of annual forbs and grasses, can be high in years of good winter and spring precipitation. Grazing management to improve grazing distribution is most economically practiced by turning on and off livestock water developments.

Leveling this soil to a flat grade permits more efficient use of irrigation water. Crop rotation and the incorporation of crop residue into the soil or the regular addition of other organic matter will improve fertility and increase both the water intake rate and available water capacity. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help maintain fertility and tilth. Wind erosion can be reduced by keeping the soil rough and cloddy when it is not protected by vegetation. When land leveling cuts are made, onsite investigation is needed. Because of the moderately rapid permeability, water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Excessive cultivation can result in the formation of a tillage pan. This can be broken by ripping when the soil is dry. This increases the effective rooting depth.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is well suited to irrigated grain and seed crops and to irrigated domestic grasses and legumes for wildlife.

The Dateland soil is in capability class IIe, irrigated, and VIIe, nonirrigated. The Denure soil is in capability class IIIs, irrigated, and VIIs, nonirrigated. The Dateland and Denure soils are in the Limy Fan, 7-10" p.z. range site.

22—Delnorte-Stagecoach complex, 1 to 20 percent slopes.

This map unit is on strongly sloping fan terraces. Elevation is 2,300 to 3,400 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 40 percent Delnorte extremely cobbly fine sandy loam and 35 percent Stagecoach very gravelly sandy loam.

Included in this unit are small areas of Nahda soils on shoulders of fan terraces, Cave and Mohave soils on lower fan terraces, and Lajitas and Lehman soils on basalt hills. Also included are small areas of Arizo soils in drainageways. Included areas make up about 25 percent of the total acreage.

The Delnorte soil is very shallow and shallow to a lime-cemented hardpan and somewhat excessively drained. It formed in mixed alluvium. Typically, the surface is covered by 30 percent gravel, 30 percent cobble, and 10 percent stones. The surface layer is pale brown extremely cobbly fine sandy loam 4 inches thick. The subsurface layer is pale brown extremely cobbly loam 5 inches thick. White, indurated, lime-cemented hardpan is at a depth of 9 inches. Under the hardpan is very gravelly sandy loam to extremely gravelly sand. These soils are calcareous throughout. Depth to the hardpan ranges from 6 to 20 inches. In some areas, the surface layer is very gravelly sandy loam.

Permeability of the Delnorte soil is moderate. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is medium to rapid, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is very slight.

The Stagecoach soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 50 to 65 percent gravel and cobble. The surface layer is light brown very gravelly sandy loam 10 inches thick. The subsoil is a pink, pinkish gray and pinkish white very gravelly loam and extremely gravelly loam 30 inches thick. The substratum to a depth of 60 inches or more is light brown very gravelly loamy sand. Many soft masses of lime are in the subsoil and substratum. These soils are calcareous throughout. In some areas, the surface layer is very cobbly sandy loam. In a few places, caliche is at a depth of 40 inches or more.

Permeability of the Stagecoach soil is moderate. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow to rapid, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is very slight. In the vicinity of the San Pedro River, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

Most areas of this unit are used for rangeland. A few areas are used for homesites and urban development.

The potential plant community on this unit is mainly bush muhly, creosotebush, fluffgrass, red

grama, and slim tridens. The present vegetation in most areas is mainly creosotebush, paloverde, ocotillo, and fluffgrass.

Included soils in drainageways on this unit produce most of the forage for use by livestock. Grazing management should be focused on improving forage production in these drainageways. Other suitable range management practices, such as fencing and livestock watering developments, can help to improve grazing distribution.

If this unit is used for homesites or urban development, the main limitations are depth to the hardpan and slope. Excavation for building sites is limited by the hardpan. Heavy machinery is needed for leveling or making shallow excavations for utilities. Sandy and gravelly material below the hardpan is subject to caving or slumping if excavations are deep. Removal of gravel and cobble in disturbed areas is needed for best results when landscaping, particularly in areas used for lawns. It is difficult to establish vegetation in areas where the surface layer has been removed, exposing the hardpan. In these areas it is commonly necessary to backfill with

several inches of good topsoil. If deep-rooted shrubs and trees are grown, it generally is necessary to excavate pits through the hardpan into more suitable and permeable material and to backfill with good soil material and organic matter. Lawn grasses, shrubs, and ornamental trees that tolerate excessive amounts of lime should be selected.

The suitability of the soil for septic tank absorption fields can be improved by ripping the hardpan to increase permeability. Because of this restrictive layer, onsite sewage disposal systems often fail or do not function properly during periods of high rainfall. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VII_s. The Delnorte soil is in the Limy Upland, 10-13" p.z. range site. The Stagecoach soil is in a Limy Upland (Deep), 10-13" p.z. range site.



Figure 5.—Roadcut through Andrada soil in a typical area of Deloro-Andrada complex, 5 to 35 percent slopes.

23—Deloro-Andrada complex, 5 to 35 percent slopes.

This map unit is on rolling pediments and steep hills. Elevation is 3,500 to 5,000 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days (fig. 5).

This unit is 40 percent Deloro extremely channery loam and 30 percent Andrada very gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Graham, Mabray, Romero, and White House soils. Also included are small areas of Caralampi, Tombstone, Kimrose family, Powerline, and Nolam soils on fan terraces and alluvium overlying pediments and Rock outcrop. Included areas make up about 30 percent of the total acreage.

The Deloro soil is shallow and well drained. It formed in mixed alluvium and colluvium. Typically, the surface is covered by 50 to 65 percent channers and flagstones and 10 percent stones. The surface layer is brown to dark brown extremely channery loam about 2 inches thick. The subsoil is reddish brown extremely channery clay 9 inches thick. Fractured and weathered phyllite that has clay in the fractures is to a depth of 60 inches or more. These soils generally are noncalcareous throughout. Depth to bedrock ranges from 10 to 20 inches. In some areas, the surface layer is very gravelly clay loam. In a few places, the subsoil has less gravel than is typical. In addition, in some areas the soil is calcareous throughout.

Permeability of the Deloro soil is slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is rapid to very rapid, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is very slight.

The Andrada soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from sandstone, shale, conglomerate, and related sedimentary rock. Typically, the surface is covered by 60 percent fine and medium angular gravel. The surface layer is dark grayish brown very gravelly loam about 8 inches thick. The subsoil is light brownish gray extremely gravelly loam 3 inches thick over lime-coated weathered sandstone. Many soft masses of lime are

in the subsoil. Depth to bedrock ranges from 6 to 20 inches. In some areas, the surface layer is thinner and lighter in color.

Permeability of the Andrada soil is moderate. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is medium to very rapid, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is very slight.

This unit is used for rangeland.

The potential plant community on the Deloro soil is mainly sideoats grama, curlymesquite, and slender grama. The potential plant community on the Andrada soil is mainly sideoats grama, black grama, wolftail, and ocotillo. The present vegetation in most areas is mainly pricklypear, curlymesquite, black grama, sideoats grama, false-mesquite, and ocotillo.

This unit produces forage for year-round use. Livestock prefer the vegetation on the Deloro soil causing increased grazing pressure on this portion of the unit. Steeper areas of this unit limit access by livestock. Grazing management, including fencing and livestock watering developments to permit more animals to graze in smaller areas for shorter periods of time, helps to overcome the grazing distribution problems.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Deloro soil is in capability subclass VI₁ and in the Volcanic Hills, 12-16" p.z. range site. The Andrada soil is in capability subclass VI₂ and in the Limy Slopes, 12-16" p.z. range site.

24—Deloro-Rock outcrop complex, 15 to 60 percent slopes.

This map unit is on moderately steep to steep hills and mountains. Elevation is 3,600 to 5,200 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 60 percent Deloro extremely channery loam that has slope gradients of 15 to 45 percent and 15 percent Rock outcrop. Also in this unit is about 10 percent Andrada very gravelly loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Lampshire, Mabray, Oracle, and Romero soils. Also included are

small areas of Keysto soils in and along drainageways. Included areas make up about 15 percent of total acreage.

The Deloro soil is shallow and well drained. It formed in mixed alluvium and colluvium. Typically, the surface is covered by 50 to 65 percent channers and flagstones and 10 percent stones. The surface layer is brown to dark brown extremely channery loam about 2 inches thick. The subsoil is reddish brown extremely channery clay 9 inches thick. Fractured and weathered phyllite that has clay in the fractures is to a depth of 60 inches or more. These soils generally are noncalcareous throughout. Depth to bedrock ranges from 10 to 20 inches. In some areas, the surface layer is very gravelly clay loam. In a few places, the subsoil has less gravel than is typical. In addition, in some areas the soil is calcareous to the surface.

Permeability of the Deloro soil is slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

Rock outcrop consists of shale, quartzite, sandstone, and rhyolite occurring as ledges and dikes. The soil and the areas of Rock outcrop are intricately intermingled; however, a higher percentage of Rock outcrop is in areas near the hilltops and mountaintops.

Most areas of this unit are used for rangeland. A few areas are used for mining activities.

The potential plant community on the Deloro soil is mainly grama grasses, curlymesquite, and false-mesquite. The present vegetation in most areas is mainly slender grama, pricklypear, curlymesquite, calliandra, and shrubby buckwheat.

This unit produces forage for year-round use. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution. Fencing, livestock watering developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time, helps to overcome the grazing distribution problems. Controlled burning and brush management help to improve grazing distribution and the range condition.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Deloro soil is in capability subclass VIIe and

in the Volcanic Hills, 12-16" p.z. range site. Rock outcrop is not assigned a range site and is in capability class VIII.

25—Deloro-Schrap association, 1 to 8 percent slopes.

This map unit is on undulating pediments. Slopes are 1 to 8 percent but range to 15 percent on some backslopes. Elevation is 3,600 to 5,000 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 55 percent Deloro extremely channery loam and 30 percent Schrap very channery loam. Deloro soils are on gently sloping summits that have slope gradients of 1 to 8 percent, and Schrap soils are on backslopes that have slope gradients of 5 to 8 percent.

Included in this unit are small areas of Andrada, Lampshire, and Romero soils. Also included are small areas of Caralampi, Tombstone, Nolam, and White House soils on fan terraces and alluvium overlying pediments. Included areas make up about 15 percent of the total acreage.

The Deloro soil is shallow and well drained. It formed in mixed alluvium and colluvium. Typically, the surface is covered by 50 to 65 percent channers and flagstones and 10 percent stones. The surface layer is brown to dark brown extremely channery loam about 2 inches thick. The subsoil is reddish brown extremely channery clay 9 inches thick. Fractured and weathered phyllite that has clay in the fractures is to a depth of 60 inches or more. These soils generally are noncalcareous throughout. In a few places, the subsoil has less gravel than is typical. In addition, in some areas the subsoil has less clay than is typical. Depth to bedrock ranges from 10 to 20 inches.

Permeability of the Deloro soil is slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

The Schrap soil is very shallow and shallow and well drained. It formed in mixed alluvium and colluvium. Typically, the surface is covered by 45 to 65 percent channers and gravel. The surface layer is light reddish brown very channery loam about 2 inches thick. The substratum is yellowish red very channery loam 9 inches thick over red and pinkish

gray fractured schist. Depth to bedrock ranges from 4 to 12 inches. In some areas, the surface layer is very gravelly loam.

Permeability of the Schrap soil is moderate. Available water capacity is very low. Effective rooting depth is 4 to 12 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

This unit is used for rangeland.

The potential plant community on the Deloro soil is mainly curlymesquite, grama grasses, and false-mesquite. The potential plant community on the Schrap soil is mainly grama grasses, threeawn, shrubby buckwheat, and false-mesquite. The present vegetation in most areas is mainly broom snakeweed, grama grasses, ocotillo, and false-mesquite.

This unit is easily traversed by livestock. It produces forage for year-round use. Livestock prefer this unit to adjacent hills and mountains. Grazing management, including use of fencing and livestock watering developments to control grazing use, can help to improve the range condition. Other suitable range management practices, such as brush management and range seeding, can help to improve the range condition.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VI. Both soils in this unit are in the Shallow Upland, 12-16" p.z. range site.

26—Denure gravelly sandy loam, 1 to 5 percent slopes.

This very deep and somewhat excessively drained soil is on gently sloping fan terraces incised by narrow drainageways. It formed in mixed alluvium. Elevation is 1,700 to 2,200 feet. The mean annual precipitation is 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

Typically, the surface is covered by 15 to 25 percent fine gravel. The surface layer is strong brown gravelly sandy loam about 4 inches thick. The subsoil is strong brown gravelly sandy loam, 13 inches thick. The substratum is reddish yellow very gravelly sandy loam, 24 inches thick over a buried subsoil of yellowish red very gravelly sandy loam. The soil is slightly calcareous in the substratum and buried subsoil. In places, the buried subsoil is deeper than typical. In some areas, the

surface layer is gravelly loamy sand, sandy loam, or loamy sand.

Included in this unit are small areas of Mohall, Pinamt, and Pahaka soils. Also included are small areas of sandy alluvial soils in and along narrow drainageways. Included areas make up about 15 percent of the total acreage.

Permeability of this Denure soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff generally is slow to medium, but the included soils in and near drainageways are subject to rare seasonal periods of flooding because of run-on from adjacent uplands. The hazard of water erosion is slight. The hazard of wind erosion is moderately high.

This unit is used for rangeland.

The potential plant community on this unit is mainly big galleta, white ratany, triangle bursage, bush muhly, and littleleaf paloverde. The present vegetation in most areas is mainly littleleaf paloverde, mesquite, ironwood, and triangle bursage.

This soil is easily traversed by livestock. It produces forage for year-round use. Carrying capacities are generally low except in years when precipitation in winter and spring is good. This soil responds to grazing management. Grazing management, such as turning on and off livestock watering developments, can help to improve grazing distribution economically.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is moderately well suited to irrigated grain and seed crops and well suited to irrigated domestic grasses and legumes for wildlife.

This map unit is in capability subclass VII. This soil is in the Sandy Loam Upland, 7-10" p.z. range site.

27—Diaspar sandy loam, 1 to 5 percent slopes.

This very deep and well drained soil is on gently sloping fan terraces incised by narrow drainageways. It formed in alluvium derived dominantly from granite and schist. Elevation is 3,200 to 3,600 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

Typically, the surface is covered by 10 to 15 percent fine gravel. The surface layer is light brown sandy loam about 2 inches thick. The upper 26 inches of the subsoil is brown and yellowish red gravelly sandy loam. The next 13 inches is reddish yellow sandy clay loam. The substratum is light

yellowish brown gravelly loam and very gravelly loam to 60 inches and more. These soils generally are noncalcareous throughout. In some areas, the surface layer is gravelly sandy loam.

Included in this unit are small areas of Altar, Caralampi, and Sasabe soils and soils that average more than 18 percent clay. Also included are small areas of Keysto soils in and along narrow drainageways. Included areas make up about 25 percent of the total acreage.

Permeability of this Diaspar soil is moderately rapid in the upper part and moderate in the lower part. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff generally is medium, but the included soils in and near drainageways are subject to rare seasonal periods of flooding because of run-on from adjacent uplands. The hazard of water erosion is slight. The hazard of wind erosion is moderately high.

This unit is used for rangeland. Some areas are used for irrigated hayland and peach orchards.

The potential plant community on this unit is mainly Arizona cottontop, plains bristlegrass, grama grasses, and threeawn. The present vegetation in most areas is mainly burroweed, mesquite, threeawn, and broom snakeweed.

This soil is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem. Competition from woody plants must be reduced before an effective cover of perennial grass can be maintained. It responds well to good grazing management practices and is potentially one of the best upland range sites in the survey area. Controlled burning is effective in controlling poisonous half-shrubs such as snakeweed and burroweed on this soil. Other suitable range management practices, such as fencing, livestock watering developments, and range seeding, can help to improve grazing distribution and the range condition.

This unit is poorly suited to irrigated crops. It is limited mainly by wind erosion, content of coarse fragments, and variation in permeability. Because of moderately rapid permeability in the upper profile and moderately slow permeability in the lower profile, care should be given to any land leveling operations. Returning crop residue to the soil or regularly adding other organic matter improves fertility and increases the water intake rate. Crop residue left on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Wind erosion can be controlled by keeping the soil rough and cloddy when it is not protected by vegetation.

This unit is well suited to desertic herbaceous plants and moderately well suited to desertic shrubs and trees for wildlife. It is well suited to irrigated grain and seed crops and irrigated domestic grasses and legumes for wildlife.

This map unit is in capability subclass VI_s, nonirrigated, and II_e, irrigated. This soil is in the Sandy Loam Upland, 12-16" p.z. range site.

28—Far-Spudrock-Rock outcrop complex, 35 to 85 percent slopes.

This map unit is on moderately steep to very steep slopes of mountains. Elevation is 5,300 to 7,500 feet. The mean annual precipitation is 20 to 24 inches, the mean annual air temperature is 45 to 54 degrees F, and the frost-free period is 140 to 170 days.

This unit is 40 percent Far very gravelly sandy loam, 30 percent Spudrock stony fine sandy loam, and 25 percent Rock outcrop. Far and Spudrock soils are mountains with slope gradients of 35 to 65 percent. The Rock outcrop has slope gradients of 35 to 85 percent.

Included in this unit are areas of soils that are moderately deep to deep to bedrock, soils that have slopes less than 15 percent or greater than 65 percent, soils that have less organic matter, and soils that have loam surface textures. Included areas make up about 5 percent of the total acreage.

The Far soil is very shallow and shallow well drained. It formed in slope alluvium and colluvium from granite and gneiss. Typically, the surface layer is grayish brown to dark grayish brown gravelly fine sandy loam 2 inches thick. The subsoil is grayish brown very gravelly fine sandy loam 6 inches thick. At 8 inches is unweathered gneiss.

Permeability of the Far soil is moderately rapid. Effective rooting depth is 5 to 20 inches. Depth to unweathered bedrock is 5 to 20 inches. Available water capacity is very low. Runoff is very rapid. The hazard of water erosion is severe, and the hazard of wind erosion is very slight.

The Spudrock soil is moderately deep and well drained. It formed in slope alluvium and colluvium from granite and gneiss. Typically, the surface is covered by a mat of dark grayish brown oak and pinyon forest litter about 1 inch thick. The surface layer is very dark grayish brown stony fine sandy loam 3 inches thick. The subsoil is pale brown very channery fine sandy loam 14 inches thick. The substratum is light yellowish brown very channery fine sandy loam 7 inches thick over weathered gneiss.

Permeability of the Spudrock soil is moderately rapid. Effective rooting depth is 20 to 40 inches. Depth to bedrock is 20 to 40 inches. Available water capacity is very low. Runoff is very rapid. The hazard of water erosion is severe, and the hazard of wind erosion is very slight.

Rock outcrop consists of areas of exposed gneiss, granite, and schist in the form of ledges, columns, and boulders larger than 10 feet in diameter and vertical cliffs. Rock outcrop also includes areas where the depth to bedrock is less than 4 inches or areas near the mountaintops.

This unit is used for rangeland and wildlife habitat.

The potential plant community for this unit is mainly sideoats and hairy grama, plains lovegrass, bullgrass, Texas bluestem oak, Mexican blue oak, Arizona white oak, Emory oak, silverleaf oak, alligator juniper, and Mexican pinyon. The present vegetation in most areas is mainly sideoats and hairy grama, plains lovegrass, bullgrass, Texas bluestem, Mexican blue oak, Arizona white oak, silverleaf oak, and Emory oak, Mexican pinyon, and alligator juniper.

This unit produces forage for year-round use. Steep slopes, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution.

Fencing, livestock water developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time can help overcome the grazing distribution problems which exist. Controlled burning and brush management help improve grazing distribution and range conditions.

This unit is well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VIIe. The Far and Spudrock soils are woodland sites in the Granitic Hills, 20-24" p.z.

29—Glendale-Bucklebar complex, 0 to 3 percent slopes.

This map unit is on nearly level stream terraces. Elevation is 2,200 to 2,800 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 40 percent Glendale silt loam and 35 percent Bucklebar sandy loam.

Included in this unit are Arizo soils on flood plains below Glendale soils, Yaqui soils on alluvial fans, and Hayhook and Sahuarita soils on fan terraces. Included areas make up about 25 percent of the total acreage.

The Glendale soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface layer is light yellowish brown silt loam about 4 inches thick. The subsoil is pale brown and yellowish brown stratified clay loam 26 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown loam. In places, lime is disseminated throughout the soil.

Permeability of the Glendale soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to rare flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks. Shallow rills are in some areas, and deposition of soil around the vegetation in these areas is common. The hazard of wind erosion is moderate.

The Bucklebar soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface layer is strong brown sandy loam about 9 inches thick. The subsoil is reddish brown loam 28 inches thick. The substratum to a depth of 60 inches or more is strong brown loam. Lime masses are common in the lower subsoil. In some areas, the surface layer is thicker and darker than is typical.

Permeability of the Bucklebar soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The surface layer is erodible, but the subsoil resists erosion and forms the sides and bottoms of shallow gullies or rills. The hazard of wind erosion is moderately high.

This unit is used mainly for rangeland.

The potential plant community on the Glendale soil is mainly mesquite, bush muhly, whiplash pappusgrass, Arizona cottontop, and fourwing saltbush. The present vegetation in most areas is mesquite.

The potential plant community on the Bucklebar soil is mainly Arizona cottontop, threeawn, Rothrock grama, and bush muhly. The present vegetation in most areas is mainly burroweed, mesquite, and triangle bursage.

This unit is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem on much of this unit. The competition from woody plants must be reduced before this unit will respond to grazing management. Other suitable range management practices, such as fencing, livestock watering developments, and range seeding, can help to improve grazing distribution and the range condition.

This unit is well suited to desertic herbaceous plants and moderately well suited to desertic shrubs and trees for wildlife.

Both the Glendale and Bucklebar soils are in capability subclass VIIc, nonirrigated. The Glendale soil is in the Loamy Bottom, 10-13" p.z. range site and the Bucklebar soil is in the Sandy Loam Upland, 10-13" p.z. range site.

30—Glendale silt loam, 0 to 3 percent slopes.

This very deep well drained soil is on nearly level stream terraces. It formed in mixed alluvium. Elevation is 2,200 to 2,800 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

Typically, the surface layer is light yellowish brown silt loam about 4 inches thick. The subsoil is pale brown and yellowish brown stratified clay loam 26 inches thick. The substratum to a depth of 60 inches or more is light yellowish brown loam. The soil has disseminated lime throughout. In places, the subsoil has more fine and very fine sand and less clay than is typical. In some areas, the surface layer is loam or fine sandy loam.

Included in this unit are small areas of Arizo soils and riverwash in drainageways. Also included are small areas of Anthony and Yaqui soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Glendale soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to rare flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks. Shallow rills are in some areas, and deposition of soil around the vegetation in these areas is common. The hazard of wind erosion is moderate. In the vicinity of the San Pedro River, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

This unit is used mainly for rangeland. It is also used for irrigated cropland and hay and pasture land.

The potential plant community on this unit is mainly bush muhly, threeawn, Arizona cottontop, Pima pappusgrass, and fourwing saltbush. The present vegetation in most areas is mainly mesquite, whitethorn, wolfberry, and fourwing saltbush.

This soil is easily traversed by livestock. It

produces forage for year-round use. Livestock prefer this soil because of availability of shade, easy access, and seasonal water from the flooding of shallow drainageways. When the protective plant cover is depleted by overgrazing, the soil is susceptible to rill and gully erosion. Grazing management, including use of fencing, can help to improve the use of forage produced after flooding and maintain the plant cover. Brush management is needed to control mesquite encroachment. Other suitable range management practices, such as livestock watering developments, range seeding, gully control, and water-spreading systems, can help to improve grazing distribution and the range condition.

This unit is well suited to hay and pasture. It has few limitations. Irrigation water can be applied by the sprinkler or border methods. Leveling helps to insure the uniform application of water.

This unit is suited to irrigated crops. It is limited mainly by seasonal flooding and wind erosion. The risk of flooding can be reduced by the use of levees, dikes, and diversions. Because of the moderately slow permeability of the soil in this unit, the length of runs should be properly designed. For the efficient application and removal of irrigation water, leveling is needed in sloping areas. Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting, and increases the water intake rate. Crop residue left on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Wind erosion can be controlled by keeping the soil rough and cloddy when it is not protected by vegetation.

This unit is well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is well suited to irrigated grain and seed crops and irrigated domestic grasses and legumes for wildlife.

This map unit is in capability subclasses I, irrigated, and VIIc, nonirrigated. This soil is in the Loamy Bottom, 10-13" p.z. range site.

31—Graham-Pantak complex, 2 to 15 percent slopes.

This map unit is on undulating to rolling long narrow hills that were formed by dissection of volcanic ash and tuff pediment. Elevation is 3,700 to 4,700 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 40 percent Graham very cobbly clay loam and 35 percent Pantak very gravelly loam. The

Graham soils are on less sloping ridgetops and have gradients of 2 to 15 percent, and the Pantak soils are on backslopes that have gradients of 8 to 15 percent. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Caralampi, Tombstone, Kimrose family, Nolam and Arivaca soils on fan terraces and alluvium overlying pediments. Also included are small areas of Rock outcrop occurring as large boulder piles and low ledges and Keysto soils in drainageways. Included areas make up about 25 percent of the total acreage.

The Graham soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from basalt, andesite, rhyolite, and other igneous rock. Typically, the surface is covered by 50 to 65 percent cobble and gravel. The surface layer is dark grayish brown very cobbly clay loam about 2 inches thick. The subsoil is dark reddish brown clay and cobbly clay 12 inches thick. Basalt is at a depth of 14 inches. Depth to bedrock ranges from 8 to 20 inches. In some areas, the surface layer is very gravelly clay loam. In a few places, the surface layer is lighter or redder in color than is typical. In addition, bedrock is deeper than typical in some areas.

Permeability of the Graham soil is slow. Available water capacity is very low. Effective rooting depth is 8 to 20 inches. Runoff is medium to rapid, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

The Pantak soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from rhyolite, andesite, conglomerate, and tuff-ash. Typically, the surface is covered by 35 to 55 percent gravel and cobble. The surface layer is brown very gravelly loam about 1 inch thick. The subsoil is dark brown extremely gravelly clay loam 7 inches thick over highly fractured andesite that has clay films in the fractures. Depth to bedrock ranges from 6 to 20 inches. In some areas, the surface layer is thinner and lighter in color.

Permeability of the Pantak soil is moderate. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is medium to rapid, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

This unit is used for rangeland.

The potential plant community on the Graham soil is mainly sideoats grama, cane bluestem, and tobosa. The potential plant community on the Pantak soil is mainly sideoats grama, black grama, slender

grama, and false-mesquite. The present vegetation in most areas is mainly slender grama, broom snakeweed, curlymesquite, prickly pear, false-mesquite, and tobosa.

This unit is easily traversed by livestock. It produces forage for year-round use. Livestock prefer this unit to adjacent hills. Tobosa, the dominant forage species on the Graham soil, is less palatable than the forage species that grow on the Pantak soil. Consequently, the Pantak soil receives excessive grazing pressure. Grazing management, including use of fencing and livestock watering developments, helps to overcome the grazing distribution problems.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VI. The Graham soil is in the Clayey Upland, 12-16" p.z. range site and the Pantak soil is in the Shallow Upland, 12-16" p.z. range site.

32—Graham-Pantak-Rock outcrop complex, 15 to 45 percent slopes.

This map unit is on moderately steep to steep hills and mountains. Elevation is 3,400 to 5,300 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 40 percent Graham very cobbly clay loam, 20 percent Pantak very gravelly loam, and 15 percent Rock outcrop. The Graham soils are on less sloping ridgetops and saddles that have gradients of 15 to 25 percent, and the Pantak soils are on steep backslopes that have gradients of 20 to 45 percent. Rock outcrop consists of exposed areas of rhyolite, basalt, and andesitic tuff on ledges and a few pinnacles. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Lampshire and Romero soils. Also included are small areas of Caralampi, Tombstone, Kimrose family, Nolam, and Arivaca soils on fan terraces and alluvium overlying pediments. Included areas make up about 25 percent of the total acreage.

The Graham soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from basalt, andesite, rhyolite, and other igneous rock. Typically, the surface is covered by 50 to 65 percent cobble and gravel. The surface layer is dark grayish brown very cobbly clay loam about 2 inches thick. The subsoil is dark reddish brown clay and cobbly clay 12 inches thick.

Basalt is at a depth of 14 inches. Depth to bedrock ranges from 8 to 20 inches. In some areas, the surface layer is very gravelly clay loam. In a few places, the surface layer is lighter or redder in color than is typical. In addition, bedrock is deeper than is typical in some areas.

Permeability of the Graham soil is slow. Available water capacity is very low. Effective rooting depth is 8 to 20 inches. Runoff is very rapid, and the hazard of water erosion is moderate. The hazard of wind erosion is very slight.

The Pantak soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from rhyolite, andesite, conglomerate, and tuff-ash. Typically, the surface is covered by 35 to 55 percent gravel and cobble. The surface layer is brown very gravelly loam about 1 inch thick. The subsoil is dark brown extremely gravelly clay loam 7 inches thick over highly fractured andesite that has clay films in the fractures. Depth to bedrock ranges from 6 to 20 inches. In some areas, the surface layer is thinner and lighter in color.

Permeability of the Pantak soil is moderate. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

This unit is used for rangeland.

The potential plant community on the Graham soil is mainly sideoats grama, cane bluestem, tobosa, and black grama. The potential plant community on the Pantak soil is mainly sideoats grama, black grama, cane beardgrass, and plains lovegrass. The present vegetation in most areas is mainly curlymesquite, sideoats grama, false-mesquite, and ocotillo.

This unit produces forage for year-round use. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution. Fencing, livestock watering developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time help to overcome the grazing distribution problems. Controlled burning can help to improve grazing distribution and the range condition.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Graham soil is in capability subclass VI and in the Basalt Hills, 12-16" p.z. range site, and the Pantak soil is in capability subclass VIIe and in the Volcanic Hills, 12-16" p.z. range site. Rock outcrop is

not assigned a range site and is in capability class VIII.

33—Guest fine sandy loam, 0 to 1 percent slopes.

This very deep and well drained soil is in level swales, drainageways, and flood plains. It formed in mixed alluvium. Elevation is 3,000 to 4,600 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 54 to 66 degrees F, and the frost-free period is 180 to 230 days.

Typically, the surface layer is brown fine sandy loam 4 inches thick. The substratum is dark brown clay 38 inches thick. The next layer is a buried subsoil that is reddish brown sandy clay loam to 60 inches or more. In some areas, the surface layer in these soils is generally calcareous to the surface with many soft lime masses in the lower part of the subsoil. In some areas, the surface layer is silty clay loam, clay loam or clay. Some pedons have buried subsoils 20 to 50 inches deep.

Included in this unit are small areas of Keysto soils and riverwash in drainageways. Also included are small areas of Riveroad and Comoro soils. Included areas make up about 20 percent of the total acreage.

Permeability of the Guest soil is slow. These soils crack when dry and swell when wet. Available water capacity is moderate to high. Effective rooting depth is 60 inches or more. This soil is subject to occasional brief periods of flooding in summer and winter. Runoff is medium, and the hazard of water erosion generally is slight, but some drainageways are entrenched and channelled. Headcutting and deposition may occur following heavy summer thunderstorms or winter storms. The hazard of wind erosion is moderately high.

Most areas of this unit are used for rangeland and wildlife habitat. A few areas are used for urban development and irrigated cropland.

The potential plant community on this unit is mainly tobosa, vine-mesquite, sideoats grama, and blue grama. The present vegetation in most areas is mainly tobosa, whitethorn, and mesquite.

Livestock prefer this soil because of seasonal availability of water and a long green season. It is very susceptible to gully erosion when the protective plant cover has been removed. This soil is a highly productive range site. Grazing management, including use of fencing and livestock watering developments, helps to effectively utilize the coarse

vegetation, such as tobosa and sacaton, on the soil. Other suitable range management practices, such as brush management, range seeding, and controlled burning, can help to improve the range condition. The riparian vegetation on this soil is extremely valuable to wildlife for food, cover, and nesting.

If this unit is used for irrigated crops, the main limitations are slow permeability and flooding. The risk of flooding can be reduced by the use of dikes, levees, and diversions. Furrow, border, corrugation, and sprinkler irrigation systems are suited to this soil. The method used generally is governed by the crop grown. Because of the slow permeability of the Guest soil, the length of runs should be adjusted to permit adequate infiltration of water. Use of pipe, ditch lining, or drop structures in irrigation ditches facilitates irrigation and reduces ditch erosion. Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting, and increases the water intake rate. Crop residue left on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Wind erosion can be controlled by keeping the soil rough and cloddy when it is not protected by vegetation. Tillage should be kept to a minimum when soil moisture is high.

The Guest soil is poorly suited to urban development. The main limitations are flooding and shrink-swell potential. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Buildings and roads should be designed to offset the effects of shrinking and swelling. If buildings are constructed on this soil, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage because of shrinking and swelling. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential.

Septic tank absorption fields do not function properly during rainy periods because of wetness and slow permeability. Development in these areas requires onsite investigation for proper design to overcome limitations. A design that includes these areas as open space should be successful.

This unit is moderately well suited to desertic herbaceous plants and desertic herbaceous plants and desertic shrubs and trees for wildlife. It is well suited to irrigated grain and seed crops and irrigated domestic grasses and legumes for wildlife.

This map unit is in capability subclasses IIIw, irrigated, and VIw, nonirrigated. This soil is in the Clayey Bottom, 12-16" p.z. range site.

34—Hantz loam, 0 to 1 percent slopes.

This very deep and well drained soil is in level swales on alluvial fans and flood plains. It formed in mixed alluvium. Elevation is 2,400 to 3,600 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

Typically, the surface layer is brown loam about 5 inches thick. The subsurface layer is grayish brown clay loam 7 inches thick. The substratum is grayish brown clay 33 inches thick. The next layer is brown clay 16 inches or more thick. These soils are calcareous throughout. In some areas, the surface layer is silty clay loam, clay loam, or clay.

Included in this unit are small areas of Arizo soils and riverwash in drainageways. Also included are small areas of Bucklebar, Tubac, and Mohave soils on fan terraces and Glendale soils on stream terraces. Included areas make up about 20 percent of the total acreage.

Permeability of the Hantz soil is slow. These soils crack when dry and swell when wet. Available water capacity is high. Effective rooting depth is 60 inches or more. This soil is subject to occasional brief periods of flooding in summer and winter. Runoff is medium and the hazard of water erosion generally is slight, but some drainageways are entrenched and channelled. Headcutting and deposition may occur following heavy summer thunderstorms or winter storms. The hazard of wind erosion is moderate.

Most areas of this unit are used for rangeland. A few areas are used for urban development and irrigated cropland.

The potential plant community on this unit is mainly tobosa, vine-mesquite, and sideoats grama. The present vegetation in most areas is mainly tobosa and mesquite.

Livestock prefer this soil because of the seasonal availability of water and a long green season. It is very susceptible to gully erosion when the protective plant cover has been removed. This soil is a highly productive range site. Grazing management, including use of fencing and livestock watering developments, helps to effectively utilize the coarse vegetation, such as tobosa. Other suitable range management practices, such as brush management, range seeding, and controlled burning, can help to improve the range condition. The riparian vegetation on this soil is extremely valuable to wildlife for food, cover, and nesting.

If this unit is used for irrigated crops, the main limitations are slow permeability and flooding. The risk of flooding can be reduced by the use of dikes,

levees, and diversions. Furrow, border, corrugation, and sprinkler irrigation systems are suited to this soil. The method used generally is governed by the crop grown. Because of the slow permeability of the Hantz soil, the length of runs should be adjusted to permit adequate infiltration of water. Use of pipe, ditch lining, or drop structures in irrigation ditches facilitates irrigation and reduces ditch erosion. Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting, and increases the water intake rate. Crop residue left on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Wind erosion can be controlled by keeping the soil rough and cloddy when it is not protected by vegetation. Tillage should be kept to a minimum when soil moisture is high.

The Hantz soil is poorly suited to urban development. The main limitations are flooding and shrink-swell potential. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Buildings and roads should be designed to offset the effects of shrinking and swelling. If buildings are constructed on this soil, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage because of shrinking and swelling. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential.

Septic tank absorption fields do not function properly during rainy periods because of wetness and slow permeability. Development in these areas require onsite investigation for proper design to overcome limitations. A design that includes these areas as open space should be successful.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is moderately well suited to irrigated grain and seed crops and irrigated domestic grasses and legumes for wildlife.

This map unit is in capability subclasses IIIw, irrigated, and VIIw, nonirrigated. This soil is in the Clayey Bottom, 10-13" p.z. range site.

35—Hayhook sandy loam, 1 to 5 percent slopes.

This very deep and well drained soil is on gently sloping fan terraces incised by narrow drainageways. It formed in alluvium derived dominantly from granite. Elevation is 2,200 to 3,600 feet. The mean annual

precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

Typically, the surface and subsurface layers are yellowish brown sandy loam about 5 inches thick. The subsoil is brown sandy loam 19 inches thick. The upper 14 inches of the substratum is yellowish brown gravelly sandy loam. The lower part to a depth of 60 inches or more is light yellowish brown gravelly loamy sand. In places, disseminated lime is below 20 inches. In some areas, the surface layer is gravelly sandy loam or loamy sand.

Included in this unit are small areas of Anthony soils on flood plains, Sahuarita soils on fan terraces, and Bucklebar soils on lower fan terraces and basin floors. Also included are small areas of Arizo soils in and along narrow drainageways. Included areas make up about 15 percent of the total acreage.

Permeability of this Hayhook soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff generally is medium, but the included soils in and near drainageways are subject to rare, very brief seasonal periods of flooding from adjacent uplands. Shallow rills are in some areas, and deposition of soil around the vegetation in these areas is common. The hazard of water erosion is slight to moderate. The hazard of wind erosion is moderately high.

Most areas of this unit are used for rangeland. A few areas are used for homesites and urban development.

The potential plant community on this unit is mainly Arizona cottontop, Santa Rita threeawn, bush muhly, and spike dropseed. The present vegetation in most areas is mainly burroweed, mesquite, paloverde, and annual grasses.

This soil is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem on much of this unit. The competition from woody plants must be reduced before this soil will respond to grazing management. Other suitable range management practices, such as fencing, livestock watering developments, and range seeding, can help to improve grazing distribution and the range condition.

If this unit is used for homesites or urban development, the main limitations are the hazard of wind erosion in disturbed areas and seepage potential. Revegetating disturbed areas around construction sites as soon as possible helps to control wind erosion. Plants native to the area are most suitable for landscaping.

If the density of housing is moderate to high,

community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VII_s. This unit is in the Sandy Loam, (Deep), 10-13" p.z. range site.

36—Hayhook-Sahuarita complex, 1 to 5 percent slopes.

This map unit is on gently sloping intermediate and low fan terraces incised by narrow drainageways. Elevation is 2,200 to 3,600 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 45 percent Hayhook sandy loam and 30 percent Sahuarita very gravelly fine sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Anthony soils on flood plains, Bucklebar soils intermingled with Sahuarita soils on fan terraces, and Palos Verdes soils on relict fan terraces in areas north of Tucson. Also included are small areas of Arizo soils in and along drainageways. Included areas make up about 25 percent of the total acreage.

The Hayhook soil is very deep and well drained. It formed in alluvium derived dominantly from granite. Typically, the surface layer is yellowish brown sandy loam about 5 inches thick. The subsoil is brown sandy loam about 19 inches thick. The upper 14 inches of the substratum is yellowish brown gravelly sandy loam. The lower part to a depth of 60 inches or more is light yellowish brown gravelly loamy sand. In places, lime is disseminated below 20 inches. In some areas, the surface layer is gravelly sandy loam or loamy sand.

Permeability of the Hayhook soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff generally is medium, but included low-lying areas along the drainageways are subject to rare, very brief seasonal periods of flooding from adjacent uplands. Shallow rills are in some areas, and deposition of soil around the vegetation in these areas is common. The hazard of water erosion is slight to moderate. The hazard of wind erosion is moderately high.

The Sahuarita soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 35 to 55 percent gravel. The surface layer is light yellowish brown very gravelly fine sandy loam about 3 inches thick. The subsoil is light yellowish brown fine sandy loam 25 inches thick. The next layer is a buried subsoil of brown loam 17 inches thick and brown very gravelly sandy clay loam 15 or more inches thick. Common fine lime filaments are in the buried subsoil. These soils are calcareous throughout. Depth to the buried subsoil ranges from 20 to 40 inches. In some areas, the surface layer is fine sandy loam.

Permeability of the Sahuarita soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff generally is slow to medium, but the included soils in and near drainageways are subject to rare seasonal periods of flooding because of run-on from adjacent uplands. Runoff is rapid because of the many shallow rills and the few deep gullies. The hazard of water erosion is slight. The hazard of wind erosion is very slight.

This unit is used mainly for rangeland. It is also used for homesites and urban development.

The potential plant community on this unit is mainly Arizona cottontop, spike dropseed, Rothrock grama, and threeawn. The present vegetation in most areas is mainly paloverde, mesquite, burroweed, and triangle bursage.

This unit is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem on much of this unit. The competition from woody plants must be reduced before this unit will respond to grazing management. Other suitable range management practices, such as fencing, livestock watering developments, and range seeding, can help to improve grazing distribution and the range condition.

This unit is well suited to homesites and urban development. The main limitations are the hazard of wind erosion and seepage potential on the Hayhook soil. Revegetating disturbed areas around construction sites as soon as possible helps to control wind erosion. Plants native to the area are most suitable for landscaping.

If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

Both soils in this map unit are in capability subclasses VIIs. The Hayhook soil is in the Sandy Loam, (Deep), 10-13" p.z. range site and the Sahuarita soil is in the Sandy Loam Upland, 10-13" p.z. range site.

37—Keysto extremely gravelly fine sandy loam, 2 to 8 percent slopes.

This very deep and well drained soil is on gently sloping stream terraces. It formed in mixed alluvium. Elevation is 3,000 to 4,500 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

Typically, the surface layer is brown extremely gravelly fine sandy loam about 1 inch thick. The subsurface layers are dark grayish brown and brown extremely gravelly loam and brown very gravelly loam 40 inches thick. A buried subsoil is at a depth of 41 inches and is brown extremely gravelly sandy clay loam. These soils generally are noncalcareous throughout. In places, the buried subsoil is not present.

Included in this unit are small areas of riverwash in drainageways. Also included are small areas of Altar and Caralampi soils on distal portions of fan terraces. Included areas make up about 20 percent of the total acreage.

Permeability of the Keysto soil is moderately rapid in the upper part and moderately slow in the lower part of the profile. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff generally is medium, but the soils in and near drainageways are subject to rare seasonal periods of flooding because of run-on from adjacent uplands. The hazard of erosion generally is slight, but some drainageways are entrenched and channelled. Headcutting and deposition may occur following heavy summer thunderstorms or winter storms. The hazard of wind erosion is very slight. In the vicinity of Cienega Creek north of Interstate 10 and along Marsh Station Road, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping and subsidence or settling caused by the dissolution of gypsum by water.

This unit is used for rangeland.

The potential plant community on this unit is mainly grama grasses, spike dropseed, Arizona cottontop, and catclaw acacia. The present vegetation in most areas is mainly mesquite, Rothrock grama, burroweed, and Santa Rita threeawn.

This soil is easily traversed by livestock. It produces forage for year-round use. Brush management is not required to have an effective plant cover. Changes in perennial grass cover are obvious in wet versus dry years because of the moderate available water capacity of the soil. Controlled burning is effective in controlling poisonous half-shrubs such as snakeweed and burroweed on this soil. Other suitable range management practices, such as range seeding, fencing, livestock watering developments, and implementing planned grazing systems, can help to improve grazing distribution.

This unit is well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VI. This soil is in the Sandy Loam, (Deep), 12-16" p.z. range site.

38—Lajitas-Delthorny-Rock outcrop complex, 25 to 60 percent slopes.

This map unit is on moderately steep to steep basalt hills and mountains. Elevation is 2,200 to 4,000 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 40 percent Lajitas extremely cobbly loam on 25 to 60 percent slopes, 20 percent Delthorny very gravelly sandy loam on 25 to 30 percent slopes, and 15 percent Rock outcrop. The soil and the areas of Rock outcrop are intricately intermingled; however, a higher percentage of Rock outcrop is in areas near the hilltops and mountaintops.

Included in this unit are small areas of Lehman soils on saddles, Stagecoach soils on fan terraces, and Pantano soils on areas underlain by tuff. Included areas make up about 25 percent of the total acreage.

The Lajitas soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from basalt. Typically, the surface is covered by 80 percent scoria cobble. The surface layer is yellowish brown extremely cobbly loam about 1 inch thick. The subsurface layer is yellowish brown extremely cobbly loam 3 inches thick over very dark gray basalt. These soils generally are noncalcareous throughout. Depth to bedrock ranges from 4 to 12 inches. In some areas, the surface layer is calcareous.

Permeability of the Lajitas soil is moderate. Available water capacity is very low. Effective rooting

depth is 4 to 12 inches. Runoff is very rapid, and the hazard of water erosion is severe. The hazard of wind erosion is very slight.

The Delthorny soil is very shallow and shallow to a lime-coated hardpan and well drained. It formed in colluvium and slope alluvium. Typically, the surface is covered by 20 percent gravel, 30 percent cobble, and 10 percent stones. The surface layer is brown very gravelly sandy loam about 2 inches thick. The subsurface layer is light brown very gravelly sandy loam 7 inches thick. White indurated lime-cemented hardpan is at a depth of 9 inches. At 16 inches is unweathered conglomerate. These soils are calcareous throughout. Depth to the hardpan ranges from 6 to 20 inches. Depth to bedrock ranges from 15 to 30 inches. In some areas, the surface layer is extremely cobbly fine sandy loam.

Permeability of the Delthorny soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is rapid, and the hazard of water erosion is moderate. The hazard of wind erosion is very slight.

Rock outcrop consists of exposed areas of rhyodacite, basalt, and andesitic tuff. It is on ledges and a few pinnacles.

This unit is used mainly for rangeland. It is also used for parks and recreation.

The potential plant community on the Lajitas soil is mainly bush muhly, tanglehead, littleleaf paloverde, and slender janusia. The present vegetation in most areas is mainly littleleaf paloverde, white brittlebush, triangle bursage, and bush muhly. The potential plant community on the Delthorny soil is creosotebush, littleleaf paloverde, bush muhly, and triangle bursage. The present vegetation in most areas is mainly littleleaf paloverde, triangle bursage, and creosotebush.

This unit produces forage for year-round use by livestock. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution. Grazing management, including fencing, livestock watering developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time, helps to overcome the grazing distribution problems.

This unit is moderately suited to recreational development. Slope limits the use of areas of this unit mainly to a few paths and trails, which should extend across the slope. Less sloping areas of the unit can be used as campsites, picnic areas, and playgrounds. Paths and trails should be constructed on the contour where possible.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Lajitas soil is in capability subclass VIIe in the Gravelly Hills, 10-13" p.z. range site. The Delthorny soil is in capability subclass VIIs and Gravelly Hills, 10-13" p.z. range site. Rock outcrop is not assigned a range site and is in capability class VIII.

39—Lampshire-Pantak-Rock outcrop complex, 25 to 60 percent slopes.

This map unit is on moderately steep to steep slopes of hills and mountains. Elevation is 3,400 to 5,300 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 40 percent Lampshire extremely gravelly sandy loam, 30 percent Pantak very gravelly sandy loam, and 20 percent Rock outcrop. The Lampshire soils and Pantak soils are on hills and mountains that have gradients of 25 to 60 percent.

Included in this unit are areas of soils that are moderately deep to bedrock, Chiricahua soils with greater than 35 percent clay, soils that have less organic matter, and Pantak soils that have loam surface textures. Included areas make up about 10 percent of the total acreage.

The Lampshire soil is very shallow, shallow, and well drained. It formed in slope alluvium and colluvium from andesite. Typically, the surface layer is dark grayish brown extremely gravelly sandy loam 10 inches thick. Unweathered andesite is at a depth of 10 inches.

Permeability of the Lampshire soil is moderately rapid. Effective rooting depth is 4 to 20 inches. Depth to bedrock is 4 to 20 inches. Available water capacity is very low. Runoff is very rapid. The hazard of water erosion is moderate to severe, and the hazard of wind erosion is very slight.

The Pantak soil is very shallow, shallow, and well drained. It formed in slope alluvium and residuum from igneous rock. Typically, the surface layer is brown to dark brown very gravelly sandy loam 1 inch thick. The subsoil is dark brown extremely gravelly clay loam 7 inches thick. At 8 inches is unweathered andesite. Some pedons have calcium carbonate in the bedrock fractures.

Permeability of the Pantak soil is moderate. Effective rooting depth is 6 to 20 inches. Depth to bedrock is 6 to 20 inches. Available water capacity is

very low. Runoff is very rapid. The hazard of water erosion is moderate to severe, and the hazard of wind erosion is very slight.

Rock outcrop consists of barren rock that occurs as ledges, massive boulders, and near vertical cliffs of andesite, granite, and schist. The higher percentage of Rock outcrop is in areas near the hilltops and mountaintops.

This unit is used for rangeland.

The potential plant community for the Lampshire soils is mainly shrubby buckwheat, plains lovegrass, cane bluestem, ocotillo, sideoats grama, and jojoba. The present vegetation in most areas is mainly mesquite, jojoba, sideoats grama, slender grama, and snakeweed.

The potential plant community for the Pantak soils is mainly sideoats grama, purple grama, cane bluestem, and plains lovegrass. The present vegetation in most areas is mainly mesquite, curlymesquite, Schott agave, pricklypear, and snakeweed.

This unit produces forage for year-round use. Steep slopes, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution. Fencing, livestock water developments and construction of trails to permit more animals to graze in smaller areas for shorter periods of time helps overcome grazing distribution problems. Controlled burning and brush management help improve grazing distribution and range conditions.

Stocker-type cattle will utilize forage on steep slopes to a greater degree than cows with calves. Control erosion and promote forage production with proper utilization. Provide periodic rest during the growing season to maintain plant vigor and production.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VIIe, nonirrigated. The Lampshire and Pantak soils are in the Granitic Hills, 12-16" p.z. range site.

40—Lampshire-Romero-Rock outcrop complex, 10 to 65 percent slopes.

This map unit is on moderately steep to very steep hills and mountains. Elevation is 3,400 to 5,400 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 45 percent Lampshire very gravelly loam, 20 percent Romero very gravelly sandy loam, and 15 percent Rock outcrop. Lampshire soils are on

moderately steep to steep backslopes near areas of Rock outcrop that have slope gradients of 10 to 65 percent, and Romero soils are on moderately steep to steep footslopes that have slope gradients at 10 to 60 percent. The soils and the areas of Rock outcrop are intricately intermingled; however, a higher percentage of Rock outcrop is in areas near the hilltops and mountaintops.

Included in this unit are small areas of Andrada soils on areas underlain by soft bedrock, Caralampi soils on fan terraces, and Oracle and White House soils on saddles and in swales. Also included are small areas of Keysto and Comoro soils on stream terraces along drainageways, and Pantak, Chiricahua, and Deloro soils. Included areas make up about 20 percent of the total acreage.

The Lampshire soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from granite, rhyolite, gneiss, and tuff. Typically, the surface is covered by 50 to 65 percent gravel, cobble, and a few stones. The surface and subsurface layers are brown very gravelly loam about 10 inches deep over gneiss. Depth to bedrock ranges from 7 to 20 inches. In some areas, the surface layer is very cobbly loam.

Permeability of the Lampshire soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 7 to 12 inches. Runoff is medium to very rapid, and the hazard of water erosion is slight to severe. The hazard of wind erosion is very slight.

The Romero soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from granite, granodiorite, or pegmatite. Typically, the surface is covered by 40 to 55 percent fine and medium gravel and a few cobble. The surface layer is dark grayish brown very gravelly sandy loam about 2 inches thick. The subsurface layer is very dark grayish brown very gravelly fine sandy loam 8 inches thick. Fractured granite (grus) with subsurface material and clay in the fractures is about 7 inches thick. At 17 inches is weathered granite (grus). Depth to bedrock ranges from 4 to 20 inches. In some areas, the surface layer is thinner and lighter in color than is typical.

Permeability of the Romero soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 4 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is rapid to very rapid, and the hazard of water erosion is slight to severe. The hazard of wind erosion is very slight.

Rock outcrop occurs as ledges and boulder piles scattered throughout the unit.

This unit is used mainly for rangeland. It is also used for recreation.

The potential plant community on this unit is mainly sideoats grama, black grama, slender grama, and plains lovegrass. The present vegetation in most areas is mainly mesquite, threeawn, sideoats grama, and slender grama.

This unit produces forage for year-round use. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution. Fencing, livestock watering developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time help to overcome the grazing distribution problems. Controlled burning and brush management help to improve grazing distribution and the range condition.

If this unit is used for recreational development, the main limitations are slope, depth to bedrock, and a very gravelly surface layer. Less sloping areas of the unit can be used as campsites, picnic areas, and playgrounds. Paths and trails should be constructed on the contour where possible.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Lampshire soil is in capability subclass VIIe and the Romero soil is in capability subclass VIIe. Both soils in this unit are in the Granitic Hills, 12-16" p.z. range site. Rock outcrop is not assigned a range site and is in capability class VIII.

41—Lehmans-Delthorny-Lajitas complex, 15 to 50 percent slopes.

This map unit is on moderately steep and steep basalt hills. Elevation is 2,400 to 4,000 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 40 percent Lehmans extremely cobbly clay loam, 25 percent Delthorny very gravelly sandy loam, and 15 percent Lajitas extremely cobbly loam. Also in this unit is about 10 percent Rock outcrop. The Lehmans soils are on moderately steep swales and saddles that have gradients of 15 to 30 percent, the Delthorny soils are on footslopes that have gradients of 15 to 25 percent near the base of the hills, and the Lajitas soils are on steep active backslopes that have gradients of 30 to 50 percent near the summit. Rock outcrop occurs as exposed ledges and pinnacles of basalt.

Included in this unit are small areas of Anklam and

Pantano soils on areas underlain by softer bedrock and Nahda, Pinaleno, Stagecoach, and Palos Verdes soils on fan terraces. Included areas make up about 10 percent of total acreage.

The Lehmans soil is shallow and well drained. It formed in mixed alluvium and colluvium derived dominantly from basalt. Typically, the surface is covered by 10 percent gravel and 70 percent cobble and stones. The surface layer is yellowish brown extremely cobbly clay loam 5 inches thick. The subsoil is brown clay 8 inches thick. Dark gray basalt is at a depth of 13 inches. Depth to bedrock ranges from 10 to 20 inches. In some areas, the surface layer is gravelly sandy clay loam.

Permeability of the Lehmans soil is slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. Runoff is very rapid, and the hazard of water erosion is moderate. The hazard of wind erosion is very slight.

The Delthorny soil is very shallow and shallow to a lime-cemented hardpan and well drained. It formed in colluvium and slope alluvium. Typically, the surface is covered by about 30 percent gravel and 40 percent cobble and stones. The surface layer is brown very gravelly sandy loam about 2 inches thick. The subsurface layer is light brown very gravelly sandy loam 7 inches thick. White indurated lime-cemented hardpan is at a depth of 9 inches. Unweathered conglomerate is at a depth of 16 inches. These soils are calcareous throughout. Depth to the hardpan ranges from 6 to 20 inches. In some areas, the surface layer is extremely cobbly fine sandy loam. Depth to bedrock ranges from 15 to 30 inches.

Permeability of the Delthorny soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is rapid, and the hazard of water erosion is moderate. The hazard of wind erosion is very slight.

The Lajitas soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from basalt. Typically, the surface is covered by 80 percent scoria cobble and a few stones. The yellowish brown extremely cobbly loam soil is about 4 inches deep over very dark gray basalt. Depth to bedrock ranges from 4 to 12 inches. These soils generally are noncalcareous throughout.

Permeability of the Lajitas soil is moderate. Available water capacity is very low. Effective rooting depth is 4 to 12 inches. Runoff is very rapid, and the hazard of water erosion is severe. The hazard of wind erosion is very slight.

This unit is used mainly for rangeland. A few areas are used for parks and recreational areas.

The potential plant community on the Lehmans soil is mainly curlymesquite, tobosa, and prickly pear cactus. The potential plant community on the Delthorny soil is mainly triangle bursage, littleleaf paloverde, bush muhly, and white brittlebush. The potential plant community on the Lajitas soil is mainly bush muhly, tanglehead, jojoba, and littleleaf paloverde. The present vegetation in most areas is littleleaf paloverde, creosotebush, white brittlebush, triangle bursage, and ocotillo.

This unit produces forage for year-round use by livestock. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution on areas of the Lajitas soil. Grazing pressure is concentrated on the areas of Lehmans and to a lesser extent the Delthorny soils, where slopes are more gentle. Grazing management, including use of fencing, livestock watering developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time, improves grazing distribution and the range condition.

If this unit is used for recreational development, the main limitations are depth to bedrock or hardpan, gravel, and cobble on the surface and slope. Less sloping areas of this unit can be used as campsites, picnic areas, and playgrounds. Paths and trails should be constructed on the contour where possible.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Lehmans soil is in capability subclass VII_s and in the Volcanic Hills, 10-13" p.z. range site. The Delthorny soil is in capability subclass VI_s and in the Gravelly Hills, 10-13" p.z. range site. The Lajitas soil is in capability subclass VI_e and in the Gravelly Hills, 10-13" p.z. range site.

42—Mabray-Deloro-Rock outcrop complex, 20 to 65 percent slopes.

This map unit is on steep and very steep limestone mountains. Elevation is 3,400 to 5,300 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 35 percent Mabray very cobbly loam with slope gradients of 20 to 65 percent, 25 percent Deloro extremely channery loam that has slope gradients of 20 to 45 percent, and 15 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Tombstone

and Kimrose family soils on fan terraces. Also included are small areas of Lampshire and Oracle soils on areas underlain by granite. Included areas make up about 25 percent of the total acreage.

The Mabray soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from limestone. Typically, the surface is covered by 30 percent gravel and 20 percent cobble. The surface layer is very dark grayish brown very cobbly loam about 4 inches thick. The substratum is light gray very gravelly loam 10 inches thick over lime-coated dark gray limestone. Depth to limestone ranges from 4 to 20 inches. In some areas, the surface layer is very gravelly loam. In a few places, the surface layer is lighter in color than is typical. In addition, bedrock is deeper than is typical in some areas (fig. 6).

Permeability of the Mabray soil is moderate. Available water capacity is very low. Effective rooting depth is 4 to 20 inches. Runoff is very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

The Deloro soil is shallow and well drained. It formed in alluvium and colluvium derived dominantly from quartzite. Typically, the surface is covered by 50 to 65 percent channers and flagstones and 10 percent stones. The surface layer is brown to dark brown extremely channery loam about 2 inches thick. The subsoil is reddish brown extremely channery clay 9 inches thick. Fractured quartzite that has clay in the fractures occurs to a depth of 60 inches or more. These soils generally are noncalcareous throughout. Depth to bedrock ranges from 10 to 20 inches. In some areas, the surface layer is very gravelly clay loam. In a few places, the subsoil has less gravel than is typical. In addition, in some areas the soil is calcareous to the surface.

Permeability of the Deloro soil is slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

Rock outcrop consists of quartzite and limestone occurring as ledges, dikes, and columns.

This unit is used for rangeland.

The potential plant community on the Mabray soil is mainly grama grasses, southwestern stipa, range ratany, and peabush. The potential plant community on the Deloro soil is grama grasses, curlymesquite, vine-mesquite, and false-mesquite. The present vegetation in most areas is mainly beargrass, soap tree yucca, threeawn, and grama grasses.



Figure 6.—Mabray soil on hard limestone in an area of Mabray-Deloro-Rock outcrop complex, 20 to 65 percent slopes.

This unit produces forage for year-round use. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution. Fencing, livestock watering developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time can help to overcome the grazing distribution problems. Controlled burning and brush management help to improve grazing distribution and the range condition.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Mabray soil is in capability subclass VIIe and in the Limestone Hills, 12-16" p.z. range site. The Deloro soil is in capability subclass VIIe and in the Volcanic Hills, 12-16" p.z. range site. Rock outcrop is not assigned a range site and is in capability class VIII.

43—Mohall gravelly fine sandy loam, 1 to 5 percent slopes.

This very deep and well drained soil is on gently sloping fan terraces dissected by ephemeral drainageways. It formed in mixed alluvium. Elevation is 1,675 to 1,900 feet. The mean annual precipitation is 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

Typically, the surface layer is light brown gravelly fine sandy loam about 3 inches thick. The upper 21 inches of the subsoil is reddish brown clay loam. The lower 21 inches is reddish brown and white loam. The substratum to a depth of 60 inches or more is pink and white sandy clay loam. In places, these soils are effervescent to the surface. Many soft masses of lime are in the lower part of the subsoil and in the substratum. In places, the subsoil has more gravel and has lime masses closer to the surface than is typical. In some areas, the surface layer is sandy loam.

Included in this unit are small areas of Denure, Momoli, and Pinamt soils. Also included are small areas of soils that have a hardpan at moderate depths. Included areas make up about 15 percent of the total acreage.

Permeability of the Mohall soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow to medium, and the hazard of water erosion is slight. The hazard of wind erosion is moderate.

This unit is used for rangeland.

The potential plant community on this unit is mainly triangle bursage, bush muhly, white ratany, and creosotebush. The present vegetation in most areas is mainly creosotebush, triangle bursage, scattered mesquite, and annual grasses.

This soil is easily traversed by livestock. Production of forage for livestock grazing is limited by low rainfall. Forage production, consisting of annual forbs and grasses, can be high in years when precipitation in winter and spring is good. Grazing management, such as turning on and off livestock watering developments, can help to improve grazing distribution economically.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This soil is in capability subclass VII_s. It is in a Sandy Loam Upland, 7-10" p.z. range site.

44—Mohall loam, 0 to 2 percent slopes.

This very deep and well drained soil is on broad, nearly level fan terraces shallowly dissected by ephemeral drainageways. It formed in mixed alluvium. Elevation is 1,675 to 1,900 feet. The mean annual precipitation is 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

Typically, the surface layer is light brown loam about 3 inches thick. The upper 21 inches of the subsoil is reddish brown clay loam. The lower 21 inches is mixed reddish brown and white loam. The substratum to a depth of 60 inches or more is mixed pink and white sandy clay loam. In places, these soils are effervescent to the surface. Many soft masses of lime are in the lower part of the subsoil and in the substratum. In some areas, the surface layer is gravelly sandy loam.

Included in this unit are small areas of Pahaka soils on alluvial fans above Mohall and Vecont soils in drainageways. Low-lying included areas along the drainageways are subject to very brief seasonal periods of flooding. Also included are small areas of saline-sodic soils. Included areas make up about 15 percent of the total acreage.

Permeability of the Mohall soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of wind erosion is moderate.

Most areas of this unit are used for rangeland.

The potential plant community on this unit is mainly bush muhly, big galleta, annuals, and threawn. The present vegetation in most areas is mainly creosotebush, triangle bursage, scattered mesquite, and annual grasses.

This soil is easily traversed by livestock. It produces forage for year-round use. Carrying capacities are generally low except in years when precipitation in winter and spring is good. This soil responds to grazing management. Grazing management, such as turning on and off livestock watering developments, can help to improve grazing distribution economically.

This unit is well suited to irrigated crops. It is limited mainly by rare periods of seasonal flooding and moderately slow permeability. The risk of flooding can be reduced by the use of dikes, diversions, and levees. Furrow, border, corrugation, and sprinkler irrigation systems are suited to this soil. The method used generally is governed by the crop grown, cost, or water availability. To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. Because of the moderately slow permeability of the Mohall soil, the application of water should be regulated so that water does not stand on the surface and damage the crops. Using pipe, ditch lining, or drop structures in irrigation ditches facilitates irrigation and reduces ditch erosion. Excessive cultivation can result in the formation of a tillage pan. This pan can be broken by subsoiling when the soil is dry. Returning crop residue to the soil or regularly adding other organic matter will improve fertility, reduce crusting, and increase the water intake rate. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. Wind erosion can be controlled by keeping the soil rough and cloddy when it is not protected by vegetation. Included areas which are saline-sodic need special management for good crop response in addition to the practices mentioned above. Salts can be reduced by leaching and applying proper amounts of soil amendments. Subsoiling opens up the soil and allows water to pass through and carry the salt with it.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is well suited to irrigated grain and seed crops and irrigated domestic grasses and legumes for wildlife.

This soil is in capability subclasses I, irrigated,

and VIIc, nonirrigated. This soil is in the Loamy Upland, 7-10" p.z. range site.

45—Mohall-Pahaka complex, 1 to 3 percent slopes.

This map unit is on nearly level fan terraces. Elevation is 1,675 to 1,900 feet. The mean annual precipitation is 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

This unit is 40 percent Mohall fine sandy loam and 40 percent Pahaka sandy loam. The Mohall soils are on fan terraces that have gradients of 1 to 3 percent, and the Pahaka soils are on fan terraces that have gradients of 1 to 2 percent. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are Denure soils that do not have the buried argillic horizon, soils that receive extra runoff water, and Pahaka soils that have loam surface textures. Included areas make up about 20 percent of the total acreage.

The Mohall soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface layer is yellowish brown fine sandy loam about 3 inches thick. The upper 21 inches of the subsoil is reddish brown clay loam. The lower 21 inches is reddish brown and white loam. The substratum to a depth of 60 inches or more is pink and white sandy clay loam. These soils generally have more than 15 percent calcium carbonate below 20 inches.

Permeability of the Mohall soil is moderately slow. Available water capacity is high. Effective rooting depth is greater than 60 inches. Runoff is slow. The hazard of water erosion is slight, and the hazard of wind erosion is moderately high.

The Pahaka soil is very deep and well drained. It formed from mixed alluvium. Typically, the surface layer is yellowish brown sandy loam 3 inches thick. The subsoil is brown sandy loam 11 inches thick. The next layers are yellowish brown and strong brown sandy loam 16 inches thick. The lower part to a depth of 60 inches or more is a buried subsoil that is yellowish red and light brown clay loam.

Permeability of the Pahaka soil is moderately rapid in the upper part and moderately slow in the lower part. Available water capacity is moderate. Effective rooting depth is greater than 60 inches. Runoff is slow. The hazard of water erosion is slight, and the hazard of wind erosion is moderately high.

This unit is used for rangeland. A few areas are abandoned cropland.

The potential plant community on this unit is mainly white bursage, threeawns, annual grasses and forbs, bush muhly, and triangle bursage. The present plant vegetation in most areas is mainly creosotebush, mesquite, triangle bursage, annual grasses, and forbs.

This unit is easily traversed by livestock. It produces forage for year-round use. Carrying capacities are generally low except in years of good winter and spring precipitation. These soils will respond to grazing management. Grazing management to improve grazing distribution is most economically practiced by turning on and off livestock water developments.

Leveling this soil to a flat grade permits more efficient use of irrigation water. Due to the slow permeability of this soil the application of water should be regulated so that water does not stand on the surface and damage crops. Crop rotation and incorporating crop residue into the soil or adding other organic matter on a regular basis will improve fertility and increase both the water intake rate and available water capacity. A tillage pan forms easily if this soil is tilled when wet. Ripping or chiseling when the soil is dry breaks up tillage pans, increasing the effective rooting depth and improving internal drainage. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures will help maintain fertility and tilth. Wind erosion can be reduced by keeping the soil rough and cloddy when it is not protected by vegetation.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is capability subclass IIe, irrigated, and VIIe, nonirrigated. The Mohall and Pahaka soils are Sandy Loam Upland, 7-10" p.z. range site.

46—Mohall-Trix complex, 0 to 1 percent slopes.

This map unit is on level fan terraces and alluvial fans. Elevation is 1,675 to 1,900 feet. The mean annual precipitation is 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost free period is 250 to 300 days.

This unit is 50 percent Mohall sandy loam and 40 percent Trix very fine sandy loam. The Mohall soils are on fan terraces that have gradients of 0 to 1

percent. The Trix soils are on alluvial fans that have gradients of 0 to 1 percent and have a hazard of flooding that is rare to occasional. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of soils that have desert pavement and gravelly surface textures, soils that are saline-sodic, Pahaka soils that have a thicker surface horizon of sandy loam material, Mohall soils that have a very fine sandy loam or loam surface texture, and soils that are calcareous throughout. Included areas make up about 10 percent of the total acreage.

The Mohall soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface layer is strong brown sandy loam 3 inches thick. The upper 21 inches of the subsoil is reddish brown clay loam. The lower 21 inches is reddish brown and white loam. The substratum to a depth of 60 inches or more is pink and white sandy clay loam. These soils generally have more than 15 percent calcium carbonate below 20 inches.

Permeability of the Mohall soil is moderately slow. Available water capacity is moderate to high. Effective rooting depth is 60 inches or more. Runoff is slow to medium. The hazard of water erosion is slight, and the hazard of wind erosion is moderately high.

The Trix soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface layer is strong brown very fine sandy loam 11 inches thick. The subsurface layer is brown loam 11 inches thick. The buried subsoil is yellowish red and reddish yellow sandy clay loam to a depth of 60 inches or more. These soils generally have less than 15 percent calcium carbonate in the upper part and more than 15 percent calcium carbonate in the lower part.

Permeability of the Trix soil is moderate in the upper part and moderately slow in the lower part. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow. The hazard of water erosion is slight, and the hazard of wind erosion is moderately high.

This unit is used for rangeland.

The potential plant community on the Mohall soil is mainly triangle bursage, bush muhly, threeawn, annual grasses and forbs, Arizona cottontop, and mesquite. The present vegetation in most areas is mainly mesquite, wolfberry, triangle bursage, creosotebush, and annual grasses and forbs. The

potential plant community on the Trix soil is mainly threeawn, Arizona cottontop, dropseeds, bush muhly, wolfberry, and mesquite. The present plant community in most areas is mesquite, annual grasses, and forbs.

This soil is easily traversed by livestock. It produces forage for year-round use. Carrying capacities are generally low except in years of good winter and spring precipitation. This soil will respond to grazing management. Grazing management to improve grazing distribution is most economically practiced by turning on and off livestock water developments. Livestock prefer the Trix soil because of the availability of shade, easy access, and seasonal water from flooding of shallow drainageways. When the protective plant cover is depleted by overgrazing, the soil is susceptible to rill and gully erosion. Grazing management utilizing fencing can help improve the use of forage produced after flooding and maintain the plant cover. Brush management is needed to keep mesquite from dominating the soil. Other suitable range management practices to improve grazing distribution and range condition include livestock water development, range seeding, gully control, and water-spreading systems.

Leveling this soil to a flat grade permits more efficient use of irrigation water. Because of the slow permeability of this soil, the application of water should be regulated so that water does not stand on the surface and damage crops. Crop rotation and incorporating crop residue into the soil or adding other organic matter on a regular basis will improve fertility and increase both the water intake rate and available water capacity. A tillage pan forms easily if this soil is tilled when wet. Ripping or chiseling when the soil is dry breaks up tillage pans, increasing the effective rooting depth and improving internal drainage. When land leveling cuts are made, onsite investigation is needed. Where this soil is not protected by dikes and levees, it is subject to periods of flooding in the summer and winter. Because of the moderately slow permeability, water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is well suited to irrigated grain and seed crops and irrigated domestic grasses and legumes for wildlife.

The Mohall soil is in capability subclass IIe

irrigated and VIIe nonirrigated, and the Trix soil is in the capability subclass IIw, irrigated, and VIIw, nonirrigated. The Mohall soil is in the Sandy Loam Upland, 7-10" p.z., and the Trix soil is in the Loamy Bottom, 7-10" p.z.

47—Mohave soils and Urban land, 1 to 8 percent slopes.

This map unit is on broad, gently sloping fan terraces shallowly dissected by ephemeral drainageways. Elevation is 2,200 to 3,300 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit has no regular pattern. Every delineation has at least one of the major components and may have both. Each of the components, however, need not be in every delineation. The percentage varies from one area to another.

Included in this unit are small areas of Bucklebar, Sahuarita, and Tubac soils intermingled with the Mohave soils, Hantz soils in drainageways, and Yaqui soils on alluvial fans. Low-lying included areas along the drainageways are subject to very brief seasonal periods of flooding.

The Mohave soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface layer is yellowish brown loam about 3 inches thick. The subsurface layer is brown sandy loam 3 inches thick. The upper 5 inches of the subsoil is brown sandy clay loam, the next 13 inches is brown and light brown clay loam, and the lower 16 inches is reddish brown sandy clay loam and mixed light reddish brown and pink clay loam. The substratum to a depth of 60 inches or more is light reddish brown and white loam. In places, these soils are effervescent to the surface. Many soft masses of lime are in the lower part of the subsoil and in the substratum. In some areas, the surface layer is gravelly sandy loam.

Permeability of the Mohave soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow to medium, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is moderate.

Urban land consists of areas of soil so altered by construction or obscured by structures and pavement that identification of the soil is difficult or impossible. Most of the Urban land is located in the city of Tucson. In general, the underlying and interspersed soil material has many of the characteristics of the Mohave soil in this unit.

Most areas of this unit are used for homesites and

urban development. A few areas are used for rangeland.

The potential plant community on this unit is mainly Arizona cottontop, threeawn, Rothrock grama, and bush muhly. The present vegetation in most areas is mainly triangle bursage, bush muhly, burweed, and creosotebush.

This soil is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem on much of this unit. The competition from woody plants must be reduced before this soil will respond to grazing management. Other suitable range management practices, such as fencing, livestock watering developments, and range seeding, can help to improve grazing distribution and the range condition.

If this unit is used for homesites or urban development, the main limitations are shrink-swell potential. If buildings are constructed on this soil, properly designing foundations and footings and diverting runoff away from buildings help to prevent structural damage because of shrinking and swelling. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential.

If this unit is used for septic tank absorption fields, the main limitations are moderately slow permeability. Absorption lines should be placed below the moderately slowly permeable layer. Increasing the size of the absorption area helps to compensate for the moderately slow permeability.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclasses VIIc. This soil is in the Loamy Upland, 10-13" p.z. range site.

48—Nahda-Pinaleno complex, 2 to 8 percent slopes.

This map unit is on gently sloping fan terraces. Elevation is 1,800 to 2,200 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 40 percent Nahda extremely gravelly sandy loam and 30 percent Pinaleno very cobbly sandy loam. Nahda soils are on broad, gently sloping summits that have slope gradients of 2 to 4 percent, and Pinaleno soils are on shoulders and backslopes that have slope gradients of 2 to 8 percent.

Included in this unit are small areas of Mohave

and Stagecoach soils. Also included are small areas of Anklam and Pantano soils on pediments and Nahda soils that have less than 35 percent rock fragments. Included areas make up about 30 percent of the total acreage.

The Nahda soil is moderately deep to a lime-cemented hardpan and well drained. It formed in alluvium derived dominantly from volcanic rock. Typically, the surface is light brown extremely gravelly sandy loam 2 inches thick. The subsoil is reddish brown very gravelly clay and very gravelly clay loam 27 inches thick. A pinkish white and a pinkish gray lime indurated hardpan is at a depth of 29 inches. Depth to the hardpan is 20 to 40 inches.

Permeability of the Nahda soil is slow. Effective rooting depth is 20 to 40 inches. Available water capacity is low. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

The Pinaleno soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 30 percent cobble and stones and 20 percent gravel. The surface layer is brown very cobbly sandy loam about 2 inches thick. The upper 28 inches of the subsoil is reddish brown and red extremely cobbly sandy clay loam. The lower 30 inches is pink extremely gravelly sandy clay loam. These soils generally are noneffervescent in the upper solum. In some areas, the surface layer is very gravelly sandy loam.

Permeability of this Pinaleno soil is moderately slow. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

This unit is used for rangeland.

The potential plant community on the Nahda soil is mainly threeawn, tobosa, annual grasses, and forbs. The present vegetation in most areas is buckhorn cholla, scattered creosotebush, and triangle bursage. The potential plant community on the Pinaleno soil is mainly creosotebush, white ratany, triangle bursage, and cacti. The present vegetation in most areas is mainly creosotebush, buckhorn cholla, triangle bursage, and saguaro.

This unit is easily traversed by livestock. Production of forage for livestock grazing is limited by low rainfall and extremely gravelly soil surfaces. Included soils in drainageways produce most of the forage for livestock on this unit. Grazing management should be focused on improving forage production in these drainageways.

This unit is moderately well suited to desertic

herbaceous plants and desertic shrubs and trees for wildlife.

The Nahda soil is in capability subclass VII_s and in the Clay Loam Upland, 10-13" p.z. range site. The Pinaleno soil is in capability subclass VII_s and in the Loamy Upland, 10-13" p.z. range site.

49 —Nahda-Stagecoach complex, 1 to 15 percent slopes.

This map unit is on nearly level to strongly sloping fan terraces. Elevation is 2,200 to 3,000 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 50 percent Nahda extremely gravelly sandy loam and 40 percent Stagecoach very gravelly sandy loam. The Nahda soils are on fan terraces that have gradients of 1 to 15 percent, and the Stagecoach soils are on fan terraces that have gradients of 3 to 15 percent. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are areas of Delnorte soils that have lime-cemented hardpans at shallow depths, Arizo soils that are sandy and gravelly in drainageways that flood, soils high in clay that have less than 35 percent rock fragments that have lime-cemented hardpans, soils high in clay that are shallow to a hardpan, Bucklebar soils that have 18 to 35 percent clay, soils that have a hardpan over bedrock, and Nahda soils that have a fine sandy loam surface texture or redder color. Included areas make up about 10 percent of the total acreage.

The Nahda soil is moderately deep to a lime-cemented hardpan and well drained. It formed in alluvium derived dominantly from volcanic rock. Typically, the surface layer is light brown extremely gravelly sandy loam 2 inches thick. The subsoil is reddish brown very gravelly clay and very gravelly clay loam 27 inches thick. A pinkish white and a pinkish gray lime-indurated hardpan is at a depth of 29 inches. Depth to the hardpan is 20 to 40 inches.

Permeability of the Nahda soil is slow. Effective rooting depth is 20 to 40 inches. Available water capacity is low. Runoff is medium. The hazard of water erosion is slight, and the hazard of wind erosion is very slight.

The Stagecoach soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface layer is brown very gravelly sandy loam 10 inches thick. The subsoil is pink, pinkish gray and pinkish white very gravelly loam and extremely gravelly loam

30 inches thick. The substratum to a depth of 60 inches or more is light brown very gravelly loamy sand. These soils are generally calcareous throughout.

Permeability of the Stagecoach soil is moderate. Effective rooting depth is 60 or more inches. Available water capacity is low. Runoff is medium. The hazard of water erosion is slight, and the hazard of wind erosion is very slight.

This unit is used for rangeland.

The potential plant community on the Nahda soil is mainly paloverde, ironwood, mesquite, bush muhly, threeawn, and Rothrock grama. The present vegetation is mainly creosotebush, ocotillo, paloverde, triangle bursage, and ironwood. The potential plant community on the Stagecoach soil is mainly creosotebush, bush muhly, red grama, slim tridens, threeawn, desert zinnia, coldenia, and paloverde. The present vegetation is mainly creosotebush, paloverde, triangle bursage, white ratany, ocotillo, fluffgrass, ironwood, saguaro, cholla, annual grasses, and forbs.

This unit is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem on much of this soil. The competition from woody plants must be reduced before this unit will respond to grazing management. This area has inclusions of Clayey Upland range sites. Included soils in drainageways in this unit produce most of the forage used by livestock. Grazing management should be focused on improving forage production in these drainageways. Suitable range management practices to improve grazing distribution and range condition include fencing, livestock water developments, and range seeding.

This unit is poorly suited to desertic herbaceous plants and desert shrubs and trees for wildlife.

This map unit is in capability subclass VII_s, nonirrigated. The Nahda soil is in the Loamy Upland, 10-13" p.z. range site that has inclusions of Clayey Upland. The Stagecoach soil is in the Limy Upland, (Deep), 10-13" p.z. range site.

50—Nahda very cobbly loam, 2 to 8 percent slopes.

This moderately deep to a lime-cemented hardpan and well drained soil is on gently sloping fan terraces at the base of volcanic hills and mountains. It formed in alluvium derived dominantly from volcanic rock. Elevation is 2,200 to 3,600 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air

temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

Typically, the surface is covered by 50 to 65 percent cobble, gravel and some stones. The surface layers are brown and reddish brown very cobbly loam about 5 inches thick. The subsoil is reddish brown very gravelly clay and very gravelly clay loam 24 inches thick. A pinkish white and pinkish gray lime indurated hardpan is at a depth of 29 inches. Depth to hardpan is 20 to 40 inches. In some areas, the surface layer is very gravelly fine sandy loam. The surface layer is stony or very stony in a few areas. The subsoil is not as red in some areas.

Included in this unit are small areas of Delnorte soils on relict fan terraces and Pinaleno soils on fan terraces and Mohave soils on lower terraces and basin floors. Also included are small areas of basalt Rock outcrop. Included areas make up about 15 percent of the total acreage.

Permeability of this Nahda soil is slow. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight. In the vicinity of the San Pedro River, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

Most areas of this unit are used for rangeland. A few areas are used for homesites.

The potential plant community on this unit is mainly threeawn, curlymesquite, false-mesquite, and bush muhly. The present vegetation in most areas is mainly cacti, cholla, paloverde, and triangle bursage.

This soil is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem on much of this soil. The competition from woody plants must be reduced before this soil will respond to grazing management. Other suitable range management practices, such as fencing, livestock watering developments, and range seeding, can help to improve grazing distribution and the range condition.

If this unit is used for homesite development, the main limitations are the potential for shrinking and swelling, large stones, and moderate soil depth to hardpan. The hardpan is rippable and therefore is not a serious limitation for most engineering uses. If buildings are constructed on the Nahda soil, properly designing foundations and footings and diverting runoff away from buildings will help to prevent structural damage because of shrinking and swelling.

When preparing building sites, the limitation of cobble and stones on the surface and in the soil can easily be overcome by using heavy equipment. It is difficult to establish vegetation in areas where the surface layer has been removed, exposing the hardpan. If deep-rooted shrubs and trees are grown, it generally is necessary to excavate pits through the hardpan or the cemented, limy material into more suitable and permeable material and to backfill with good soil material and organic matter. Plants native to the area are most suitable for landscaping.

If this unit is used for septic tank absorption fields, the main limitations are moderate soil depth to hardpan and slow permeability. Absorption lines should be placed below the hardpan and slowly permeable layer. Increasing the size of the absorption area helps to compensate for the slow permeability. The limitation of slow permeability can also be overcome by removing the soil in the absorption field and then backfilling with more permeable material and by enlarging the absorption field. Installing aerating or holding tanks or using separate absorption fields for kitchen and laundry waste and for toilet water are alternate methods of waste disposal.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Nahda soil is in capability subclass VII₂ and in the Clay Loam Upland, 10-13" p.z. range site.

51—Nolam-Tombstone complex, 8 to 30 percent slopes.

This map unit is on rolling to hilly fan terraces. Elevation is 3,500 to 5,000 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 45 percent Nolam extremely gravelly fine sandy loam on fan terraces that have gradients of 8 to 15 percent and 40 percent Tombstone very gravelly loam on hilly fan terraces that have gradients of 15 to 30 percent. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Bernardino and White House soils on nearly level to slightly concave crests, Caralampi soils intermingled with Nolam soils on fan terrace shoulders, and Kimrose family soils on relict fan terraces. Also included are small areas of Comoro, Riveroad, and Keysto soils on stream terraces along drainageways. Included areas make up about 15 percent of the total acreage.

The Nolam soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 40 to 60 percent gravel and a few cobble. The surface layer is brown extremely gravelly fine sandy loam about 1 inch thick. The upper 18 inches of the subsoil is reddish brown and light reddish brown very gravelly sandy clay loam. The lower 41 inches or more is pink extremely gravelly sandy loam. These soils are calcareous throughout. Many soft masses of lime are in the subsoil and substratum. In some areas, the surface layer is extremely gravelly loam.

Permeability of the Nolam soil is moderate. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

The Tombstone soil is very deep and well drained. It formed in gravelly alluvium derived dominantly from calcareous sedimentary rock. Typically, the surface is covered by 50 to 65 percent gravel and scattered cobble. The surface layers are grayish brown and dark grayish brown very gravelly loam about 13 inches thick. The subsoil to a depth of 60 inches or more is white and light gray extremely gravelly loam. These soils are calcareous throughout. Many soft masses of lime are in the subsoil and substratum. In some areas, the surface layer is thinner and lighter in color.

Permeability of the Tombstone soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is moderate. The hazard of wind erosion is very slight. In the vicinity of Cienega Creek north of Interstate 10 and along Marsh Station Road, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

This unit is used for rangeland.

The potential plant community on the Nolam soil is mainly sideoats grama, black grama and false-mesquite. The potential plant community on the Tombstone soil is mainly black grama, sideoats grama, hairy grama, and slim tridens. The present vegetation in most areas is mainly grama grasses, threeawn, slim tridens, false-mesquite, mesquite, and curlymesquite.

This unit is easily traversed by livestock. It provides forage for year-round use. The vegetation on the Nolam soil is preferred by livestock. Brush encroachment is a serious problem on this soil. Grazing management, including use of fencing and

livestock watering developments, helps to improve grazing distribution. Other suitable range management practices, such as range seeding and brush management, can help to improve the range condition.

This unit is well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Nolam soil is in capability class VIs nonirrigated, and the Tombstone soil is in capability subclass VIs, nonirrigated. The Nolam soil is in the Loamy Upland, 12-16" p.z. range site, and the Tombstone soil is in the Limy Slopes, 12-16" p.z. range site.

52—Oracle-Romero-Rock outcrop complex, 5 to 35 percent slopes.

This map unit is on hilly granitic pediments and steep hills. Elevation is 3,400 to 5,000 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 30 percent Oracle very gravelly loam, on slopes of 5 to 20 percent, 25 percent Romero very gravelly sandy loam on slopes of 10 to 35 percent, and 20 percent Rock outcrop. The amount of Rock outcrop varies from about 5 percent in some areas to as much as 30 to 40 percent in other areas. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Caralampi and White House soils on inset fan terraces and Comoro soils on fan terraces and stream terraces along drainageways. Also included are small areas of Deloro and Lampshire soils. Included areas make up about 25 percent of the total acreage.

The Oracle soil is shallow and well drained. It formed in alluvium and colluvium derived dominantly from granite and granodiorite. Typically, the surface is covered by 45 to 55 percent fine and medium gravel and a few cobble. The surface layer is dark grayish brown very gravelly loam about 1 inch thick. The subsurface layer is dark grayish brown gravelly loam 4 inches thick. The subsoil is brown gravelly clay loam 13 inches thick. Fractured granite (grus) with clay in the fractures is at a depth of 18 inches. Depth to bedrock ranges from 10 to 20 inches. In some areas, the surface layer is very gravelly sandy loam and lighter in color than is typical. In a few places, the subsoil has more gravel than is typical.

Permeability of the Oracle soil is moderately slow.

Available water capacity is very low. Effective rooting depth is 10 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is medium to very rapid, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is very slight.

The Romero soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from granite, granodiorite, or pegmatite. Typically, the surface is covered by 40 to 55 percent fine and medium gravel and a few cobble. The surface layer is dark grayish brown very gravelly sandy loam about 2 inches thick. The subsurface layer is very dark grayish brown very gravelly fine sandy loam 8 inches thick. Fractured granite (grus) with subsurface material and clay in the fractures is about 7 inches thick. At 17 inches is weathered granite (grus). Depth to bedrock ranges from 4 to 20 inches. In a few areas, bedrock is deeper than typical. In some areas, the surface layer is thinner and lighter in color than is typical.

Permeability of the Romero soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 4 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is rapid to very rapid, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is very slight.

Rock outcrop occurs as ledges and boulder piles scattered throughout the unit.

Most areas of this unit are used for rangeland. A few areas are used for recreational areas.

The potential plant community on this unit is mainly sideoats grama, hairy grama, plains lovegrass, and false-mesquite. The present vegetation in most areas is mainly turpentinebush, false-mesquite, threeawn, grama grasses, and some oak and juniper at higher elevations on north-facing slopes.

This unit produces forage for year-round use. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution on the Romero soil. Grazing pressure is concentrated on the Oracle soil where slopes are more gentle. Grazing management, including use of fencing and livestock watering developments, helps to improve grazing distribution and the range condition.

If this unit is used for recreational development, the main limitations are slope and depth to bedrock. Less sloping areas of the unit can be used as campsites, picnic areas, and playgrounds. Paths and

trails should be constructed on the contour where possible.

Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The soils in this map unit are in capability subclass VI_s. The Oracle soil is in the Shallow Upland, 12-16" p.z. range site, and the Romero soil is in the Granitic Hills, 12-16" p.z. range site. Rock outcrop is not assigned a range site and is in capability class VIII.

53—Pahaka fine sandy loam, 1 to 5 percent slopes.

This very deep and well drained soil is on gently sloping fan terraces. It formed in mixed alluvium. Elevation is 1,650 to 2,200 feet. The mean annual precipitation is 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

Typically, the surface layer is reddish yellow fine sandy loam about 3 inches thick. The subsoil is brown sandy loam 11 inches thick. The next layer is yellowish brown and strong brown sandy loam 16 inches thick. The substratum to a depth of 60 inches or more is a buried subsoil that is yellowish red and light brown clay loam.

Included in this unit are small areas of Mohall, Pinamt, and Denure soils. Also included are small areas of sandy alluvial soils in and along narrow drainageways. The included soils in and near drainageways are subject to rare seasonal periods of flooding because of run-on from adjacent uplands. Included areas make up about 15 percent of the total acreage.

Permeability of the Pahaka soil is moderately rapid in the upper part and moderately slow in the lower part. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff generally is slow to medium, and the hazard of water erosion is slight to moderate. Shallow rills are in some areas, and deposition of soil around the vegetation in these areas is common. The hazard of wind erosion is moderately high.

Most areas of this unit are used for rangeland.

The potential plant community on this unit is mainly creosotebush, white ratany, triangle bursage, and annual forbs and grasses. The present vegetation in most areas is mainly creosotebush, annual forbs, mesquite, Mediterraneangrass, and triangle bursage.

This soil is easily traversed by livestock. Production of forage for livestock grazing is limited by low rainfall. Forage production, consisting of annual forbs and grasses, can be high in years when precipitation in winter and spring is good. Grazing management, such as turning on and off livestock watering developments, can help to improve grazing distribution economically.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclasses VII_s, nonirrigated. This soil is in the Limy Fan, 7-10" p.z. range site.

54—Palos Verdes-Jaynes complex, 2 to 8 percent slopes.

This map unit is on gently sloping relict fan terraces. Elevation is 2,200 to 3,200 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 40 percent Palos Verdes gravelly sandy loam and 35 percent Jaynes gravelly sandy loam. Also in this unit is about 10 percent Delthorny extremely cobbly fine sandy loam. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Tubac, Hayhook, Mohave, Pinaleno, and Sahuarita soils on fan terraces. Also included are small areas of Arizo soils in drainageways and channel bottoms. Included areas make up about 15 percent of the total acreage.

The Palos Verdes soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 15 to 35 percent gravel. The surface layer and upper part of the subsoil is brown gravelly sandy loam about 3 inches thick. The next 12 inches of the subsoil is reddish brown gravelly sandy clay loam. The lower 4 inches is yellowish red and reddish brown gravelly sandy loam. The upper part of the substratum is pinkish white and pink compacted unconsolidated sandy loam 19 inches thick. The lower part of the substratum to a depth of 60 inches or more is pinkish white and pink compacted unconsolidated gravelly loamy coarse sand. Depth to compacted unconsolidated sediments ranges from 8 to 20 inches.

Permeability of the Palos Verdes soil is moderately slow in the upper part and very slow in the lower part of the profile. Available water capacity is low. Effective rooting depth is 8 to 20 inches. However,

roots and water may be present to a depth of 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is slight.

The Jaynes soil is very deep and well drained. It formed in alluvium derived dominantly from schist and gneiss. Typically, the surface is covered by 20 to 30 percent gravel. The surface layer is light yellowish brown gravelly sandy loam about 5 inches thick. The next layer is pale brown gravelly sandy loam 5 inches thick. The substratum is light brown compacted unconsolidated loamy fine sand 23 inches thick. To a depth of 60 inches or more is a reddish yellow and pinkish white compacted unconsolidated loamy fine sand. The soil is calcareous throughout. Depth to compacted unconsolidated sediments ranges from 4 to 16 inches.

Permeability of the Jaynes soil is moderately rapid in the upper part and very slow in the lower part of the profile. Available water capacity is very low. Effective rooting depth is 4 to 16 inches. In many places, the sediments have been ruptured by rodents or other agents, and roots penetrate deeper. Runoff is medium rapid, and the hazard of water erosion is slight. The hazard of wind erosion is moderately high.

This unit is used mainly for homesites and other urban development including recreation. It is also used for rangeland. A few small areas in the foothills of the Santa Catalina Mountains are used for growing citrus.

The potential plant community on the Palos Verdes soil is mainly bush muhly, Rothrock grama, threeawn, and Arizona cottontop. The potential plant community on the Jaynes soil is mainly creosotebush, bush muhly, fluffgrass, and slim tridens. The present vegetation in most areas is mainly creosotebush, paloverde, triangle bursage, and mesquite.

This unit is easily traversed by livestock. The Palos Verdes soil produces forage for year-round use. It responds to good grazing management. Production of forage for livestock grazing on the Jaynes soil is limited by high concentrations of lime at or near the soil surface. Suitable range management practices, such as fencing, livestock watering developments, brush management, and range seeding, can help to improve grazing distribution and the range condition.

This unit is well suited to recreational development. It is limited mainly by depth to compacted unconsolidated sediments. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

Population growth has resulted in increased construction of homes on this unit. The main limitation is depth to compacted unconsolidated

sediments. The sediments are rippable and therefore are not a serious limitation for most engineering uses. Preserving the existing plant cover during construction helps to control erosion.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is poorly suited to irrigated grain and seed crops and moderately well suited to irrigated domestic grasses and legumes for wildlife.

This map unit is in capability subclass IVs, irrigated, and VIIs, nonirrigated. The Palos Verdes soil is in the Loamy Upland, 10-13" p.z. range site, and the Jaynes soil is in the Limy Upland, 10-13" p.z. range site.

55—Palos Verdes-Sahuarita complex, 2 to 8 percent slopes.

This map unit is on undulating fan terraces and relict fan terraces. Elevation is 2,600 to 3,600 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 40 percent Palos Verdes gravelly sandy loam and 40 percent Sahuarita very gravelly fine sandy loam. Palos Verdes soils are on relict fan terraces. Sahuarita soils are on fan terraces. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Bucklebar, Hayhook, Tubac, Jaynes, and Pinaleno soils. Also included are small areas of Arizo soils in drainageways and channel bottoms. Included areas make up about 20 percent of the total acreage.

The Palos Verdes soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 15 to 35 percent gravel. The surface layer is brown gravelly sandy loam about 3 inches thick. The upper 12 inches of the subsoil is reddish brown gravelly sandy clay loam. The lower 4 inches is yellowish red and reddish brown gravelly loam. The next layer is a pinkish white and pink compacted unconsolidated sandy loam 19 inches thick. The substratum to a depth of 60 inches or more is pinkish white and pink compacted unconsolidated gravelly loamy coarse sand. Depth to compacted unconsolidated sediments ranges from 8 to 20 inches.

Permeability of the Palos Verdes soil is moderately slow in the upper part and very slow in the lower part of the profile. Available water capacity is low. Effective rooting depth is 8 to 20 inches. However, roots and water may be in fractures to a depth of 60

inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is slight.

The Sahuarita soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 35 to 55 percent gravel. The surface layer is light yellowish brown very gravelly fine sandy loam about 3 inches thick. The subsoil is light yellowish brown fine sandy loam 25 inches thick. The next layer is a buried subsoil of brown loam 17 inches thick and brown very gravelly sandy clay loam 15 or more inches thick. Common fine lime filaments are in the buried subsoil. These soils are calcareous throughout. Depth to the buried subsoil ranges from 20 to 40 inches. In some areas, the surface layer is fine sandy loam.

Permeability of the Sahuarita soil is moderate in the upper part, over moderately slow in the lower part of the profile. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow to medium, but the included soils in and near drainageways are subject to rare seasonal periods of flooding because of run-on from adjacent uplands. Runoff is rapid in the many shallow rills and the few deep gullies. The hazard of water erosion is slight. The hazard of wind erosion is very slight.

This unit is used mainly for rangeland. It is also used for homesites. A few small areas in the foothills of the Santa Catalina Mountains are used for growing citrus.

The potential plant community on this unit is mainly bush muhly, Rothrock grama, threeawn, and Arizona cottontop. The present vegetation in most areas is mainly paloverde, whitethorn, burweed, and cacti.

This unit is easily traversed by livestock. This unit produces forage for year-round use. It responds to good grazing management. Suitable range management practices, such as fencing, livestock watering developments, brush management, and range seeding, can help to improve grazing distribution and the range condition.

If this unit is used for homesite development, the main limitation is depth to compacted unconsolidated sediments on the Palos Verdes soil. The sediments are rippable and therefore are not a serious limitation for most engineering uses.

If this unit is used for septic tank absorption fields, the main limitations are moderately slow permeability and depth to compacted unconsolidated sediments on the Palos Verdes soil. In areas where extensive cuts and fills have been made, addition of topsoil may be needed to establish vegetation.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is poorly suited to irrigated grain and seed crops and moderately well suited to irrigated domestic grasses and legumes for wildlife.

The Palos Verdes soil is in capability subclass IVs, irrigated, and VIIs, nonirrigated and in the Loamy Upland 10-13" p.z. range site. The Sahuarita soil is in capability subclass IIs, irrigated, and VIIs, nonirrigated, and in the Sandy Loam Upland, 10-13" p.z. range site.

56—Pantak-Deloro complex, 8 to 35 percent slopes.

This map unit is on rolling hills, pediments, and small mountains. Elevation is 3,300 to 5,400 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 50 percent Pantak very gravelly loam and 20 percent Deloro extremely channery loam. Also in this unit is about 5 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are Graham and Lampshire soils. Also included are small areas of Keysto soils in and along drainageways and Caralampi and White House soils on fan terraces. Included areas make up about 25 percent of the total acreage.

The Pantak soil is very shallow and shallow and well drained. It formed in mixed alluvium and colluvium derived dominantly from rhyolite, andesite, conglomerate, and igneous rock. Typically, the surface is covered by 45 to 60 percent gravel, cobble, and stones. The surface layer is brown very gravelly loam about 1 inch thick. The subsoil is dark brown extremely gravelly clay loam 7 inches thick over highly fractured andesite with clay films in the fractures. These soils generally are noncalcareous throughout. Depth to bedrock ranges from 6 to 20 inches. In some areas, the surface layer is very gravelly clay loam or very cobbly loam.

Permeability of the Pantak soil is moderate. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is medium to very rapid, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is very slight.

The Deloro soil is shallow and well drained. It formed in mixed alluvium and colluvium. Typically, the surface is covered by 65 to 70 percent channers and flagstones. The surface layer is brown to dark brown extremely channery loam about 2 inches thick. The

subsoil is reddish brown extremely channery clay 9 inches thick. Fractured and weathered phyllite with clay in the fractures is to a depth of 60 inches or more. Depth to bedrock ranges from 10 to 20 inches. These soils generally are noncalcareous throughout. In some areas, the surface layer is extremely gravelly loam.

Permeability of the Deloro soil is slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is rapid to very rapid, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is very slight.

Most areas of this unit are used for rangeland. A few areas are used for open pit copper mining.

The potential plant community on this unit is mainly sideoats grama, slender grama, cane bluestem, and false-mesquite. The present vegetation in most areas is mainly ocotillo, curlymesquite, janusia, and false-mesquite.

This unit produces forage for year-round use. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution. Fencing, livestock watering developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time help to overcome the grazing distribution problems. Controlled burning and brush management help to improve grazing distribution and the range condition.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VI.

This unit is in the Volcanic Hills, 12-16" p.z. range site.

57—Pantak-Rock Outcrop complex, 25 to 50 percent slopes.

This map unit is on steep hills and mountains. Elevation is 4,000 to 5,500 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 50 percent Pantak very gravelly loam and 20 percent Rock outcrop.

Included in this unit are small areas of Caralampi and White House soils on fan terraces and small areas of Deloro, Graham, and Lampshire soils. Also included are small areas of Keysto soils in and along drainageways. Included areas make up about 30 percent of the total acreage.

The Pantak soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from rhyolite, andesite, and igneous rock. Typically, the surface is covered by 45 to 60 percent gravel, cobble, and stones. The surface layer is brown very gravelly loam about 1 inch thick. The subsoil is dark brown extremely gravelly clay loam 7 inches thick over highly fractured rhyolitic tuff with clay films in the fractures. These soils generally are noncalcareous throughout. Depth to bedrock ranges from 6 to 20 inches. In some areas, the surface layer is very gravelly clay loam or very cobbly loam.

Permeability of the Pantak soil is moderate. Available water capacity is very low. Effective rooting depth is 6 to 20 inches. Runoff is very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

Rock outcrop consists of exposed areas of rhyolitic tuff and conglomerate. It occurs as low ledges and occasional pinnacles. The soil and the areas of Rock outcrop are intricately intermingled; however, a higher percentage of Rock outcrop is in areas near the hilltops and mountaintops.

Most areas of this unit are used for rangeland. A few areas are used for mining operations.

The potential plant community on the Pantak soil is mainly sideoats grama, false-mesquite, slender grama, and plains lovegrass. The present vegetation in most areas is mainly mesquite, cacti, whitethorn, and curlymesquite.

This unit produces forage for year-round use. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution. Fencing, livestock watering developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time help to overcome the grazing distribution problems. Controlled burning and brush management help to improve grazing distribution and the range condition.

This unit is well suited to desertic herbaceous plants and moderately well suited to desertic shrubs and trees for wildlife.

The Pantak soil is in capability subclass VIIe and in the Volcanic Hills, 12-16" p.z. range site. Rock outcrop is not assigned a range site and is in capability class VIII.

58—Pantano-Granolite complex, 5 to 25 percent slopes.

This map unit is on rolling and hilly pediments at the base of mountains. Elevation is 2,400 to 3,600

feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 40 percent Pantano extremely gravelly loam and 35 percent Granolite extremely gravelly sandy loam. Also in this unit is about 10 percent Rock outcrop. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Mohave, Stagecoach, Palos Verdes, and Pinaleno soils on fan terraces, Chimenea and Lehman soils on less sloping pediments, and Saguaro soils on limestone hills. Also included are small areas of Arizo soils in and along drainageways. Included areas make up about 15 percent of the total acreage.

The Pantano soil is shallow and well drained. It formed in mixed alluvium and colluvium. Typically, the surface is covered by 65 to 70 percent gravel and cobble. The surface layer is pale brown extremely gravelly loam about 1 inch thick. The upper 9 inches of the subsoil is brown very gravelly loam. The lower 6 inches of the subsoil is white and pale brown extremely gravelly loam. Lime-coated highly fractured schist is at a depth of 16 inches. Depth to bedrock ranges from 10 to 20 inches. The soil has many lime masses in the subsoil. In some areas, the surface layer is extremely gravelly loam.

Permeability of the Pantano soil is moderate. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is medium to very rapid, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is very slight.

The Granolite soil is shallow and well drained. It formed in mixed alluvium and residuum derived dominantly from fractured rhyolite. Typically, the surface is covered by 55 to 65 percent gravel, cobble, and stones. The surface layer is reddish brown extremely gravelly sandy loam about 2 inches thick. The subsoil is dark reddish brown and dark yellowish brown extremely gravelly sandy clay 14 inches thick. Weathered rhyolite that has clay in the fractures is at a depth of 16 inches. Unweathered rhyolite is at 24 inches. Depth to bedrock ranges from 10 to 20 inches. In some areas, the surface layer is very gravelly sandy clay loam or very cobbly sandy loam.

Permeability of the Granolite soil is slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. However, roots and water may be in fractures to a depth of 20 to 30 inches. Runoff is

medium to very rapid, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is very slight.

This unit is used mainly for rangeland. It is also used for homesites, urban development and recreational areas.

The potential plant community on the Pantano soil is mainly creosotebush, bush muhly, slim tridens, and ratany. The potential plant community on the Granolite soil is mainly Arizona cottontop, false-mesquite, slender grama, and bush muhly. The present vegetation in most areas is mainly paloverde, cacti, whitethorn, and triangle bursage. Creosotebush is common on Pantano soils.

This unit is easily traversed by livestock. The Granolite soil produces forage for year-round use. It responds to good grazing management. Production of forage for livestock grazing on the Pantano soil is limited by high concentrations of lime in the soil. Suitable range management practices, such as fencing, and livestock watering developments, can help to improve grazing distribution and the range condition.

If this unit is used for recreational development, the main limitations are coarse fragments on the surface, depth to bedrock, and slope. Less sloping areas of the unit can be used as campsites, picnic areas, and playgrounds. Paths and trails should be constructed on the contour where possible. Erosion and sedimentation can be controlled and the beauty of the area enhanced by maintaining adequate plant cover.

If this unit is used for homesites or urban development, the main limitations are depth to bedrock and slope. Excavation for buildings and roads is limited by shallow depth to bedrock. Because removal of the bedrock to a suitable depth is costly, consider construction methods that do not involve excavation of the bedrock. Roads and building sites should conform to the natural landscape so as to minimize erosion.

If this unit is used for septic tank absorption fields, the main limitations are depth to bedrock and slope. Septic tank absorption fields may not function properly because of the shallow depth to bedrock. Consider the use of holding tanks or absorption beds.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VII. The Pantano soil is in the Limy Upland, 10-13" p.z. range site, and the Granolite soil is in the Shallow Upland, 10-13" p.z. range site.

59—Pantano-Rock Outcrop complex, 25 to 60 percent slopes.

This map unit is on steep hills and mountains. Elevation is 2,200 to 3,800 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 50 percent Pantano extremely gravelly loam on slope gradients of 25 to 50 percent and 25 percent Rock outcrop. The soil and the areas of Rock outcrop are intricately intermingled; however, a higher percentage of Rock outcrop is in areas near the hilltops and mountaintops.

Included in this unit is Anklam soils intermingled with Pantano soils, Cave soils on relict fan terraces, Stagecoach soils on fan terraces, and Saguaro soils on limestone hills and mountains. Also included are small areas of Arizo soils in and along drainageways and sandstone Rock outcrop. Included areas make up about 25 percent of the total acreage.

The Pantano soil is shallow and well drained. It formed in mixed alluvium and colluvium. Typically, the surface is covered by 65 to 70 percent gravel and cobble. The surface layer is pale brown extremely gravelly loam about 1 inch thick. The upper 9 inches of the subsoil is brown very gravelly loam. The lower 6 inches is white and pale brown extremely gravelly loam. Lime-coated highly fractured schist is at a depth of 16 inches. Depth to bedrock ranges from 10 to 20 inches. The soil has many lime masses in the subsoil. A few areas have subsoils that are redder and contain more clay than is typical. In addition, some areas have higher concentrations of lime than is typical.

Permeability of the Pantano soil is moderate. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

Rock outcrop consists of exposed areas of schist. It occurs as low ledges and very steep cliffs.

This unit is used mainly for rangeland. It is also used for recreational areas.

The potential plant community on the Pantano soil is mainly creosotebush, bush muhly, slim tridens, and ratany. The present vegetation in most areas is mainly creosotebush, brittlebush, paloverde, and bush muhly.

Included soils in drainageways on this unit produce most of the forage for use by livestock. Grazing management should be focused on improving forage

production in these drainageways. Other suitable range management practices, such as fencing and livestock watering developments, can help to improve grazing distribution.

If this unit is used for recreational development, the main limitations are coarse fragments on the surface, depth to bedrock, and slope. Slope limits the use of areas of this unit mainly to a few paths and trails, which should extend across the slope.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Pantano soil is in capability subclass VIIe and in the Gravelly Hills, 10-13" p.z. range site. Rock outcrop is not assigned a range site and is in capability class VIII.

60—Pinaleno-Stagecoach complex, 5 to 16 percent slopes.

This map unit is on strongly sloping fan terraces. Elevation is 2,200 to 3,600 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 40 percent Pinaleno very cobbly sandy loam and 35 percent Stagecoach very gravelly sandy loam. Pinaleno soils are on crests and shoulders that have gradients of 5 to 10 percent, Stagecoach soils are on shoulders and backslopes that have gradients of 5 to 16 percent.

Included in this unit are small areas of Tubac and Mohave soils on broad summits and Palo Verdes and Jaynes soils on relict fan terraces. Also included are small areas of rubble and talus at the footslopes of mountains. In these areas the rock fragments are 3 to 36 inches or more in diameter. Included areas make up about 25 percent of the total acreage.

The Pinaleno soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 30 percent cobble and stones and 20 percent gravel. The surface layer is brown very cobbly sandy loam about 2 inches thick. The upper 28 inches of the subsoil is reddish brown and red extremely cobbly sandy clay loam. The lower 30 inches is pink extremely gravelly sandy clay loam. These soils generally are noneffervescent in the upper solum. In some areas, the surface layer is very gravelly sandy loam.

Permeability of the Pinaleno soil is moderately slow. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

The Stagecoach soil is very deep and well drained. It formed in gravelly mixed alluvium. Typically, the surface is covered by 50 to 65 percent gravel and cobble. The surface layer is light brown very gravelly sandy loam about 10 inches thick. The next layer is a pink, pinkish gray, and pinkish white very gravelly loam and extremely gravelly loam 30 inches thick. The substratum to a depth of 60 inches or more is light brown very gravelly loamy sand. Many soft masses of lime are in the subsoil and substratum. These soils are calcareous throughout. In some areas, the surface layer is very cobbly sandy loam. In a few places, caliche is at a depth of 40 inches or more.

Permeability of the Stagecoach soil is moderate. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight. In the vicinity of Cienega Creek north of Interstate 10 and along Marsh Station Road, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

Most areas of this unit are used for rangeland and for homesites and recreational areas. A few areas are used for sand and gravel quarries.

The potential plant community on the Pinaleno soil is mainly bush muhly, threeawn, Arizona cottontop, and littleleaf paloverde. The present vegetation in most areas is mainly paloverde, triangle bursage, bush muhly, and saguaro and other cacti. The potential plant community on the Stagecoach soil is mainly creosotebush, fluffgrass, red grama, and bush muhly. The present vegetation in most areas is mainly creosotebush, paloverde, desert zinnia, and fluffgrass.

This unit is easily traversed by livestock. The Pinaleno soil produces forage for year-round use. It responds to good grazing management. Production of forage for livestock grazing on the Stagecoach soil is limited by high concentrations of lime in the soil. Suitable range management practices, such as fencing, livestock watering developments, brush management, and range seeding, can help to improve grazing distribution and the range condition.

This unit is well suited to recreational development. It is limited mainly by slope and large cobble and stones on the surface. Less sloping areas of the unit can be used as campsites, picnic areas, and playgrounds. Paths and trails should be constructed on the contour where possible.

If this unit is used for homesite development, the

main limitations are slope and high lime content in the Stagecoach soils. Erosion is a hazard in the steeper areas. Only the part of the site that is used for construction should be disturbed. Deep cuts needed to provide level building sites can expose underlying material that is high in content of lime. Revegetating disturbed areas around construction sites as soon as possible helps to control wind erosion. Lawn grasses, shrubs, and ornamental trees that tolerate excessive amounts of lime should be selected. Plants native to the area are most suitable for landscaping.

If this unit is used for septic tank absorption fields, the main limitations are moderately slow permeability in the subsoil and seepage in underlying material. Absorption lines should be placed below the slowly permeable layer. Increasing the size of the absorption area helps to compensate for the moderately slow permeability. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This unit is moderately well suited to desert herbaceous plants and desert shrubs and trees for wildlife.

The Pinaleno soil is in capability subclass VII_s and in the Loamy Upland, 10-13" p.z. range site. The Stagecoach soil is in capability subclass VII_s and in the Limy Upland (Deep), 10-13" p.z. range site.

61—Pinaleno-Stagecoach-Palos Verdes complex, 10 to 35 percent slopes.

This map unit is on moderately steep and steep fan terraces and relict fan terraces. Slopes are commonly 10 to 35 percent but range from 5 to 60 percent. Elevation is 2,400 to 3,600 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 35 percent Pinaleno very cobbly sandy loam, 35 percent Stagecoach very gravelly sandy loam, and 15 percent Palos Verdes gravelly sandy loam. Pinaleno soils are on shoulders and crests of fan terraces that have gradients of 10 to 35 percent. Stagecoach soils are on backslopes of fan terraces that have gradients of 20 to 35 percent, and Palos Verdes soils are on relict fan terraces that have gradients of 10 to 15 percent.

Included in this unit are small areas of badland on very steep eroded backslopes and Jaynes soils on relict fan terraces. Also included are small areas of Arizo soils and riverwash in washes. Included areas make up about 15 percent of the total acreage.

The Pinaleno soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 30 percent cobble and stones and 20 percent gravel. The surface layer is brown very cobbly sandy loam about 2 inches thick. The upper 28 inches of the subsoil is reddish brown and red extremely cobbly sandy clay loam. The lower 30 inches is pink extremely gravelly sandy clay loam. These soils generally are noneffervescent in the upper solum. In some areas, the surface layer is very gravelly sandy loam.

Permeability of the Pinaleno soil is moderately slow. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium to rapid, and the hazard of water erosion is moderate. The hazard of wind erosion is very slight. In the vicinity of the San Pedro River, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

The Stagecoach soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 50 to 65 percent gravel and cobble. The surface layer is light brown very gravelly sandy loam about 10 inches thick. The next layer is a pink, pinkish gray, and pinkish white very gravelly loam and extremely gravelly loam 30 inches thick. The substratum to a depth of 60 inches or more is light brown very gravelly loamy sand. Many soft masses of lime are in the subsoil and substratum. These soils are calcareous throughout. In some areas, the surface layer is very cobbly sandy loam. In a few places, caliche is at a depth of 40 inches or more.

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

The Palos Verdes soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 15 to 35 percent gravel. The surface layer is brown gravelly sandy loam about 3 inches thick. The upper 12 inches of the subsoil is reddish brown gravelly sandy clay loam. The lower 4 inches is yellowish red and reddish brown gravelly sandy loam. The next layer is a pinkish white and pink compacted unconsolidated sandy loam 19 inches thick. The substratum to a depth of 60 inches or more is pinkish white and pink compacted unconsolidated gravelly loamy coarse sand. Depth to compacted unconsolidated sediments ranges from 8 to 20 inches.

Permeability of the Palos Verdes soil is moderately slow. Available water capacity is low. Effective rooting depth is 8 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is slight.

Most areas of this unit are used for rangeland. A few areas are used for homesite and recreational areas.

The potential plant community on Pinaleno soil is mainly bush muhly, threeawn, Arizona cottontop, and littleleaf paloverde. The present vegetation in most areas is mainly paloverde, triangle bursage, bush muhly, and saguaro and other cacti. The potential plant community on the Stagecoach soil is mainly creosotebush, fluffgrass, red grama, and bush muhly. The present vegetation in most areas is mainly creosotebush, paloverde, desert zinnia, and fluffgrass. The potential plant community on the Palos Verdes soil is mainly bush muhly, Rothrock grama, threeawn, and plains bristlegrass. The present vegetation in most areas is mainly paloverde, triangle bursage, creosotebush, and cacti.

This unit produces forage for year-round use by livestock. Steepness of slope and stony surfaces limit access and result in poor grazing distribution. Grazing use is concentrated on ridgetops. Grazing management, including use of fencing and livestock watering developments, helps to improve grazing distribution.

If this unit is used for homesite development, the main limitations are slope on the Pinaleno and Stagecoach soils and depth to compacted unconsolidated sediments on the Palos Verdes soil. Erosion is a hazard in the steeper areas. Only the part of the site that is used for construction should be disturbed. Excavation for building sites is limited by the compacted unconsolidated sediments on the Palos Verdes soil. The compacted unconsolidated sediments are rippable and therefore not a serious limitation for most engineering uses. Plants native to the area are most suitable for landscaping.

If this unit is used for septic tank absorption fields, the main limitations are moderately slow permeability, slope, seepage potential, and the depth to compacted unconsolidated sediments on the Palos Verdes soil. Steepness of slope limits the distribution of effluent, which may surface at points downslope. Placing absorption lines on the contour slows the movement of effluent through the drains and promotes dispersion throughout the absorption field. If the density of housing is moderate to high, community sewage systems are needed to prevent

contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This unit is moderately suited to recreational development. Less sloping areas of the unit can be used as campsites, picnic areas, and playgrounds. Paths and trails should be constructed on the contour where possible.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Pinaleno soil is in capability subclass VII_s and in the Loamy Hills, 10-13" p.z. range site. The Stagecoach soil is in capability subclass VII_s and in the Limy Slopes, 10-13" p.z. range site. The Palos Verdes soil is in capability subclass VII_s and in the Loamy Upland, 10-13" p.z. range site.

62—Pinaleno very cobbly sandy loam, 1 to 8 percent slopes.

This very deep and well drained soil is on gently sloping fan terraces. It formed in mixed alluvium. Elevation is 2,200 to 3,450 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

Typically, the surface is covered by 30 percent cobble and stones and 20 percent gravel. The surface layer is brown very cobbly sandy loam about 2 inches thick. The upper 28 inches of the subsoil is reddish brown and red extremely cobbly sandy clay loam. The lower 30 inches is pink extremely gravelly sandy clay loam. These soils generally are noneffervescent in the upper solum. In some areas, the surface layer is very gravelly sandy loam.

Included in this unit are small areas of Nahda, Tubac, Mohave, Stagecoach, and Palos Verdes soils. Also included are small areas of Arizo soils and riverwash in drainageways and channel bottoms. Included areas make up about 20 percent of the total acreage.

Permeability of the Pinaleno soil is moderately slow. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight. In the vicinity of Cienega Creek north of Interstate 10 and along Marsh Station Road, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

Most areas of this unit are used for rangeland. A

few areas are used for homesites and urban development.

The potential plant community on this unit is mainly bush muhly, threeawn, Arizona cottontop, and plains bristlegrass. The present vegetation in most areas is mainly paloverde, saguaro and other cacti, creosotebush, and triangle bursage.

This soil is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem on much of this soil. The competition from woody plants must be reduced before this soil will respond to grazing management. Other suitable range management practices, such as fencing, livestock watering developments, and range seeding, can help to improve grazing distribution and the range condition.

This unit is well suited to homesites or urban development. It has few limitations. Plants native to the area are most suitable for landscaping.

If this unit is used for septic tank absorption fields, the main limitations are moderately slow permeability in the subsoil and seepage below the subsoil. Absorption lines should be placed below the moderately slowly permeable layer. Increasing the size of the absorption area helps to compensate for the moderately slow permeability. During the rainy season, effluent from onsite sewage disposal systems may seep at points downslope. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Pinaleno soil is in capability subclass VII_s and in the Loamy Upland, 10-13" p.z. range site.

63—Pinamt-Momoli complex, 1 to 10 percent slopes.

This map unit is on gently sloping fan terraces. Elevation is 1,800 to 2,200 feet. The mean annual precipitation is 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

This unit is 50 percent Pinamt very gravelly sandy loam and 30 percent Momoli very gravelly sandy loam. Pinamt soils are on crests and shoulders, and Momoli soils are on shoulders and backslopes.

Included in this unit are small areas of Mohall soils on broad fan terraces and soils moderately deep to a hardpan. Included areas make up about 20 percent of the total acreage.

The Pinamt soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 50 to 60 percent gravel. The surface layer is brown very gravelly sandy loam about 2 inches thick. The upper 22 inches of the subsoil is reddish brown and red extremely gravelly sandy clay loam. The lower 16 inches is reddish brown very gravelly sandy loam. The upper 12 inches of the substratum is light brown very gravelly sandy loam. The lower part to a depth of 60 inches or more is light brown very gravelly loamy coarse sand. Many soft masses of lime are in the subsoil and substratum. In some areas, the surface layer is very cobbly sandy loam.

Permeability of the Pinamt soil is moderately slow to a depth of 24 inches and moderately rapid below this depth. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

The Momoli soil is very deep and somewhat excessively drained. It formed in mixed alluvium. Typically, the surface is covered by 50 to 60 percent gravel and cobble. The surface layer is light brown very gravelly sandy loam about 10 inches thick. The subsoil is light brown very gravelly sandy loam 7 inches thick. The upper 21 inches of the substratum is light brown very gravelly sandy loam. The lower part to a depth of 60 inches or more is light brown very gravelly loamy coarse sand. These soils are calcareous throughout. In some pedons, a hardpan that is cemented with lime and silica is below a depth of 40 inches. In some areas, the surface layer is very cobbly sandy loam.

Permeability of the Momoli soil is moderately rapid to a depth of 38 inches and rapid below this depth. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow to medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

This unit is used as rangeland (fig. 7).

The potential plant community on the Pinamt soil is mainly creosotebush, white ratany, triangle bursage, and cacti. The potential plant community on the Momoli soil is mainly creosotebush, white ratany, big galleta, and bush muhly. The present vegetation in most areas is mainly creosotebush, littleleaf paloverde, ironwood, and triangle bursage.

This unit is easily traversed by livestock. It produces a limited amount of forage for year-round use. In years when precipitation in winter and spring is good, production of annual forbs and grasses on the Momoli soil is high. Grazing management should be focused on improving the range condition in

drainageways in and adjacent to this unit. Other suitable range management practices, such as fencing and livestock watering developments, can help to improve grazing distribution.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Pinamt soil is in capability subclass VII_s and in the Limy Upland, 7-10" p.z. range site. The Momoli soil is in capability subclass VII_s and in the Limy Upland, (Deep), 7-10" p.z. range site.

64—Pits, dumps.

This unit is on hills and mountains. Slopes range from 0 to over 100 percent. Areas are often rectangular in shape and range from 10 to over 1,000 acres in size. Elevation is 2,300 to 4,000 feet. The mean annual precipitation is 10 to 16 inches, the mean annual air temperature is 57 to 70 degrees F, and the frost-free period is 180 to 280 days.

This unit is 40 percent open pit mines, 20 percent extremely stony waste rock dumps, and 15 percent mine-tailing impoundments and mine support facilities such as buildings, equipment yards, and dike-enclosed undisturbed areas that will be used for future tailing ponds. Also in this unit is about 10 percent sanitary landfills and pits for source materials, such as sand, gravel and crushed limestone. About 8 large open-pit copper mines are located south and west of Tucson primarily in the Sierrita and Silver Bell Mountains. They are characterized by steep scarps on the ends and sides. In 1981, these mines produced 600 million pounds of copper, about 28 percent of Arizona's total production. Sanitary land-fills and sand and gravel pits are located mostly along major rivers and washes. Quarrying operations are scattered throughout the survey area, the largest being on the north end of the Tucson Mountains.

Included in this unit are small areas of Anklam and Pantano soils on volcanic hills, Romero soils on granite hills, Saguaro soils on limestone hills, and small areas of Hayhook, Palos Verdes, and Pinaleno soils on fan terraces. Also included are small areas of Torriorthents in areas of reclaimed dumps.

The open pit mines are as much as 1,500 feet deep and 2 miles in length at the top. Waste rock and ore are removed by large trucks and conveyor belts. Extremely stony waste rock is piled adjacent to the pits. Dumps extend a mile or more from the pits. The tailing impoundments are built up by a series of dikes that are raised as the tailings accumulate from the treated copper ore. The tailings consist of pulverized



Figure 7.—An area of Pinamt-Momoli complex, 1 to 10 percent slopes in the foreground. Anklam-Cellar-Rock outcrop complex, 15 to 55 percent slopes, is in the background.

rock and have a texture of silt loam. The mine tailing dumps appear as huge benches which are nearly level on top. The ends and sides of these benches are very steep and rise as much as 300 feet above the surrounding area.

Most areas of this unit are used for mining of copper and molybdenum. A few areas are used for homesites and urban development.

If this unit is used for homesites and urban development, the main limitations are slope and the hazards of wind erosion, seepage, and of sheet and rill and gully erosion. Dust can be temporarily controlled by using sprinklers. Dust and sediment from erosion can be permanently reduced by vegetative reclamation of the mine tailings and waste rock dumps. Since the tailings are droughty, a soil

cap of about six inches is usually necessary to establish vegetative cover. Grasses such as buffelgrass, blue panicgrass, Lehmann lovegrass, and shrubs, such as fourwing saltbush, have proven a successful cover. In the tailing impoundments, alkali sacaton and bermudagrass grow well. Eucalyptus will grow in these areas to provide an aesthetic visual screen. An onsite investigation is needed on all areas considered for development if it is to be successful.

If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This unit is not assigned a range site and is in capability class VIII.

65—Powerline-Kimrose family complex, 10 to 35 percent slopes.

This map unit is on strongly sloping to steep hills. Slopes are dominantly 10 to 35 percent but range from 5 to 65 percent. Elevation is 3,300 to 4,900 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 40 percent Powerline very gravelly sandy loam and 35 percent Kimrose family extremely gravelly loam. The Powerline soils are on moderately steep to steep shoulders that have gradients of 10 to 35 percent and Kimrose family soils are on strongly sloping crests above Powerline that have gradients of 10 to 15 percent.

Included in this unit are small areas of Noland and Tombstone soils on nearly level ridgetops and in swales and Redington soils on very steep backslopes. Also included are small areas of Keysto and Comoro soils in and along drainageways. Included areas make up about 25 percent of the total acreage.

The Powerline soil is moderately deep and well drained. It formed in mixed alluvium and colluvium derived dominantly from calcareous sedimentary rock. Typically, the surface is covered by 50 to 65 percent gravel and cobble. The surface layer is pale brown very gravelly sandy loam about 3 inches thick. The upper 14 inches of the subsoil is very pale brown gravelly loam. The lower 12 inches is very pale brown very gravelly sandy loam. Lime-coated fanglomerate is at a depth of 29 inches. Many soft masses of lime are in the subsoil. In some areas, the surface layer is gravelly sandy loam. Depth to bedrock ranges from 20 to 40 inches.

Permeability of the Powerline soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is medium to rapid, and the hazard of water erosion is slight to moderate. Hazard of wind erosion is very slight.

The Kimrose family soil is very shallow and shallow to a lime-cemented hardpan and well drained. It formed in mixed alluvium. Typically, the surface is covered by 50 to 65 percent gravel and cobble and 10 percent stones. The Kimrose family soil is dark grayish brown extremely gravelly loam about 7 inches deep over a 5 inch thick indurated hardpan (caliche) over sandy fanglomerate to 60 inches or more. These soils are calcareous throughout. In some areas, the surface layer is thinner and lighter in color. In addition, a few areas have a soil horizon

above the indurated caliche which is redder and contains more clay than is typical. Depth to indurated caliche ranges from 7 to 18 inches.

Permeability of the Kimrose family soil is moderate. Available water capacity is very low. Effective rooting depth is 7 to 18 inches. Runoff is medium, and the hazard of water erosion is slight. Hazard of wind erosion is very slight. In the vicinity of Cienega Creek north of Interstate 10 and along Marsh Station Road, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

This unit is used for rangeland.

The potential plant community on the Powerline soil is mainly sideoats grama, black grama, wolftail, and range ratany. The potential plant community on the Kimrose family soil is mainly bush muhly, black grama, and creosotebush. The present vegetation in most areas is mainly creosotebush, blue threeawn, catclaw, and sotol.

This unit produces year-round forage for use by livestock. Steep side slopes on this unit limit access and result in poor grazing distribution. Grazing management practices such as fencing, livestock watering developments, and implementing planned grazing systems can help overcome the grazing distribution problems. This unit is an excellent winter forage area because of the abundance of black grama and bush muhly it produces. Other suitable range management practices, such as brush management and range seeding, can help to improve the range condition.

This unit is well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Powerline soil is in capability subclass VI₁ and in the Limy Slopes, 12-16" p.z. range site. The Kimrose family is in capability subclass VI₁ and in the Limy Upland, 12-16" p.z. range site.

66—Redington very gravelly fine sand, 3 to 50 percent slopes.

This very deep somewhat excessively drained soil is on hills. It formed from mixed stream alluvium and fan alluvium. Elevation is 2,200 to 3,800 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

Typically, the surface is covered by 20 to 65 percent gravel and cobble. The surface layer is brown very gravelly fine sand 2 inches thick. The upper part of the substratum is brown to light brown alternating

fine sand and sand 38 inches thick. The lower part of the substratum is light brown stratified gravelly coarse sand and sand to 60 inches or more. In some areas, the surface layer is thicker and darker than is typical.

Included in this unit is about 15 percent Anthony soils on flood plains and Arizo soils on drainageways and 10 percent badland. Also included are areas of Redington that receive more precipitation and have dark surface colors. Also included are small areas of Nahda, Delnorte, Stagecoach, Palos Verdes, and Pinaleno soils on fan terraces. Included areas make up about 25 percent of the total acreage.

Permeability of the Redington soil is rapid in the upper part and moderately rapid in the lower part. Available water capacity is low. Effective rooting depth is 60 inches or more; however, the dense layers are very hard when dry, but roots can penetrate when it is moist. Runoff is medium to very rapid, and the hazard of water erosion is slight to severe. The hazard of wind erosion is very slight. In a few areas near Vail, Arizona, the soil is underlain by a clay shale which has gypsum crystals in fractures. In the vicinity of the San Pedro River and Cienega Creek north of Interstate 10 and along Marsh Station Road, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

Most areas of this unit are used for rangeland. A few areas are used for mining clay shale for bricks and cement.

The potential plant community on this unit is mainly bush muhly, slim tridens, creosotebush, blue threeawn, and whitethorn. The present vegetation in most areas is mainly Spanish dagger, creosotebush, fluffgrass, and whitethorn.

This unit produces year-round forage for use by livestock. Steep side slopes on this unit limit access and result in poor grazing distribution. Grazing management practices such as fencing, livestock watering developments, and implementing planned grazing systems can help overcome the grazing distribution problems. This unit is an excellent winter forage area because of the abundance of black grama and bush muhly it produces. Other suitable range management practices, such as brush management and range seeding, can help to improve the range condition.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VIIe. This soil is in the Limy Slopes, 10-13" p.z. range site.

67—Redo very gravelly sand, 15 to 50 percent slopes.

This very deep and excessively drained soil is on moderately steep to steep hills. It formed in mixed stream alluvium and fan alluvium. Elevation is 2,600 to 3,800 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

Typically, the surface layer is brown to dark brown very gravelly sand 2 inches thick. The upper part of the subsoil is brown to dark brown very gravelly sand 12 inches thick. The lower part of the subsoil is light brown extremely gravelly sand to 60 inches. These soils are calcareous throughout.

Included in this unit are areas of soils that have less organic matter, Arizo soils in the wash that are sandy-skeletal and have rare flooding frequency, soils that have less than 5 percent calcium carbonate, and soils that have less coarse fragments and/or more clay. Included areas make up about 20 percent of the total acreage.

Permeability of the Redo soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Runoff is slow. The hazard of water erosion is moderate to severe, and the hazard of wind erosion is very slight. In the vicinity of Cienega Creek, north of Interstate 10 and along Marsh Station Road and the area along the San Pedro River, this map unit could have various amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

This unit is used for rangeland and wildlife habitat.

The potential plant community on this unit is mainly creosotebush, mesquite, whitethorn acacia, sideoats and black grama, slim tridens, and bush muhly. The present vegetation in most areas is mainly mesquite, creosotebush, cacti, other shrubs, and annual grasses and forbs.

This unit produces year-round forage for use by livestock. Steep side slopes on this unit limit access and result in poor grazing distribution. Grazing management practices such as fencing, livestock watering developments, and implementing planned grazing systems can help overcome the grazing distribution problems. This unit is an excellent winter forage area because of the abundance of black

grama and bush muhly it produces. Other suitable range management practices, such as brush management and range seeding, can help to improve the range condition.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VIIe. The Redo soil is in the Limy Slopes, 10-13" p.z. range site.

68—Riveroad and Comoro soils, 0 to 2 percent slopes.

This map unit is on nearly level flood plains. Elevation is 2,400 to 4,600 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

Included in this unit are small areas of nearly vertical scarps that have Keysto soils and riverwash on channel bottoms. Also included are small areas of Guest and Combate soils. Included areas make up about 15 percent of the total acreage.

The Riveroad soil is very deep and well drained. It formed in moderately fine textured alluvium. Typically, the surface is covered by a thin strata of silt loam and very fine sandy loam deposited by slow runoff. The surface layer is brown stratified clay loam about 4 inches thick. The substratum is stratified brown to dark brown and dark grayish brown clay loam 56 inches or more thick. In some areas, the surface layer is lighter in color than is typical.

Permeability of the Riveroad soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to rare flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks. The hazard of wind erosion is slight.

The Comoro soil is very deep and well drained. It formed in moderately coarse textured alluvium. Typically, the surface layer is very dark and dark grayish brown sandy loam about 4 inches thick. The subsurface layer is dark grayish brown sandy loam 33 inches thick. The substratum to a depth of 60 inches or more is brown to dark brown fine sandy loam. In some areas, the surface layer is lighter in color than is typical.

Permeability of the Comoro soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is

subject to rare flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks. The hazard of wind erosion is moderately high. In the vicinity of Cienega Creek north of Interstate 10 and along Marsh Station Road, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

Most areas of this unit are used for rangeland. A few areas are used for homesites and urban development and irrigated cropland.

The potential plant community on this unit is mainly sacaton, vine mesquite, and sideoats grama. The present vegetation in most areas is mainly mesquite, sacaton, broom snakeweed, and grama grasses.

This unit is potentially the most productive range in the survey area. Livestock prefer this unit because of the availability of water, shade, and a long green season. Large areas of this may require fencing and livestock watering developments to achieve better grazing management. Sacaton, the dominant forage species, is unpalatable when cured. Periodic controlled burning or heavy grazing help to keep this forage species usable. Other suitable range management practices, such as brush management, range seeding, and water spreading, can help to improve the range condition.

This unit is well suited to hay and pasture. Annual applications of nitrogen fertilizer are needed to maintain production of high quality irrigated pasture.

This unit is moderately well suited to irrigated crops. It is limited mainly by brief periods of flooding. The risk of flooding can be reduced by the use of levees, dikes, and diversions. Furrow, border, corrugation, and sprinkler irrigation systems are suited to this unit. The method used generally is governed by the crop grown. To avoid overirrigating and leaching of plant nutrients, applications of irrigation water should be adjusted to the available water capacity, the water intake rate, and the crop needs. For the efficient application and removal of irrigation water, leveling is needed in sloping areas. Use of pipe, ditch lining, or drop structures in irrigation ditches facilitates irrigation and reduces ditch erosion. Leaving crop residue on or near the surface helps to conserve moisture, maintain tilth, and control erosion. The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable rotation. Crops respond to nitrogen and phosphorus fertilizer.

If this unit is used for homesites or urban

development, the main limitations are flooding in unprotected areas and shrink-swell potential on Riveroad soils. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Roads and streets should be located above the expected flood level. If buildings are constructed on Riveroad soils, properly designing foundations and footings and diverting runoff away from buildings will help to prevent structural damage caused by shrinking and swelling. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees.

If this unit is used for septic tank absorption fields, the main limitations are moderately slow permeability in the Riveroad soils. If the Riveroad soil is used for septic tank absorption fields, the limitation of moderately slow permeability can be overcome by increasing the size of the absorption field.

This unit is well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is well suited to irrigated grain and seed crops and irrigated domestic grasses and legumes for wildlife.

The Riveroad soil is in capability subclasses I, irrigated, and VIc, nonirrigated. The Comoro soil is in capability subclass IIs, irrigated, and VIs, nonirrigated. The Riveroad soil is in the Loamy Bottom, 12-16" p.z., and the Comoro soils are in the Sandy Bottom, 12-16" p.z. range site.

69—Romero-Lampshire-Rock Outcrop complex, 15 to 65 percent slopes.

This map unit is on moderately steep to very steep slopes of mountains. Elevation is 3,400 to 5,300 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 35 percent Romero very gravelly sandy loam, 30 percent Lampshire very gravelly sandy loam, and 30 percent Rock outcrop. The Romero soils have gradients of 15 to 65 percent, and the Lampshire soils have gradients of 15 to 60 percent.

Included in this unit are areas of soils that are moderately deep to deep to bedrock, soils that have slopes less than 15 percent or greater than 65 percent, soils that have less organic matter, and Romero soils that have a loam surface texture.

The Romero soil is very shallow and shallow and well drained. It formed in colluvium and residuum from granite. Typically, the surface layer is brown to dark brown very gravelly sandy loam 2 inches thick.

The subsurface layer is very dark grayish brown very gravelly fine sandy loam 8 inches thick. Fractured granite (grus) that have subsurface material and clay in the fractures is about 7 inches thick. At 17 inches is weathered granite (grus). Depth to bedrock is 6 to 20 inches.

Permeability of the Romero soil is moderately rapid. Effective rooting depth is 6 to 20 inches. Available water capacity is very low. Runoff is very rapid. The hazard of water erosion is moderate to severe, and the hazard of wind erosion is very slight.

The Lampshire soil is very shallow and shallow well drained. It formed in mixed slope alluvium and colluvium from igneous and metamorphic rocks. Typically, the surface layer is very dark grayish brown very gravelly sandy loam 2 inches thick. The next layer is brown extremely gravelly sandy loam 8 inches thick. At 10 inches is unweathered granite. Depth to bedrock is 4 to 20 inches.

Permeability of the Lampshire soil is moderately rapid. Effective rooting depth is 4 to 20 inches. Available water capacity is very low. Runoff is rapid. The hazard of water erosion is moderate to severe, and the hazard of wind erosion is very slight.

Rock outcrop consists of areas of exposed gneiss and granite in the form of pinnacles, ledges, columns, and boulders larger than 10 feet in diameter. Rock outcrop also includes areas where the depth to bedrock is less than 4 inches.

This unit is used for rangeland and wildlife habitat.

The potential plant community for this unit is mainly sideoats grama, slender grama, hairy grama, black grama, shrubby buckwheat, plains lovegrass, tanglehead, and cane bluestem. The present vegetation in most areas is mainly sideoats grama, bush muhly, catclaw acacia, shrubby buckwheat and ocotillo.

This unit produces forage for year-round use. Steep slopes, rocky surfaces, and areas of Rock outcrop limit access and results in poor grazing distribution.

Fencing, livestock water developments and construction of trails to permit more animals to graze in smaller areas for shorter periods of time help overcome the grazing distribution problems which exists. Controlled burning and brush management help improve grazing distribution and range conditions.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Romero soil is in capability subclass VIIe, and the Lampshire soil is in capability subclass VIIe. The Romero and Lampshire soils are in the Granitic Hills, 12-16" p.z. range site.

70—Romero-Oracle complex, 25 to 60 percent slopes.

This map unit is on steep and very steep granitic hills and mountains. Elevation is 3,600 to 5,400 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is about 45 percent Romero very gravelly sandy loam and 30 percent Oracle very gravelly loam. Also in this unit is about 10 percent Rock outcrop. The Romero soils are on steep to very steep mountains that have gradients of 30 to 60 percent, and the Oracle soils are on steep hills that have gradients of 25 to 45 percent. Rock outcrop consists of exposures of barren rock that occur as ledges, massive boulder piles, and nearly vertical cliffs of gneiss, granite, quartz monzonite, and schist that are extremely resistant to weathering.

Included in this unit are small areas of Pantak and Lampshire soils that are intermingled with Romero soils, Deloro soils on areas underlain by shale, and Graham soils on areas underlain by volcanic rock. Also included are small areas of Caralampi soils on fan terraces and Keysto soils in drainageways. Included areas make up about 15 percent of the total acreage.

The Romero soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from granite, granodiorite, or pegmatite. Typically, the surface is covered by 40 to 55 percent fine and medium gravel and a few cobble. The surface layer is dark grayish brown very gravelly sandy loam about 2 inches thick. The subsurface layer is very dark grayish brown very gravelly fine sandy loam 8 inches thick. Fractured granite (grus) with subsurface material and clay in the fractures is about 7 inches thick. At 17 inches is weathered granite (grus). Depth to bedrock ranges from 4 to 20 inches. In some areas, the surface layer is thinner and lighter in color than is typical.

Permeability of the Romero soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 4 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is very rapid, and the hazard of water erosion is severe. The hazard of wind erosion is very slight.

The Oracle soil is shallow and well drained. It formed in alluvium and colluvium derived dominantly from granite and granodiorite. Typically, the surface is covered by 45 to 55 percent fine and medium gravel and a few cobble. The surface layer is dark grayish brown very gravelly loam about 1 inch thick. The

subsurface layer is dark grayish brown gravelly loam 4 inches thick. The subsoil is brown gravelly clay loam 13 inches thick. Fractured granite (grus) that has clay in the fractures is at a depth of 18 inches. Depth to bedrock ranges from 10 to 20 inches. In some areas, the surface layer is very gravelly sandy loam and more lighter in color than is typical. In a few places, the subsoil has more gravel than is typical.

Permeability of the Oracle soil is moderately slow. Available water capacity is very low. Effective rooting depth is 10 to 20 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

This unit is used for rangeland.

The potential plant community on this unit is mainly sideoats grama, black grama, plains lovegrass, and hairy grama. The present vegetation in most areas is mainly sideoats grama, mesquite, bush muhly, false-mesquite, catclaw, and a few oak and juniper at higher elevations on north-facing slopes.

This unit produces forage for year-round use. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution. Fencing, livestock watering developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time help to overcome the grazing distribution problems. Controlled burning and brush management help to improve grazing distribution and the range condition.

The areas of Rock outcrop provide nesting areas for birds of prey.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Romero soil is in capability subclass VIIe, and the Oracle soil is in capability subclass VIIe. Both soils in this unit are in the Granitic Hills, 12-16" p.z. range site.

71—Saguaro-Rock Outcrop complex, 15 to 45 percent slopes.

This map unit is on moderately steep and steep limestone mountains. Elevation is 2,000 to 3,800 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 45 percent Saguaro extremely gravelly fine sandy loam and 30 percent Rock outcrop. The components of this unit are so intricately intermingled

that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Cave, Delnorte, and Stagecoach soils on fan terraces. Also included are small areas of Anklam and Pantano soils on areas underlain by volcanic and metamorphic rock. Included areas make up about 25 percent of the total acreage.

The Saguaro soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from limestone and marble. Typically, the surface is covered by 60 percent gravel and 20 percent cobble. The surface layer is pale brown extremely gravelly fine sandy loam about 1 inch thick. The substratum is light yellowish brown extremely gravelly fine sandy loam 3 inches thick over light gray limestone. These soils are calcareous throughout. Depth to limestone ranges from 4 to 18 inches. In some areas, the surface layer is very cobbly loam. In a few places, the surface layer is darker in color than is typical. In addition, bedrock is deeper than is typical in some areas.

Permeability of the Saguaro soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 4 to 19 inches. Runoff is very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

Rock outcrop consists of quartzite and limestone occurring as ledges, dikes, and columns.

Most areas of this unit are used for rangeland. A few areas are used for mining limestone.

The potential plant community on this unit is mainly slim tridens, red grama, slender grama, littleleaf paloverde, and jojoba. The present vegetation in most areas is mainly creosotebush, fluffgrass, desert zinnia, and brittlebush.

This unit produces forage for year-round use by livestock. Steepness of slope, rocky surfaces, and areas of Rock outcrop limit access and result in poor grazing distribution. Grazing management, including fencing, livestock watering developments, and construction of trails to permit more animals to graze in smaller areas for shorter periods of time, helps to overcome the grazing distribution problems.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Saguaro soil is in capability subclass VIIe and in the Limestone Hills, 10-13" p.z. range site. Rock outcrop is not assigned a range site and is in capability class VIII.

72—Sahuarita soils, Mohave soils and Urban land, 1 to 5 percent slopes.

This map unit is on gently sloping fan terraces. Elevation is 2,200 to 2,800 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit has no regular pattern. Every delineation has at least one of the major components and may have all. Each of the components, however, need not be in every delineation. The percentage varies from one area to another.

Included in this map unit are small areas of Arizo and Anthony soils on flood plains below Sahuarita soils, Yaqui soils on alluvial fans, and Hayhook soils on fan terraces.

The Sahuarita soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 35 to 55 percent gravel. The surface layer is light yellowish brown very gravelly fine sandy loam about 3 inches thick. The subsoil is light yellowish brown fine sandy loam 25 inches thick. The next layer is a buried subsoil of brown loam 17 inches thick and brown very gravelly sandy clay loam 15 or more inches thick. Common fine lime filaments are in the buried subsoil. These soils are calcareous throughout. Depth to the buried subsoil ranges from 20 to 40 inches. In some areas, the surface layer is fine sandy loam.

Permeability of the Sahuarita soil is moderate in the upper part and moderately slow in the lower part of the profile. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff generally is slow to medium, but the included soils in and near drainageways are subject to rare seasonal periods of flooding because of run-on from adjacent uplands. Runoff is rapid in the many shallow rills and the few deep gullies. The hazard of water erosion is slight. The hazard of wind erosion is very slight.

The Mohave soil is very deep and well drained. It formed in mixed alluvium. The surface layer is yellowish brown loam about 3 inches thick. The subsurface layer is brown sandy loam 3 inches thick. The upper 5 inches of the subsoil is brown sandy clay loam, the next 13 inches is brown and light brown clay loam, and the lower 16 inches is reddish brown, light reddish brown, and pink sandy clay loam and clay loam. The substratum to a depth of 60 inches or more is light reddish brown and white loam. In places, these soils are effervescent to the surface.

Many soft masses of lime are in the lower part of the subsoil and in the substratum. In some areas, the surface layer is gravelly sandy loam.

Permeability of the Mohave soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow to medium, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is moderate.

Urban land consists of areas of soil so altered by construction or obscured by structures and pavement that identification of the soil is difficult or impossible. Most of the Urban land is located in the city of Tucson. In general, the underlying and interspersed soil material has many of the characteristics of the associated soils in the complex.

This unit is used mainly for rangeland. It is also used for homesites and urban development.

The potential plant community on the Sahuarita soil is mainly creosotebush, bush muhly, threeawn, and whitestem paperflower. The potential plant community on the Mohave soil is mainly Arizona cottontop, bush muhly, Rothrock grama, and threeawn. The present vegetation in most areas is mainly creosotebush, mesquite, fluffgrass, and triangle bursage. This unit is easily traversed by livestock. It produces a limited amount of forage for year-round use. Forage production, consisting of annual forbs and grasses, can be very high in years when precipitation in winter and spring is good. Grazing management should be focused on improving forage production in the drainageways in and adjacent to this unit. Other suitable range management practices, such as fencing and livestock watering developments, can help to improve grazing distribution.

This unit is moderately well suited to urban development. The main limitations are moderate shrink-swell on the Mohave soil and dustiness in disturbed areas. If buildings are constructed on Mohave, properly designing foundations and footings and diverting runoff away from buildings will help to prevent structural damage caused by shrinking and swelling. In places, excavation for houses and access roads exposes material that is highly susceptible to wind erosion. Revegetating disturbed areas around construction sites as soon as possible helps to control wind erosion. Plants native to the area are most suitable for landscaping. Lawn grasses, shrubs, and ornamental trees that tolerate excessive amounts of lime should be selected.

If this unit is used for septic tank absorption fields, the main limitations are moderately slow permeability on the Mohave soil. If the Mohave soil is used for septic tank absorption fields, the limitation of

moderately slow permeability can be overcome by increasing the size of the absorption field.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Sahuarita soil is in capability subclass VIIc and in the Limy Fan, 10-13" p.z. range site, and the Mohave soil is in capability subclass VIIc and in the Loamy Upland, 10-13" p.z. range site.

73—Sasabe-Caralampi complex, 1 to 15 percent slopes.

This map unit is on gently sloping to rolling hills and fan terraces. Elevation is 3,100 to 3,700 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 45 percent Sasabe sandy loam and 30 percent Caralampi extremely gravelly sandy loam. The Sasabe soils are on crests and shoulders of fan terraces that have gradients of 1 to 5 percent, and the Caralampi soils are on strongly sloping fan terrace and hill backslopes that have gradients of 5 to 15 percent.

Included in this unit are small areas of Tombstone and Nolam soils on terrace ends, Guest soils on flood plains, and Riveroad and Comoro soils on stream terraces along drainageways. Included areas make up about 25 percent of the total acreage.

The Sasabe soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 10 to 15 percent gravel and a few cobble. The surface layer is strong brown sandy loam about 5 inches thick. The upper 17 inches of the subsoil is yellowish red and red clay loam and clay. The next layer is yellowish red gravelly clay loam and gravelly sandy clay loam 19 inches thick. The next layer to 60 inches or more is yellowish red very gravelly sandy clay loam. In some pedons, a hardpan that is cemented with lime and silica is below a depth of 40 inches.

Permeability of the Sasabe soil is slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is moderately high.

The Caralampi soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 40 to 65 percent gravel and cobble. The surface layer is dark brown extremely gravelly sandy loam about 1 inch thick. The subsoil is reddish brown very gravelly clay loam and extremely gravelly sandy clay loam 27 inches thick. The substratum to a depth

of 60 inches or more is light reddish brown and yellowish red extremely gravelly sandy loam. These soils generally are noneffervescent in the upper 30 inches or more. In some areas, the surface layer is very cobbly sandy loam.

Permeability of the Caralampi soil is moderately slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

This unit is used for rangeland.

The potential plant community on this unit is mainly grama grasses, curlymesquite, cane bluestem, and false-mesquite. The present vegetation in most areas is mainly grama grasses, mesquite, false-mesquite, and threeawn.

This unit is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem. The competition from woody plants must be reduced before an effective plant cover can be maintained. Because of its moderately slow and slow permeability and medium to rapid runoff from intense summer storms, this unit responds slowly to good grazing management if the perennial grass cover is depleted. Controlled burning is effective in controlling poisonous half-shrubs such as snakeweed and burroweed on this unit. Other suitable range management practices, such as fencing, livestock watering developments, implementing planned grazing systems, and range seeding, can help to improve grazing distribution.

This unit is moderately well suited to desertic herbaceous plants and well suited to desertic shrubs and trees for wildlife.

The Sasabe soil is in capability subclass VIe, and the Caralampi soil is in capability subclass VIi. This unit is in the Loamy Upland, 12-16" p.z. range site.

74—Schrap very channery loam, 5 to 30 percent slopes.

This very shallow and shallow, well drained soil is on moderately steep pediments. It formed in alluvium and colluvium derived dominantly from shale, schist, and sandstone. Elevation is 3,200 to 4,500 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

Typically, the surface is covered by 45 to 65 percent channers and gravel. The surface layer is light reddish brown very channery loam about 2 inches thick. The substratum is yellowish red very channery loam 9 inches thick over red and pinkish

gray fractured schist. Depth to bedrock ranges from 4 to 12 inches. In some areas, the surface layer is very gravelly loam.

Included in this unit are small areas of Andrada and Deloro soils. Also included are small areas of Keysto soils and riverwash in drainageways and channel bottoms and Caralampi soils on fan terraces. Included areas make up about 25 percent of the total acreage.

Permeability of the Schrap soil is moderate. Available water capacity is very low. Effective rooting depth is 4 to 12 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is medium to very rapid, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is very slight.

Most areas of this unit are used for rangeland.

The potential plant community on this unit is mainly grama grasses, threeawn, false-mesquite, and shrubby buckwheat. The present vegetation in most areas is mainly grama grasses, threeawn, false-mesquite, and broom snakeweed.

This soil is easily traversed by livestock. It produces forage for year-round use. Livestock prefer this unit to adjacent hills and mountains. Grazing management, including use of fencing and livestock watering developments to control grazing use, can help to improve the range condition. Other suitable range management practices, such as brush management and range seeding, can help to improve the range condition.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VIi. This soil is in the Granitic Hills, 12-16" p.z. range site.

75—Spudrock-Boriana complex, 10 to 35 percent slopes.

This map unit is on moderately steep and steep gneissic hills and mountains. Elevation is 7,400 to 8,670 feet but may range as low as 6,800 feet on north-facing slopes. The mean annual precipitation is 24 to 30 inches, the mean annual air temperature is 45 to 50 degrees F, and the frost-free period is 140 to 150 days.

This unit is 55 percent Spudrock very flaggy sandy loam on slope gradients of 15 to 35 percent and 20 percent Boriana very flaggy sandy loam on slope gradients of 10 to 35 percent. Also in this unit is about 10 percent Rock outcrop occurring as large boulders and ledges.

Included in this unit are small areas of Far and

Lemmon soils at lower elevations or on south-facing slopes. Included areas make up about 15 percent of the total acreage.

The Spudrock soil is moderately deep and well drained. It formed in alluvium and colluvium derived dominantly from gneiss. Typically, the surface is covered by a mat of dark grayish brown decomposed pine forest litter about 1 inch thick. The surface layer is brown very flaggy sandy loam about 5 inches thick. The subsoil is pale brown very channery fine sandy loam 12 inches thick. The substratum is light yellowish brown very channery fine sandy loam 7 inches thick over weathered gneiss. The soil is noncalcareous throughout. Depth to bedrock ranges from 20 to 40 inches. In some areas, the surface layer is thicker and darker than is typical.

Permeability of the Spudrock soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 20 to 40 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is rapid to very rapid, and the hazard of water erosion is moderate to severe. Hazard of wind erosion is very slight.

The Boriana soil is shallow and very shallow and well drained. It formed in alluvium and colluvium derived dominantly from gneiss. Typically, the surface is covered by a mat of dark grayish brown slightly decomposed forest litter about 2 inches thick. The surface layer is dark gray very flaggy sandy loam about 4 inches thick. The substratum is light gray very flaggy sandy loam 6 inches thick over white and very pale brown partially weathered gneiss 2 inches thick. Unweathered gneiss is at a depth of 12 inches. The soil is noncalcareous throughout. Depth to bedrock ranges from 4 to 12 inches.

Permeability of the Boriana soil is moderate. Available water capacity is very low. Effective rooting depth is 4 to 12 inches. Runoff is rapid to very rapid, and the hazard of water erosion is moderate. Hazard of wind erosion is very slight.

This unit is used mainly for woodland. It is also used for recreational areas.

Native overstory plants include ponderosa pine and Mexican pinyon. Common understory plants include mountain muhly, manzanita, prairie junegrass, muttongrass, and Wright silktassel. The site index for ponderosa pine and Mexican pinyon ranges from 75 to 85. Hazard of erosion is severe in disturbed areas. Use of heavy equipment for road building or logging is severely limited by slope and depth to bedrock. Seedling survival is high, and plant competition is moderate.

This unit is moderately well suited to wild herbaceous plants and hardwood trees for wildlife. It

is well suited to shrubs, vines, and coniferous trees for wildlife.

This unit is in capability subclass VI_s. The Spudrock soils are woodland site in the Granitic Hills, 20-24" p.z. The Boriana soils are woodland site in the Mountains, 24"+ p.z.

76—Spudrock-Far-Rock Outcrop complex, 25 to 65 percent slopes.

This map unit is on steep and very steep granitic and gneissic hills and mountains. Elevation is 5,400 to 7,800 feet. The mean annual precipitation is 20 to 24 inches, the mean annual air temperature is 45 to 54 degrees F, and the frost-free period is 140 to 170 days.

This unit is 45 percent Spudrock very flaggy sandy loam, 20 percent Far gravelly fine sandy loam, and 15 percent Rock outcrop.

Included in this unit are small areas of Cortaro and Faraway soils at lower elevations or on south-facing slopes. Also included are small areas of Boriana soils at higher elevations or on north-facing slopes and Lemmon soils on areas underlain by schist. Included areas make up about 20 percent of the total acreage.

The Spudrock soil is moderately deep and well drained. It formed in alluvium and colluvium derived dominantly from granite, gneiss, and schist. Typically, the surface is covered by a mat of dark grayish brown oak and pinyon forest litter about 1 inch thick. The surface layer is brown very flaggy sandy loam about 5 inches thick. The subsoil is pale brown very channery fine sandy loam 12 inches thick. The substratum is light yellowish brown very channery fine sandy loam 7 inches thick over weathered gneiss. The soil is noncalcareous throughout. Depth to bedrock ranges from 20 to 40 inches. In some areas, the surface layer is very cobbly or very stony sandy loam.

Permeability of the Spudrock soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 20 to 40 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is rapid to very rapid, and the hazard of water erosion is severe. The hazard of wind erosion is very slight.

The Far soil is very shallow and shallow and well drained. It formed in alluvium and colluvium derived dominantly from granite, gneiss, and schist. Typically, the surface is covered by a mat of brown and dark brown intermediately decomposed forest litter about 2 inches thick. Typically, the surface layer is grayish brown and dark grayish brown gravelly fine sandy loam about 2 inches thick. The substratum is grayish

brown very gravelly fine sandy loam 6 inches thick. Depth to hard bedrock ranges from 5 to 20 inches. In places, bedrock is much deeper than is typical. In some areas, the surface layer is very cobbly loam.

Permeability of the Far soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 5 to 20 inches. Runoff is very rapid, and the hazard of water erosion is severe. The hazard of wind erosion is very slight.

Rock outcrop consists of exposures of barren rock that occur as ledges, massive boulder piles, and nearly vertical cliffs of gneiss, granite, quartz monzonite, and schist that are extremely resistant to weathering. The soil and the areas of Rock outcrop are intricately intermingled; however, a higher percentage of Rock outcrop is in areas near the hilltops and mountaintops.

This unit is used mainly for woodland. It is also used for recreational areas.

Native overstory plants include Emory oak, Arizona white oak, Mexican pinyon, and alligator juniper. Common understory plants include Wright siltkassel, manzanita, bullgrass, Texas bluestem, wooly bunchgrass, prairie junegrass, and sacahuista. The site index for a mixed stand of oak, pinyon, and juniper ranges from 65 to 80. The hazard of erosion is severe in disturbed areas. Use of heavy equipment for road building or logging is severely limited by slope and depth to bedrock. Seedling survival is high, and plant competition is slight.

This unit is moderately well suited to wild herbaceous plants, hardwood, and coniferous trees for wildlife. It is well suited to shrubs and vines for wildlife.

The soils in this map unit are in capability subclass VIIe. Rock outcrop is in capability class VIII. These soils are woodland sites in the Granitic Hills, 20-24" p.z.

77—Spudrock-Lemmon complex, 15 to 45 percent slopes.

This map unit is on moderately steep and steep schist and gneiss hills and mountains. Elevation is 5,400 to 8,100 feet. The mean annual precipitation is 20 to 24 inches, the mean annual air temperature is 45 to 54 degrees F, and the frost-free period is 140 to 170 days.

This unit is 40 percent Spudrock very flaggy sandy loam on gradients of 15 to 45 percent and 30 percent Lemmon flaggy loam on gradients 15 to 35 percent. Also, this unit is about 10 percent Rock outcrop that occurs as large boulders and slump blocks.

Included in this unit are small areas of Cortaro and Faraway soils at lower elevations or on south-facing slopes and Far soils on areas underlain by hard granite. Also included are small areas of Borianna soils at higher elevations or on north-facing slopes. Included areas make up about 20 percent of the total acreage.

The Spudrock soil is moderately deep and well drained. It formed in alluvium and colluvium derived dominantly from granite, gneiss, and schist. Typically, the surface is covered by a mat of dark grayish brown oak and pinyon forest litter about 1 inch thick. The surface layer is brown very flaggy sandy loam about 5 inches thick. The subsoil is pale brown very channery fine sandy loam 12 inches thick. The substratum is light yellowish brown very channery fine sandy loam 7 inches thick over weathered gneiss. The soil is noncalcareous throughout. Depth to bedrock ranges from 20 to 40 inches. In some areas, the surface layer is very cobbly or very stony sandy loam.

Permeability of the Spudrock soil is moderately rapid. Available water capacity is very low. Effective rooting depth is 20 to 40 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is rapid to very rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

The Lemmon soil is moderately deep and well drained. It formed in alluvium and colluvium derived dominantly from schist. Typically, the surface is covered by a mat of yellowish brown slightly decomposed forest litter about 2 inches thick. The surface layer is black flaggy loam about 1 inch thick. The subsurface layer is very pale brown channery loam 6 inches thick. The next layer is pink channery loam mixed with small blocks of reddish yellow clay 13 inches thick. The subsoil is reddish yellow clay 12 inches thick. Weathered pale yellow mica-schist is at a depth of 32 inches. The soil is noncalcareous throughout. Depth to schist ranges from 20 to 40 inches. In places, bedrock is much deeper than is typical. In areas above about 7,800 feet, the soil is colder than typical.

Permeability of the Lemmon soil is slow. Available water capacity is low. Effective rooting depth is 20 to 40 inches. However, roots and water may be in fractures to a depth of 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe. The hazard of wind erosion is very slight.

This unit is used mainly for woodland. It is also used for recreational areas.

Native overstory plants on the Spudrock soil include silverleaf oak, Arizona white oak, Mexican

pinyon and alligator juniper, and some ponderosa pine and Mexican white pine at higher elevations. Common understory plants include manzanita, bullgrass, prairie junegrass, and sacahuista. The site index for a mixed stand of oak, pinyon, and juniper ranges from 80 to 90. Native overstory plants on the Lemmon soil include Ponderosa pine. Common understory plants include Texas bluestem, sideoats grama, bullgrass, prairie junegrass, sacahuista, manzanita, and California bricklebrush. The site index for ponderosa pine ranges from 70 to 80. Hazard of erosion is severe in disturbed areas. Use of heavy equipment for road building or logging is severely limited by slope and depth to bedrock. Seedling survival is high, and plant competition is slight.

This unit is moderately well suited to wild herbaceous plants and hardwood and coniferous trees for wildlife. It is well suited to shrubs and vines for wildlife.

This map unit is in capability subclass VIIe. These soils are woodland sites in the Granitic Hills, 20-24" p.z.

78—Stagecoach-Sahuarita association, 1 to 8 percent slopes.

This map unit is on gently sloping fan terraces. Elevation is 2,200 to 3,200 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 50 percent Stagecoach very gravelly sandy loam and 25 percent Sahuarita very gravelly fine sandy loam. Stagecoach soils are on crests and shoulders with gradients of 3 to 8 percent, and Sahuarita soils are on lower lateral toeslopes with gradients of 1 to 3 percent. The components of this unit are so intricately intermingled that it was not practical to map them separately at the scale used.

Included in this unit are small areas of Anthony soils on flood plains and along drainageways, Mohave soils on fan terraces below Sahuarita soils, Pinaleno soils on shoulders of fan terraces, Hantz soils on flood plains, and Cave soils intermingled within the Stagecoach soils. Included areas make up about 25 percent of the total acreage.

The Stagecoach soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 50 to 65 percent gravel and cobble. The surface layer and upper part of the subsoil is light brown very gravelly sandy loam about 10 inches thick. The next layer is a pink, pinkish gray and pinkish white very gravelly loam and extremely gravelly loam 30 inches thick. The substratum to a

depth of 60 inches or more is light brown very gravelly loamy sand. Many soft masses of lime are in the subsoil and substratum. These soils are calcareous throughout. In some areas, the surface layer is very cobbly sandy loam. In a few places, caliche is at a depth of 40 inches or more.

Permeability of the Stagecoach soil is moderate to a depth of 40 inches. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow to medium, and the hazard of water erosion is slight. The hazard of wind erosion is very slight.

The Sahuarita soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 35 to 55 percent gravel. The surface layer is light yellowish brown very gravelly fine sandy loam about 3 inches thick. The subsoil is light yellowish brown fine sandy loam 25 inches thick. The next layer is a buried subsoil of brown loam 17 inches thick and brown very gravelly sandy clay loam 15 or more inches thick. Common fine lime filaments are in the buried subsoil. These soils are calcareous throughout. Depth to the buried subsoil ranges from 20 to 40 inches. In some areas, the surface layer is fine sandy loam.

Permeability of this Sahuarita soil is moderate in the upper part and moderately slow in the lower part of the profile. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff generally is slow to medium, but the included soils in and near drainageways are subject to rare seasonal periods of flooding because of run-on from adjacent uplands. Runoff is rapid in the many shallow rills and the few deep gullies. The hazard of water erosion is slight. The hazard of wind erosion is very slight.

Most areas of this unit are used for rangeland. A few areas are used for homesites.

The potential plant community on the Stagecoach soil is mainly bush muhly, red grama, coldenia, and creosotebush. The potential plant community on the Sahuarita soil is mainly creosotebush, bush muhly, whitestem paperflower, and threeawn. The present vegetation in most areas is mainly creosotebush, whitethorn, desert zinnia, and fluffgrass.

This unit is easily traversed by livestock. It produces a limited amount of forage for year-round use. In years when precipitation in winter and spring is good, production of annual forbs and grasses on the Sahuarita soil is high. Production of forage on the Stagecoach soil is limited by high concentrations of lime and low available water capacity. Grazing management should be focused on improving the range condition in drainageways in and adjacent to this unit. Other suitable range management practices, such as fencing and livestock watering

developments, can help to improve grazing distribution.

This unit is well suited to homesite development. The main limitations are dust and the hazard of gully erosion. Building sites should be selected in interfluvial areas of the unit that do not flood. In places, excavation for houses and access roads exposes material that is highly susceptible to wind erosion. The hazard of erosion is increased if the soil is left exposed during site development. Dust can be controlled by using sprinklers. Revegetating disturbed areas around construction sites as soon as possible helps to control wind erosion. Plants native to the area are most suitable for landscaping.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VIIc. The Stagecoach soil is in the Limy Upland (Deep), 10-13" p.z. range site, and the Sahuarita soil is in the Limy Fan, 10-13" p.z. range site.

79—Tombstone very gravelly loam, 15 to 50 percent slopes.

This very deep and well drained soil is on deeply incised, moderately steep to steep fan terraces. It formed in mixed alluvium and colluvium. Elevation is 3,600 to 5,200 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

Typically, the surface is covered by 50 to 65 percent gravel and cobble. The surface layer is grayish brown and dark grayish brown very gravelly loam about 13 inches thick. The next layer to a depth of 60 inches or more is a white and light gray extremely gravelly loam. These soils are calcareous throughout. Many soft masses of lime are in the subsoil and substratum. In some areas, the surface layer is very cobbly loam. In a few places, the surface layer is thinner and lighter in color than is typical.

Included in this unit are small areas of Bernardino and Kimrose family soils on ridgetops and Noland soils in drainage swales and on stable sideslopes. Also included are small areas of Keysto soils in drainageways. Included areas make up about 15 percent of the total acreage.

Permeability of the Tombstone soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is moderate to severe. The hazard of wind erosion is very slight.

This unit is used for rangeland.

The potential plant community on this unit is mainly sideoats grama, black grama, false-mesquite, and wolftail. The present vegetation in most areas is mainly black grama, yucca, fluffgrass, and sideoats grama (fig. 8).

This soil produces forage for year-round use. Steepness of slope limits access and results in poor grazing distribution. Grazing pressure is concentrated on ridgetops and in drainageways. Grazing management, including use of fencing and livestock watering developments, helps to improve grazing distribution. This soil is an excellent winter forage site for livestock because of the abundance of black grama and bush muhly it produces.

This unit is moderately well suited to desertic herbaceous plants and well suited to desertic shrubs and trees for wildlife.

This map unit is in capability subclass VIIc. This soil is in the Limy Slopes, 12-16" p.z. range site.

80—Tubac complex, 0 to 2 percent slopes.

This very deep and well drained soil is on nearly level basin floors. It formed in mixed alluvium. Elevation is 2,200 to 3,000 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

This unit is 40 percent Tubac loam and 30 percent Tubac sandy loam.

Included in this unit are areas of soils with cemented calcium carbonate hardpans above 40 inches, Bucklebar soils that have less than 35 percent clay, Hayhook soils that have sandy loam textures, Arizo soils that are gravelly and sandy and that flood, Tubac soils that have a gravelly surface, and Tubac soils that have saline-sodic properties. Included areas make up about 30 percent of the total acreage.

Typically, the surface layer is brown loam or sandy loam about 2 inches thick. The subsurface layer is reddish brown and pinkish gray loam 12 inches thick. The upper 17 inches of the subsoil is reddish brown clay. The lower subsoil to a depth of 66 inches or more is reddish brown and brown gravelly sandy clay loam. Many soft masses of lime are in the subsoil and substratum.

Permeability of the Tubac soil is slow. Effective rooting depth is 60 or more inches. Available water capacity is moderate. Runoff is medium. The hazard of flooding is none to rare. The hazard of water

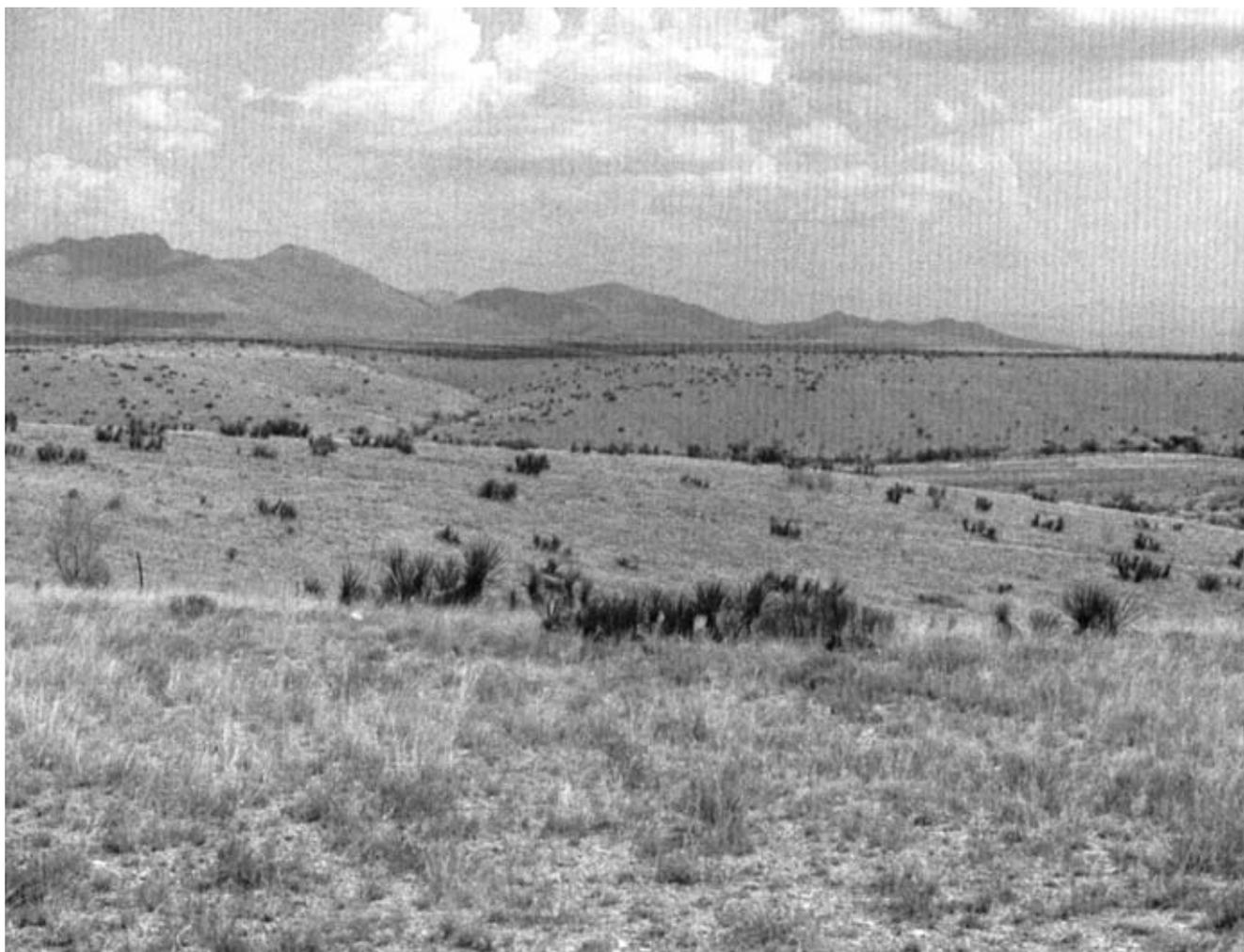


Figure 8.—Semi-desert grassland in a typical area of Tombstone very gravelly loam, 15 to 30 percent slopes.

erosion is moderate, and the hazard of wind erosion is moderately high.

This unit is used for rangeland and irrigated cropland.

The potential plant community on this unit is mainly Rothrock grama, Arizona cottontop, threeawns, tobosa, bursage, and mesquite. The present vegetation in most areas is mainly mesquite, snakeweed, pricklypear, staghorn cholla, annual grasses, and forbs.

This unit is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem on much of this unit. The competition from woody plants must be reduced before this unit will respond to grazing management. Suitable range management practices to improve grazing distribution and range condition include fencing, livestock water developments, and range seeding.

Leveling this soil to a flat grade permits more efficient use of irrigation water. A tillage pan forms easily if this soil is tilled when wet. Ripping or chiseling when the soil is dry breaks up tillage pans, increasing the effective rooting depth and improving internal drainage. Because of the slow permeability of this soil, the application of water should be regulated so that water does not stand on the surface and damage crops. Crop rotation and the incorporation of crop residue in the soil or the regular addition of other organic matter improves fertility and increases both the water intake rate and available water capacity.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is well suited to irrigated grain and seed crops and irrigated domestic grasses and legumes for wildlife.

This map unit is in capability subclass IIIs, irrigated, and VIIs, nonirrigated. The Tubac loam soil is

in the Clay Loam Upland, 10-13" p.z. range site, and the Tubac sandy loam soil is in the Sandy Loam Upland, 10-12" p.z. range site.

81—Tubac gravelly loam, 1 to 8 percent slopes.

This very deep and well drained soil is on broad, gently sloping fan terraces shallowly dissected by ephemeral drainageways. It formed in mixed alluvium. Elevation is 2,400 to 3,200 feet. The mean annual precipitation is 10 to 13 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

Typically, the surface is covered by 25 percent gravel and 5 percent cobble. The surface layer is brown to dark brown gravelly loam about 2 inches thick. The subsurface layer is reddish brown and pinkish gray loam 12 inches thick. The upper 17 inches of the subsoil is reddish brown clay. The lower subsoil to a depth of 60 inches or more is reddish brown and brown gravelly sandy clay loam. In places, these soils are effervescent to the surface. Many soft masses of lime are in the lower part of the subsoil and in the substratum. In some areas, the surface layer is coarse sandy loam.

Included in this unit are small areas of Mohave, Pinaleno, and Sahuarita soils on fan terraces above Tubac soils, Yaqui soils on alluvial fans, and Hantz soils in drainageways. Included areas make up about 20 percent of the total acreage.

Permeability of the Tubac soil is slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is slight.

Most areas of this unit are used for rangeland. A few areas are used for homesites and urban development.

The potential plant community on this unit is mainly Arizona cottontop, threeawn, Rothrock grama, and bush muhly. The present vegetation in most areas is mainly cholla, burroweed, bush muhly, and creosotebush.

This soil is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem on much of this unit. The competition from woody plants must be reduced before this soil will respond to grazing management. Other suitable range management practices, such as fencing, livestock watering developments, and range seeding, can help to improve grazing distribution and the range condition.

If this unit is used for homesites or urban

development, the main limitations are shrink-swell potential. If buildings are constructed on this soil, properly designing foundations and footings and diverting runoff away from buildings will help to prevent structural damage caused by shrinking and swelling. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential.

If this unit is used for septic tank absorption fields, the main limitation is slow permeability. Absorption lines should be placed below the slowly permeable layer. Increasing the size of the absorption area also helps to compensate for the slow permeability.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VI_s. This soil is in the Loamy Upland, 10-13" p.z. range site.

82—Tubac sandy loam, 0 to 2 percent slopes.

This very deep and well drained soil is on nearly level basin floors and fan terraces. It formed in mixed alluvium. Elevation is 2,200 to 3,400 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

Typically, the surface layer is brown sandy loam about 2 inches thick. The subsurface layers are reddish brown and pinkish gray loam 12 inches thick. The upper 17 inches of the subsoil is reddish brown clay. The lower subsoil is reddish brown and brown gravelly sandy clay loam to a depth of 66 inches or more. Many soft masses of lime are in the subsoil and substratum. In some areas, the surface layer is gravelly coarse sandy loam.

Included in this unit are small areas of Bucklebar and Mohave on fan terraces above Tubac soils, Hantz soils in drainageways, and Yaqui soils on alluvial fans. Included areas make up about 25 percent of the total acreage.

Permeability of the Tubac soil is slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The hazard of wind erosion is moderately high.

Most areas of this unit are used for rangeland. A few areas are used for homesites and urban development.

The potential plant community on this unit is mainly Arizona cottontop, Rothrock grama, and bush muhly. The present vegetation in most areas is

mainly chainfruit cholla, burroweed, fourwing saltbush, mesquite, and creosotebush.

This soil is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem on much of this unit. The competition from woody plants must be reduced before this soil will respond to grazing management. Other suitable range management practices, such as fencing, livestock watering developments, and range seeding, can help to improve grazing distribution and the range condition.

If this unit is used for homesites or urban development, the main limitation is shrink-swell potential. If buildings are constructed on this soil, properly designing foundations and footings and diverting runoff away from buildings will help to prevent structural damage caused by shrinking and swelling. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential.

If this unit is used for septic tank absorption fields, the main limitation is slow permeability. The limitation of slow permeability can be overcome by removing the soil in the absorption field and then backfilling with more permeable material and by enlarging the absorption field. Installing aerating or holding tanks or using separate absorption fields for kitchen and laundry waste and for toilet water are alternate methods of waste disposal.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VII_s. This soil is in the Sandy Loam Upland, 10-13" p.z. range site.

83—Vecont clay loam, 0 to 1 percent slopes.

This very deep and well drained soil is in swales on level basin floors. It formed in mixed alluvium. Elevation is 1,650 to 1,800 feet. The mean annual precipitation is 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

Typically, the surface layer is brown clay loam about 3 inches thick. The upper 25 inches of the subsoil is reddish brown clay loam and clay. The upper part of the buried subsoil is red sandy clay loam 14 inches thick. The lower part to a depth of 60 inches or more is pink loam. These soils generally are noneffervescent in the upper 30 inches or more.

In some areas, the surface layer is silty clay loam or clay.

Included in this unit are small areas of Mohall, Denure, and Pahaka soils on interfluves. Also included are small areas of sandy soils and riverwash in drainageways. Included areas make up about 20 percent of the total acreage.

Permeability of the Vecont soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. This soil is subject to occasional, very brief flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks. Runoff is medium, and the hazard of water erosion generally is slight, but some drainageways are entrenched and channelled. Headcutting and deposition may occur following heavy summer thunderstorms or winter storms. Shallow rills are in some areas, and deposition of soil around the vegetation in these areas is common. The hazard of wind erosion is moderate.

Most areas of this unit are used for rangeland. A few areas are abandoned cropland.

The potential plant community on this unit is mainly tobosa, cactus, and wolfberry. The present vegetation in most areas is mainly tobosa, creosotebush, mesquite, and wolfberry.

Livestock prefer this soil because of seasonal availability of water and a long green season. It is very susceptible to gully erosion when the protective plant cover has been removed. This soil is a highly productive range site. Grazing management, including use of fencing and livestock watering developments, helps to effectively utilize the coarse vegetation, such as tobosa, on the soil. The riparian vegetation on this soil is extremely valuable to wildlife for food, cover, and nesting.

If this unit is used for irrigated crops, the main limitations are slow permeability and flooding. The risk of flooding can be reduced by the use of dikes, levees, and diversions. Furrow, border, corrugation, and sprinkler irrigation systems are suited to this soil. The method used generally is governed by the crop grown. Because of the slow permeability of the Vecont soil, the length of runs should be adjusted to permit adequate infiltration of water. For the efficient application and removal of irrigation water, leveling is needed in sloping areas. Use of pipe, ditch lining, or drop structures in irrigation ditches facilitates irrigation and reduces ditch erosion. Returning crop residue to the soil or regularly adding other organic matter improves fertility, reduces crusting, and increases the water intake rate. Crop residue left on or near the surface helps to conserve moisture,

maintain tillage, and control erosion. Wind erosion can be controlled by keeping the soil rough and cloddy when it is not protected by vegetation. Tillage should be kept to a minimum.

This unit is well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is well suited to irrigated grain and seed crops and irrigated domestic grasses and legumes for wildlife.

This map unit is in capability subclasses IIIw, irrigated, and VIIw, nonirrigated. This soil is in the Clayey Bottom, 7-10" p.z. range site.

84—White House-Caralampi complex, 5 to 25 percent slopes.

This map unit is on moderately steep dissected fan terraces. Elevation is 3,500 to 5,200 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

This unit is 45 percent White House gravelly loam on slopes of 5 to 15 percent and 40 percent Caralampi very gravelly sandy loam on slopes of 10 to 25 percent. The White House soils are on crests and shoulders, and the Caralampi soils are on steep backslopes.

Included in this unit are small areas of Tombstone and Nalam soils on terrace ends, Comoro and Riveroad soils on stream terraces, and Guest soils along drainageways. Included areas make up about 15 percent of the total acreage.

The White House soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 25 to 35 percent gravel and cobble. The surface layer is reddish brown gravelly loam about 1 inch thick. The subsurface layer is dark reddish gray clay loam 2 inches thick. The upper 15 inches of the subsoil is reddish brown and dark reddish brown clay. The lower 18 inches is red clay. The substratum to a depth of 60 inches or more is yellowish red sandy clay loam. These soils generally are noneffervescent in the upper 20 inches or more. In some areas, the surface layer is very gravelly or very cobbly loam or sandy loam.

Permeability of the White House soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is slight.

The Caralampi soil is very deep and well drained. It formed in mixed alluvium. Typically, the surface is covered by 40 to 65 percent gravel and cobble. The surface layer is dark brown extremely gravelly sandy

loam about 1 inch thick. The subsoil is reddish brown very gravelly clay loam and extremely gravelly sandy clay loam 27 inches thick. The substratum to a depth of 60 inches or more is light reddish brown and yellowish red extremely gravelly sandy loam. These soils generally are noneffervescent in the upper 30 inches or more. In some areas, the surface layer is very cobbly sandy loam.

Permeability of the Caralampi soil is moderately slow. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium to rapid, and the hazard of water erosion is slight to moderate. The hazard of wind erosion is very slight.

This unit is used for rangeland.

The potential plant community on this unit is mainly grama grasses, cane bluestem, and false-mesquite. The present vegetation in most areas is mainly grama grasses, curlymesquite, false-mesquite, and threeawn.

This soil is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a serious problem. The competition from woody plants must be reduced before an effective plant cover can be maintained. Because of moderately slow and slow permeability and medium to rapid runoff from intense summer storms, this soil responds slowly to good grazing management if the perennial grass cover is depleted. Controlled burning is effective in controlling poisonous half-shrubs such as snakeweed and burroweed on this soil. Other suitable range management practices, such as fencing, livestock watering developments, implementing planned grazing systems, and range seeding, can help to improve grazing distribution.

This unit is well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

The Whitehouse soil is in capability subclass VIc, and the Caralampi soil is in capability subclass VIc. This unit is in the Loamy Upland, 12-16" p.z. range site.

85—White House gravelly loam, 1 to 8 percent slopes.

This very deep and well drained soil is on nearly level to undulating fan terraces. It formed in mixed alluvium. Elevation is 3,200 to 5,200 feet. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

Typically, the surface is covered by 25 to 35 percent gravel and cobble. The surface layer is reddish brown gravelly loam about 1 inch thick. The subsurface layer is dark reddish gray clay loam 2

inches thick. The upper 15 inches of the subsoil is reddish brown and dark reddish brown clay. The lower 18 inches is red clay. The substratum to a depth of 60 inches or more is yellowish red sandy clay loam. These soils generally are noneffervescent in the upper 20 inches or more. In some areas, the surface layer is very gravelly or very cobbly loam or sandy loam.

Included in this unit are small areas of Bernardino, Caralampi, Nolam, Sasabe, and Arivaca soils. Also included are small areas of Riveroad and Comoro soils on stream terraces along drainageways. Included areas make up about 20 percent of the total acreage.

Permeability of the White House soil is slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is slight. The hazard of wind erosion is slight. In the vicinity of Cienega Creek north of Interstate 10 and along Marsh Station Road, this map unit has variable amounts of gypsum in the soil. Soil management problems associated with gypsum are accelerated water erosion, soil piping, and subsidence or settling caused by the dissolution of gypsum by water.

Most areas of this unit are used for rangeland. A few areas are used for homesites and irrigated pasture.

The potential plant community on this unit is mainly grama grasses, plains lovegrass, cane bluestem, and false-mesquite. The present vegetation in most areas is mainly curlymesquite, mesquite, burroweed, and false-mesquite.

This soil is easily traversed by livestock. It produces forage for year-round use. Brush encroachment is a problem in some areas; however, brush management is not required to maintain an effective plant cover. Because of slow permeability and medium runoff, this soil responds slowly to good grazing management if the perennial grass cover is depleted. Controlled burning is effective in controlling poisonous half-shrubs such as burroweed and snakeweed on this soil. Other suitable range management practices, such as fencing, livestock watering developments, range seeding, and implementing planned grazing systems, can help to improve grazing distribution and the range condition.

If this unit is used for homesite development, the main limitation is shrink-swell potential. If buildings are constructed on this soil, properly designing foundations and footings and diverting runoff away

from buildings will help to prevent structural damage caused by shrinking and swelling. The effects of shrinking and swelling can be minimized by using proper engineering designs and by backfilling with material that has low shrink-swell potential.

If this unit is used for septic tank absorption fields, the main limitation is slow permeability. Absorption lines should be placed below the slowly permeable layer. Increasing the size of the absorption area helps to compensate for the slow permeability.

This unit is well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife. It is moderately well suited to irrigated grain and well suited to seed crops and irrigated domestic grasses and legumes for wildlife.

This map unit is in capability subclass VIc. This soil is in the Loamy Upland, 12-16" p.z. range site.

86—Yaqui fine sandy loam, 1 to 3 percent slopes.

This very deep and well drained soil is on gently sloping alluvial fans. It formed in mixed alluvium. Elevation is 2,200 to 3,600 feet. The mean annual precipitation is 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

Typically, the surface layer is strong brown fine sandy loam about 4 inches thick. The subsoil is brown to dark brown sandy clay loam 27 inches thick. The next layer is a buried subsoil of yellowish red clay loam 12 inches thick over pink gravelly loam to 60 inches or more. Common fine lime filaments are in the buried subsoil. These soils are calcareous throughout. In some areas, the surface layer is loam or very fine sandy loam.

Included in this unit are small areas of Anthony soils on alluvial fans, Bucklebar, Sahuarita, and Tubac soils on fan terraces below Yaqui soils, and Hantz soils on flood plains. Also included are small areas of Arizo soils in and along narrow drainageways. Included areas make up about 20 percent of the total acreage.

Permeability of this Yaqui soil is moderate to a depth of 31 inches and moderately slow below this depth. Available water capacity is high. Effective rooting depth is 60 inches or more. This soil is subject to rare, very brief flooding during prolonged, high-intensity storms. Channeling and deposition are common along streambanks. Shallow rills are in some areas, and deposition of soil around the vegetation in these areas is common. Runoff is

generally slow except where concentrated in shallow rills and gullies. Hazard of water erosion is slight. The hazard of wind erosion is moderately high.

Most areas of this unit are used for rangeland or homesites and urban development.

The potential plant community on this unit is mainly creosotebush, bush muhly, threeawn, and whiplash pappusgrass. The present vegetation in most areas is mainly creosotebush, mesquite, whitethorn, and bush muhly.

This soil is easily traversed by livestock. It produces a limited amount of forage for year-round use. Forage production, consisting of annual forbs and grasses, can be very high in years when

precipitation in winter and spring is good. Grazing management should be focused on improving forage production in the drainageways in and adjacent to this soil. Other suitable range management practices, such as fencing and livestock watering developments, can help to improve grazing distribution.

If this unit is used for homesite development, the main limitations are flooding and the hazard of wind erosion in disturbed areas.

This unit is moderately well suited to desertic herbaceous plants and desertic shrubs and trees for wildlife.

This map unit is in capability subclass VIIe. This soil is in the Limy Fan, 10-13" p.z. range site.

Use and Management of the Soils

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

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

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

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

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

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

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the nation's short- and long-range needs for food and

fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from irrigation. The temperature and growing season are favorable. The level of alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

About 9,000 acres in the survey area, or about 1/2 of 1 percent of the total acreage, meets the soil requirements for prime farmland if an adequate and dependable supply of irrigation water is available. The crops grown on this land include pasture and forage grasses, alfalfa, small grains, various nut crops, citrus, vegetables, and some cotton.

A recent trend in land use in some parts of the survey area has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This

list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Soils that have limitations, such as frequent flooding during the growing season, or inadequate rainfall, qualify for prime farmland only in areas where these limitations have been overcome by such measures as flood control, or irrigation. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not these limitations have been overcome by corrective measures.

Crops and Pasture

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

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

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

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

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include erosion control, and protection from flooding; the proper

planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

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

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

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Natural Resources Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Irrigated Cropland

Maurice J. Bossuyt, district conservationist (retired), Natural Resources Conservation Service, prepared this section.

Five areas within the survey area are currently cultivated with water supplied by irrigation. The areas are (1) southwest of Tucson near Three Points (Robles Junction) adjacent to the Altar/Brawley Wash area, (2) south of Tucson along the Sopori Wash drainage up to Arivaca, (3) isolated farms and pastures beside Rillito Creek in Tucson, (4) southeast of Tucson along the Ciego Creek, and (5) northeast of Tucson along the San Pedro River. A small area northwest of Tucson in the Aguirre Valley has been abandoned following damaging floods in 1983 and 1993. Many other small areas used for pasture or some specialty crops such as oranges, peaches, grapes, and vegetables are scattered throughout the survey area. One area not covered by this survey is the major agricultural areas within the Santa Cruz and Avra Valleys. These are discussed in Soil Survey: Tucson-Avra Valley Area, Arizona (USDA, 1972).

Major crops grown in the area are small grains, pasture and forage grasses, nutcrops such as pecans and pistachios, vegetables, and cotton. Cotton is grown primarily along the San Pedro River,

the Altar/Brawley Wash, and in the Aguirre Valley. Nutcrops are grown primarily along the Cienega and Rillito Creeks and near Arivaca.

The high level of management required for farming within the survey area depends on the following practices: conservation cropping sequence, crop residue use, some form of reduced tillage, irrigation water management, a properly designed irrigation system with an adequate supply of good quality water, and nutrient and pesticide management.

Conservation cropping sequence implies rotations that maintain or improve the soil to a desirable condition for plant growth, controls weeds and minimizes plant diseases. This practice encourages rotating crops that have different rooting characteristics, nutrient requirements, and residue characteristics. A good rotation usually includes legumes and green manure crops.

Crop residue use consists of either plowing or disking crop residue into the soil to increase organic matter or leaving residue on the surface to protect the soil. These measures help increase water infiltration, maintain or improve organic matter content, reduce soil loss from wind erosion, and improve soil tilth and structure.

Reduced tillage is defined as using only the essential cultural practices that are necessary to grow the crop. Excessive use of equipment compacts soil, reducing air and water movement in the soil, which reduces yields by restricting root growth. The Riverroad and Guest soil types are especially susceptible to compaction. Soils should not be worked when soil moisture levels are high, as this will increase the chance of compaction.

Water management is the key to a successful irrigated farming enterprise. With water costs constantly increasing, it is important that water management be as efficient as possible. This means that the water application efficiency should be high and the total water use should be low. A good method for determining the amount of water needed is by probing the soil and using the "feel" method to ascertain the amount of water remaining in the root zone. Natural Resources Conservation Service technicians can assist you in this determination if needed.

Water application is based on the available water capacity of the soil and depth of the plants root zone within the soil profile. Generally, irrigation water is applied when 50 percent of the water available to the plant is depleted in the root zone. The amount of water needed and the frequency of application depends on the type of crop and the kind of soil. The

rate of application should be such that runoff and subsequent erosion is held to a minimum.

There are several types of irrigation systems: sprinkler, surface, and drip systems. For the proper design, all systems must consider soil intake rate, soil depth, crop requirements, quantity of water available, and size of the field to be irrigated.

Since most of the irrigation systems in Pima County are surface systems, we will discuss this type of system. There are generally two kinds of surface systems: sloped and level or nearly level. Although the sloped system is the most often used within the survey area, it generally has the lowest water application efficiency. Efficiency of the sloped system ranges from 40 to 60 percent. This means that the farmer may have overirrigated at times and underirrigated at other times. Overirrigation usually occurs when the crop is immature and underirrigation may occur when the crop is maturing and has the highest water requirement. Level or nearly level systems allow water to be more uniformly applied to the field and are usually more efficient.

Leveling of farm land falls into two categories: leveling to a uniform grade and leveling to a flat or nearly flat grade. Uniform leveling removes slope irregularities, and flat leveling reduces existing grade. Both categories allow for more uniform water application. The category to use depends on the soil depth, soil intake rate, and quantity of water available.

An adequate and dependable supply of good quality water is essential in designing an irrigation system. Most irrigation water in Pima County has medium salinity and low sodium and can be used for all crops on all soils. There is some water, however, that has high sodium to calcium ratios and low total soluble salts. This can cause dispersion of soils, reduced soil intake rates, and problems with water and air movement in the soil. It is important that irrigation water be tested for water quality so a determination can be made what treatment may be necessary.

An adequate water supply for irrigation purposes means that a sufficient supply is available to irrigate all cropped fields. A general rule of thumb is 10 gallons of irrigation water per minute is necessary to irrigate one acre. An exact determination depends on slope, soil type, crop, irrigation method used, the length of the irrigation furrow, and size of the field.

Fertilization of all irrigated crops is necessary to produce profitable yields. Nitrogen is needed for all crops with the exception of the legumes. Applications of phosphates are generally desirable on those crops

that use considerable amounts of phosphorus such as alfalfa. Amounts and types of fertilizer needed are determined by soil testing and by the requirements of the crop grown. This would be especially true for crops such as pecans, pistachios, citrus, and vegetable crops. Experiments on amounts, types, time of application, and crop requirements are conducted by the University of Arizona Experimental Station, and the information is readily available through the Cooperative Extension Service.

Insect, weed, and disease control can be accomplished in a number of ways. Insects can be controlled through the use of cultural practices, predators, or insecticides. Cultural practices include crop rotations and after harvest tillage. Predators used for insect controls are natural or biological, such as ladybugs which are used to control aphid populations. Insecticides may be applied by ground rig or aircraft at the time needed. Need, timing, wind, and time of day are all important factors for a successful insecticide program.

Weed control is accomplished much the same way as insect control through the use of cultural practices such as crop rotations and through the use of selective herbicides.

Disease control in plants can be accomplished through cultural practices like crop rotations and through the use of fungicides. In addition, plant breeding is a biological control that is very effective. Effects of root rot and verticillium wilt can be reduced through crop rotation and aeration of the soil by cultivation.

Pastureland

Proper management of irrigated pastures includes a well designed irrigation system, fencing, fertilization, and a grazing and irrigation cycle. The objective of good grazing management is to place a large number of cattle per acre on each pasture, graze it for a short period of time, and then move the cattle to the next pasture. This involves precise timing of irrigation and dry-out periods prior to grazing so soil compaction is minimized. It also requires multiple pastures and a uniform grazing cycle. Generally, perennial forage crops are used for efficiently managed pasture systems.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they

are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation; *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, shows that the chief limitation is climate that is very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no

erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification for each map unit is given in the section "Detailed Soil Map Units."

Rangeland

Daniel G. Robinett, range conservationist, Natural Resources Conservation Service, prepared this section.

About 1.7 million acres, or about 91 percent of the survey area, is rangeland. The area has a very long history of use for livestock raising dating back to 1701, when Father Eusabio Kino, a Jesuit missionary, brought cattle from his own herd in Delores, Mexico to the San Xavier Mission, south of present day Tucson (Hastings and Turner, 1972).

In the early 1700's, the Indian missions along the Santa Cruz River were well stocked with livestock. By mid-century, Apache raids had drastically reduced ranching activities. In the 1820's, after Apache raids were reduced, the Spanish government made several land grants to Spanish and Mexican stockmen for ranching purposes. These grants include the Canoa, San Rafael, Buena Vista, Boquillas, and Babacomari grants. The period of 1830 to 1846 saw increased Apache raiding to the point that by 1846 nearly all of the Spanish rancherias in the area had been abandoned. Estimates in the 1850s placed the number of wild cattle along the Santa Cruz and San Pedro rivers at 50,000 to 150,000 head (Hastings and Turner, 1972).

With the Gadsden Purchase of 1853, the Anglo settlers began to rebuild the grazing industry. In 1880, it was estimated there were 20,000 head of cattle south of the Gila River. By 1885, there were about 650,000 cattle in the Arizona Territory, mostly in southern Arizona. By 1890, the number rose to 1.1 million. One year later the figure rose to an estimated 1.5 million, mainly in southern Arizona. The summer rains of 1891 were very poor, and by May of 1892, cattle in the area began to die. The summer rains of 1892 were also very poor. By May of 1893, the losses were staggering. It was estimated that 50 to 75 percent of the cattle in Pima County had died. C. Cameron, head of the Livestock Sanitary Commission, said that had the summer rains of 1893 been poor, virtually all of the cattle in southern Arizona would have perished (Hastings and Turner, 1972).

The period between this tremendous expansion of livestock grazing in the late 1800s and the present has seen a drastic change in rangeland conditions and plant communities in the survey area. One major

factor affecting the change in rangeland conditions was the channel cutting of the major streams. Floods occurred on the Santa Cruz River in 1888, 1889, and 1890. From August 5 through August 15, 1890, a channel cut the flood plain of the Santa Cruz River at Tucson. It started in an irrigation ditch owned by Sam Hughes. By August 15 it was as much as 20 feet deep, 150 feet wide, and over a mile long. Twenty-two years later, in 1912, the gully had grown to a length of 18 miles. A major tributary of the Santa Cruz River, the Rillito Creek, cut a channel during the same time as did Cienega Creek. From 1883 to 1892, the San Pedro River cut a trench from the Gila River to Babacomari Creek. The Altar Valley channel began about 1900. By 1923, it was as much as 6 feet deep and extended from Puertocita Wash to the Anvil Ranch. Fourteen years later, the Altar Wash had cut a trench the entire length of the valley. In places, it was 20 feet deep and 600 feet wide. Present-day dimensions of these channels are well known (Hastings and Turner, 1972).

Trenching of these major streams has had a drying effect on their watersheds. Nearly all of the tributaries of these streams have been affected by the trenching, which created networks by which water is removed rapidly from the watersheds. The result is that range forage production is but a fraction of what it once was in the survey area.

In 1849, the Santa Cruz River at Tucson consisted of a few small brooks running through a grassy meadow. At the time, the Santa Cruz and the San Pedro rivers harbored native trout and beaver. Wild turkeys nested in the tall grass bottom of the upper Santa Cruz River. When Manuel King arrived in the Altar Valley in 1885, the Altar bottom and its tributaries were vegetated with sacaton and not entrenched (Hastings and Turner, 1972; King, 1981). When George Roskrige first surveyed the Altar Valley in 1868 he found no evidence of gullies in the valley floor (Cooke and Reeves, 1976).

These bottoms, with their high water tables, produced a tremendous amount of forage. They offered livestock green feed and water when forage on the plains and foothills was dry and water was scarce. Present-day ranches in the survey area exist without this vital resource for the most part. Present-day grazing capacities are probably less than 10 percent of what they once were. In 1900, Colonel H. C. Hooker of the Sierra Bonita Ranch estimated that grazing capacities in southern Arizona had declined by 50 percent in the preceding 25 years (Hastings and Turner, 1972).

Present day critics of grazing in this area point to past and present overgrazing as the main factor

leading to the range deterioration. Overgrazing, or lack of grazing management, played a part in the events that occurred, but other factors contributed as well. Entrenchment of the Santa Cruz River began along an irrigation ditch. The arroyo in the Altar Valley follows several man-made features on the flood plain. The Altar channel follows the old wagon road that ran from Tucson to Altar, Sonora, for about 4 miles along Puertocita Wash and for about 4 miles north and south of the Palo Alto Ranch. It also follows two fields which were fenced in the bottom in 1886. One was 6 miles south of the Palo Alto Ranch and ran upstream 8 miles and enclosed some 600 acres of bottomland owned by A. Hemme. The other was just south of the Anvil Ranch headquarters and ran 3 miles upstream and enclosed some 200 acres (Cooke and Reeves, 1976).

A large earthquake, with the epicenter near Bavispe, Sonora, occurred in 1878. This earthquake caused cracks in the flood plains in southern Cochise County, Arizona, and may have had an impact on the arroyo formation in the San Pedro and Cienega Creek Watersheds (DuBois and Smith, 1980).

In other major streams, the arroyos originated along man made features on the flood plain. The floods of the late 1880's may have been less severe had the watersheds not been laid bare by overgrazing. However, factors other than overgrazing may have contributed to the depletion of vegetation.

Upward displacement of plant species along a dry to wet gradient may have contributed in altering vegetation in the watershed. In some cases, the range of plant communities has expanded. For instance, the paloverde, bursage, and saguaro communities have expanded their range into the higher elevations formerly dominated by perennial grasses. In other cases, the range of the species has contracted. Oaks no longer occupy sites drier than was thought to be typical for the species, as is the case northwest of Sonoita. This may indicate a shift towards hotter and drier conditions (Hastings and Turner, 1972).

Another contributing factor may be a climatic shift. The frequency of light summer rains was lower and frequency of high intensity rains was higher in the late 1800s than at present. As a result, moisture for grasses in their main season may have been less and as a result the protective cover was less. The above, coupled with higher intensity storms, produced more runoff (Cooke and Reeves, 1976).

Tree ring analysis of fir and pine forests in the mountains of southern Arizona indicate three periods having a high probability of below normal seasonal rainfall. These periods (1773-92, 1804-23, 1870-89)

coincide with the periods of high livestock numbers. The last period coincides with the period of highest livestock numbers in the past (Cooke and Reeves, 1976).

Further evidence of climatic change is revealed in a study of stream flow records along the Santa Cruz river near Tucson. The period from 1910 to 1935 had flooding events dominated by fall and winter storms. The period of 1936 to 1960 had flood events dominated by summer monsoonal activity. The last era from 1961 to present has flooding again dominated by fall and winter storms (Webb and Betancourt, 1992).

Deterioration of the grassland plains and foothills and the resultant change in vegetation from grassland to shrubland may not have occurred until the late 1920s and 1930s, when individual ranches were fenced. For example, the spread of mesquite and grassland deterioration in the Altar Valley did not occur until the late 1920's when the ranches there were fenced, restricting cattle to certain locations (King, 1981).

There is some evidence that naturally occurring fires were important in maintaining these open grasslands. Grazing-reduced fuels and fire suppression have combined to virtually eliminate fire from these ecosystems over the last 90 years (Humphrey, 1987 and Bahre, 1991).

From all of this it seems reasonable to conclude that several factors, some natural and some human-caused, interacted to bring about the changes that have occurred in the last 100 years. Photographic evidence documents very well where vegetative change has and has not occurred (Hastings and Turner, 1972, Humphrey, 1987, and Myrick, 1981). Although plant communities have changed in the recent past, basically the plant species we have today have been in southern Arizona for the last 4 to 8 thousand years, since the plants of the Mexican oak woodland came to Arizona (Martin, 1970).

To better manage and improve the condition of these rangelands there is a need for information about the potential of a certain soil type, in a given climatic area, to produce vegetation. Existing conditions can be compared to what is thought to be potential, and management can be designed to allow for improvement in the range condition.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil

map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, soil depth, and slope are also important.

Range sites occur in different areas where temperatures, rainfall, elevation and soils are different. Each of these areas is called a Major Land Resource Area (MLRA) (USDA, 1981). MLRA D40-2 is classified Central Arizona Basin and Range - Phoenix Desert Shrub. Soils are generally calcareous and the potential plant communities are dominated by desert shrubs and trees. Characteristic plants of this area are creosotebush, ironwood, littleleaf paloverde, and annuals. MLRA D40-1 is classified Central Arizona Basin and Range-Upper Sonoran Desert Shrub. Soils are generally not as calcareous as in MLRA D40-2, and the plant communities have an overstory of desert trees, shrubs, and cacti with an understory of perennial grasses and forbs. Characteristic plants of this area are paloverde, bursage, saguaro, jojoba, Rothrock grama, tobosa grass, bush muhly, threeawns, and cholla species. MLRA D41-3 is classified Southeastern Arizona Basin and Range-Chihuahuan Semidesert Grassland. Soils are generally non-calcareous, and the potential plant communities are grassland. Characteristic plants include grama grasses, curlymesquite, cane beardgrass, Arizona cottontop, sacaton, range ratany, false-mesquite, and burroweed. MLRA D41-1 is classified Southeastern Arizona Basin and Range - Mexican Oak-Pine Woodland and Oak Savannah. Soils are generally non-calcareous and are more moist and cooler than in MLRA D41-3. Potential plant communities are oak-grasslands. Characteristic plant species of this area include Mexican blue oak, Emory oak, Arizona white oak, grama grasses, bullgrass, Texas bluestem, deergrass, cane beardgrass, green sprangletop, wooly bunchgrass, and crinkleawn.

Table 7 shows, for each soil in the survey area, the range site and the total annual production of vegetation in favorable, normal, and unfavorable years. Only those soils that are used as or are suited to rangeland are listed. Explanation of the column headings in table 7 follows.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year,

the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available moisture.

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

The most important thing needed to bring about improvement in range condition in the soil survey area is grazing management. A system that includes grazing, then resting areas on a ranch, needs to be tailored to the physical features, the range sites, and the type of livestock on the ranch. Water developments and fencing needed to facilitate such management should be planned, giving careful consideration to the range sites present, their condition and the way the livestock use the country. Systems of grazing have been developed in the survey area which result in better rangeland condition.

Woodland

Daniel G. Robinett, range conservationist, Natural Resources Conservation Service, prepared this section.

About 50,720 acres of mixed woodland and true woodland is in the survey area. Mixed woodland is found in the highest elevations of the Sierrita and Baboquivari Mountains and in the intermediate elevations of the Rincon Mountains: Major Land Resource Area D41-1; Mexican Oak-Pine Woodland and Oak Savannah. Pine woodland is in the highest elevations of the Rincon Mountains (USDA, 1981).

Although many thousands of acres of lower elevation lands in the survey area resemble woodland because of their dominance by mesquite, this land is classified as rangeland because it was grassland historically. Furthermore, management of these areas is aimed at partial grassland restoration. Soil protection is ensured only by maintenance of herbaceous (grass) covers.

The upper woodland in the survey area consists of ponderosa pine and associated species (Mexican white pine, Apache pine, Douglas fir, white fir, Chihuahua pine, and Gambel oak) at elevations of 6,800-8,670 feet. Rainfall for these areas averages from 24 to over 30 inches annually. Below the pine forest are two areas of mixed woodland. The first occurs at elevations of 5,400 to 7,800 feet and has an average annual precipitation of 20 to 24 inches. It is dominated by silverleaf oak, Arizona white oak, Mexican pinyon, and alligator juniper. The second occurs at elevations of 4,600 to 6,200 feet and has an

average annual precipitation of 16 to 20 inches. It is transitional between rangeland and woodland. It is dominated by Emory oak, Mexican pinyon, alligator juniper, manzanita, Arizona white oak, and Mexican blue oak. The overlapping of elevations from one woodland type to another is primarily a result of north-south aspect. Rainfall patterns for all three woodland areas are bimodal with about an equal division between summer (July-September) precipitation and winter (October-March) precipitation.

One of the more important natural features shaping the nature of the woodlands in the soil survey area is wildfire. The combination of dry lightning storms in late June and July and dry surface fuel conditions resulted in periodic burning of much of southern Arizona's range and woodland. The natural frequency of wildfires has been documented for some plant communities and is still a matter of speculation in others, but reasonable assumptions can be made. The last 60 to 70 years has seen a marked decrease in large natural wildfires. Removal of fine fuels by grazing and fire suppression practiced by federal agencies has led to unnatural conditions in woodland plant communities.

Fire frequency intervals in the ponderosa pine woodland were about 7 to 10 years (Wright and Bailey, 1982). Stands remained open with grass and forb understories. Fires usually were low-intensity ground fires that did little damage to mature trees but kept natural reproduction from turning into doghair thickets with suppressed growing conditions. In the ponderosa pine woodland of the Rincon Mountains, several fires ranging in size from 900 to 5,000 acres occurred from 1943 to 1956. For the next 25 years, wildfires were suppressed. If such policies were to continue, fuel accumulations could lead to extremely destructive burns (Coss, 1984). Fortunately, federal agencies that have a better understanding of these woodland ecosystems are developing fire management plans and are using combinations of silvicultural practices and prescribed burning to achieve vegetative conditions whereby natural wildfires can be allowed to burn and assume their former role in the ecosystem (Palek 1991).

Fire frequency intervals in the upper pinyon, oak, and juniper woodland was probably much longer than in the ponderosa pine type. This interval probably exceeds 50 years and perhaps much more. This woodland is characterized by virtually no herbaceous understory fuel, high live tissue moisture content during the lightning season and a moderate composition of fire-sensitive species (pinyon),

suggesting a relatively long interval between natural fires.

The middle oak woodland, especially on granitic-like parent materials, had a fire-free interval of from 25 to 35 years. These communities have a higher percentage of manzanita which becomes decadent after 20 years and carries so much standing dead wood in the community that the probability of large fires increases with age. Its ecological similarity to the upper elevations of the Arizona chaparral in central Arizona furthers the argument for moderate to long fire-free intervals (Wright and Bailey, 1982).

The occurrence of large scale fires in these oak, juniper, and pinyon communities may be closely linked to both woody fuel (live and dead) accumulation (time since last burn) and to severe drought (not predictable). A good example was the 1950s drought, after which Kitt Peak and large areas in both the Rincon and Catalina Mountains burned off completely. Such fires may also be caused by other unusual events. A large regional earthquake in 1878 caused huge rockslides and fires in all the mountain ranges in southern Arizona as far west as the Coyote Mountains near Kitt Peak. Fires raged for weeks after this event (DuBois and Smith 1980)

At the lower limits of this mixed oak woodland, fire frequency was probably greater. This woodland is transitional to oak-grassland savannah at the lower elevations. This savannah area owes its appearance to fire frequencies of 10 to 20 years (Wright and Bailey, 1982; Humphrey, 1987) Also, this woodland has more herbaceous understory and higher percentages of fire tolerant species (Arizona white oak, Emory oak, catclaw mimosa and Wright silkassel) suggesting a shorter fire-free interval.

It appears that this mixed oak, juniper and pinyon woodland has thickened at its lower limits in the last 100 years as a result of fire suppression and the removal of herbaceous fuels by grazing. If this is the case, reintroducing fire to this area should increase the area of oak-grassland savannah.

Historically, the woodlands in the soil survey area were mainly used for grazing purposes. A limited amount of lumbering occurred in the Rincon Mountains around the turn of the century (Coss, 1984). Small mines localized in the Sierrita, Cerro Colorado, Las Guijas, and Baboquivari mountains certainly used the mixed woodland for mine timbers and firewood (Bahre, 1991). Ranchers have always used these areas of woodland for fence, corral materials, and firewood.

Present day uses of the woodlands in the soil survey area are largely limited to recreational

activities. Portions of the woodland area in the Sierrita and Baboquivari mountains are grazed to a very limited extent by domestic livestock. All of the woodland area in the Rincon Mountains is included in a wilderness area administered by the National Park Service. A trail and campground system is established for recreational uses in this area. Maintenance, however, is minimal in the wilderness area. National Park Service policy for wilderness areas precludes the use of motorized equipment (Coss, 1984).

The *site index* shown in table 8 for the ponderosa pine woodland is expressed as the height that properly spaced trees will achieve in 100 years on the soil involved (i.e. site index of 80 — trees 80 feet in height in 100 years) (USDA, 1980). The *ordination symbol* for ponderosa pine is a combination of an ordination number, which denotes potential productivity in terms of cubic meters of wood per hectare per year, and a subordination letter, which indicates certain soil or physiographic characteristics that contribute to hazards or limitations in management (USDA, 1980). An ordination number of 3 indicates a site with an average annual productivity of 3 cubic meters of wood per hectare for ponderosa pine. A subordination letter *D* refers to restricted rooting depths. These are shallow soils underlain by hard bedrock. A subordination letter *R* refers to steep slopes which may hinder use and management. A subordination *F* refers to rock fragments of gravel- to cobble-size within the soil that may hinder use and management.

The site index for the mixed woodland in the soil survey area is a function of the basal area, in square feet per acre, when the main stand of trees averages 5 inches in diameter at 1 foot above ground (Sauerwein, 1981). The ordination symbol for mixed woodland reflects certain ranges in site index. Ordination number 3 is for site indexes of 100 or more, ordination number 2 is for site indexes of 50 to 100, and ordination number 1 is for site indexes of less than 50 (Sauerwein, 1981). The subordination letters *R*, *F*, and *D* have the same meanings as explained above for ponderosa pine.

Management of the ponderosa pine woodland for whatever use is made of it (recreation, wildlife, timber, etc.) should be done by combining techniques used to achieve varied spacing of trees for the site involved, with small interspersed clearings. Proper spacing of trees for optimum growth would be 30 to 35 feet in Southern Arizona. Where fuels, both down and living (ladder), have accumulated to a point where a naturally occurring summer fire would be devastating, silvicultural methods or controlled

burning should be used to reduce fuel loadings to a point where naturally occurring wildfire can again be allowed to act as a natural part of the ecosystem (Harrington, 1981; USDA, 1983).

Woodland Management and Productivity

Table 8 can help woodland owners or forest managers plan the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, and fire lanes and in log-handling areas. Forests that have been burned or overgrazed also are subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of moderate indicates that erosion-control measures are needed in certain silvicultural activities. A rating of severe indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of moderate indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of severe indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of slight indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of moderate indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of slight indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of moderate indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong.

Plant competition ratings indicate the degree to which undesirable species are expected to invade and grow when openings are made in the tree canopy. The main factors that affect plant competition are depth to the water table and the available water capacity. A rating of slight indicates that competition from undesirable plants is not likely to prevent natural regeneration or suppress the more desirable species. Planted seedlings can become established without undue competition. A rating of moderate indicates that competition may delay the establishment of desirable species. Competition may hamper stand development, but it will not prevent the eventual development of fully stocked stands. A rating of severe indicates that competition can be expected to prevent regeneration unless precautionary measures are applied.

Woodland Understory Vegetation

Understory vegetation consists of grasses, forbs, shrubs, and other plants. If well managed, some woodland can produce enough understory vegetation to support grazing of livestock or wildlife, or both, without damage to the trees.

The quantity and quality of understory vegetation vary with the kind of soil, the age and kind of trees in the canopy, the density of the canopy, and the depth and condition of the litter. The density of the canopy determines the amount of light that understory plants receive.

Table 9 shows, for each soil suitable for woodland, the potential for producing understory vegetation. The total production of understory vegetation includes the herbaceous plants and the leaves, twigs, and fruit of woody plants up to a height of 4.5 feet. It is expressed in pounds per acre of air-dry vegetation in favorable, normal, and unfavorable years. In a favorable year, soil moisture is above average during the optimum part of the growing season; in a normal year, soil moisture is average; and in an unfavorable year, it is below average.

The table also lists the common names of the

characteristic vegetation on each soil and the *composition*, by percentage of air-dry weight, of each kind of plant. The table shows the kind and percentage of understory plants expected under a canopy density that is most nearly typical of woodland in which the production of wood crops is highest.

Recreation

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

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

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not

dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Donald W. Welch, biologist, Natural Resources Conservation Service, prepared this section.

The two most important factors affecting the quality and quantity of wildlife habitat are soil and precipitation. Without either of these, there is no habitat. Other factors significantly affecting habitat type are elevation, aspect, geology, slope, and frequency of flooding.

Temperature, elevation, and precipitation determine the broad vegetational communities, or environmental zones. These vegetative communities include the upper Sonoran desert shrub in the northwest part of the survey area and the Chihuahuan semi-desert grassland in the eastern part of the area.

Several general habitat types occur within each of these environmental zones. The different habitat types are more a function of soils, slope, aspect, geology, frequency of flooding, and human activity.

The vegetative composition of each of these habitat types will vary depending on the environmental zone. These habitat types are distinct, however, and occur in every environmental zone. They include the habitats of the mountains, habitats of the valleys, riparian habitats, cropland habitats, and wetland habitats.

Habitat of the mountains. The variety of vegetation on mountains is highly dependent upon the geologic age of the range. The younger ranges have less developed soils and support only sparse stands of vegetation. However, the rocky slopes are nearly inaccessible to domestic livestock and provide more protection for vegetation. Furthermore, the many crevices and cavities in the rock formations provide wildlife protection from the extreme temperatures encountered in this environment. Sheer cliffs and vertical rock faces are used by many bird species, including birds of prey, for nesting. This habitat within the soil survey varies from the desert shrub mountains of the upper Sonoran desert through the oak-pine habitats of the mid-elevation mountains, to the Ponderosa pine habitat of the higher elevation mountains.

Habitats of valleys. Valleys are located between the mountain ranges. They vary in width from a few hundred yards to several miles. They consist of alluvial fans that spread from the mountains, sloping steeply downward at first and eventually flattening out on the valley bottom. Where two fans merge from opposite slopes, drainage channels have formed and are commonly termed washes or arroyos.

In the upper Sonoran desert shrub environmental zone, a few species of wildlife persist primarily on these creosote bush flat valley uplands. They may forage for food here or traverse these flats traveling from and to better habitat types.

More wildlife species tend to persist on these valley uplands as the elevation increases up through the oak woodland environmental zone. Wildlife activity then tends to decrease in large dense stands of Ponderosa pine valley uplands.

Riparian habitats. Riparian habitats occur along most drainages in the soil survey area. They are characterized by increased plant diversity and vigor stimulated by additional run-in moisture. These habitats generally contain brushy or woody tree species.

Mesquite, paloverde, and desert hackberry are characteristic of the drier riparian areas in the upper Sonoran, with willow and cottonwood indicating wetter riparian types. As the elevation increases, the tree species change to netleaf hackberry, sycamore, Arizona walnut, and some oak species with older

Rocky Mountain maple and aspen indicating the riparian habitats at the higher elevations.

Riparian habitats are the most productive of all habitats in terms of species diversity and in many cases, of total productivity. They provide much of the food and nesting and escape cover in many of the environmental zones. In the case of the drier upper Sonoran zone, wildlife depends almost entirely on riparian habitat, traversing the creosote bush flats basically to get from one riparian zone to another.

The riparian areas may be of somewhat less importance in the better uplands habitats of the higher environmental zones, but remains an essential habitat component of most wildlife.

Cropland habitat. For the most part, cropland itself only provides a temporary habitat component. It is not a component on which wildlife can depend for yearlong sustenance. It can provide food, water, and cover for short periods. During the part of the year when these habitats are most limiting, however, agricultural land is barren.

Cropland can be a significant factor for some migrating species. Grain crops can provide a bountiful food supply during nesting periods for whitewing and mourning doves, for example, significantly increasing the reproduction potential. These species migrate south during the fallow fall and winter periods.

Wetland habitat. This habitat type is characterized basically by wetland plants characteristic of perennially wet soil or open water. The habitat type may occur in any environmental zone and is essential for several wildlife types, including migrating waterfowl and shore and wading birds.

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

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of

grain and seed crops are corn, wheat, oats, barley, sorghum, and sunflower.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, alfalfa tall wheatgrass, bermuda grass, and trefoil.

Desertic herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of desertic herbaceous plants are bush muhly, vine mesquite, Arizona cottontop, Mormon-tea, false mesquite, curlymesquite, threeawn, globemallow, and grama grasses.

Hardwood trees include nonconiferous trees and associated woody understory plants that provide wildlife cover or that produce nuts, buds, catkins, twigs, bark, or foliage used as food by wildlife.

Coniferous plants, cone-bearing trees, shrubs, and associated understory shrubs furnish wildlife cover or supply food in the form of browse, seeds, or fruitlike cones. They are commonly established through natural processes but may be planted or transplanted. Examples are pine, spruce, fir, and juniper trees.

Desertic shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are fourwing saltbush, mesquite, whitethorn, catclaw, skunkbush, sumac, and yucca.

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

Most of the soils in this survey area are rated as poor or very poor for natural wetland plants. These soils may rate higher for wetland plants under irrigated or constructed wetland conditions.

If consideration is being given to a constructed wetland under irrigated conditions a site survey should be made.

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

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

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants.

Wildlife attracted to these areas include Gambel quail, meadowlark, field sparrow, cottontail rabbits, small rodents, jackrabbits, and predators.

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

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. It is made up of nearly all the undisturbed land in the soil survey area. It includes all the riparian woodlands, the oak-pine woodlands and the Ponderosa pine woodlands. It includes much of the upper Sonoran desert shrubland and some of the Chihuahuan semi-desert grassland. The number of rangeland vertebrate wildlife species occupying this habitat classification, permanently or seasonally, undoubtedly exceeds 300. Some species in this broad habitat range include desert shrew, pallid bat, freetail bat, cottontail rabbit, rock squirrel, valley pocket gopher, coyote, badger, bobcat, mule deer, turkey vulture, and mockingbird.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for

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

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

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

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a

special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered slight if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; moderate if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and severe if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

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

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

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all

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

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfill. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is

disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation should be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

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

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

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

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated good, fair, or poor as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as

construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet and have a water table at a depth of less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material

for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

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

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

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

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

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

The surface layer of most soils is generally preferred for topsoil because of its organic matter

content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees. The limitations are considered slight if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; moderate if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and severe if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

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

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

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a

depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

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

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

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

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

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 15.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

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

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2

millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

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

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

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

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are

based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and plasticity index (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

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

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties

are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. Very high, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a

soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

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

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

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

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

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are moderately erodible. Crops can be grown if intensive measures to control wind erosion are used.

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

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material.

These soils are slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

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

The four hydrologic soil groups are:

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

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

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

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

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months.

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

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

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

hard or massive, blasting or special equipment generally is needed for excavation.

Cemented pans are cemented or indurated subsurface layers within a depth of 5 feet. Such pans cause difficulty in excavation. Pans are classified as thin or thick. A thin pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A thick pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

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

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

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

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (USDA, 1975). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Fluvent (*Fluv*, meaning river, with connotations of flood plain, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Torrifuvents (*Torri*, meaning hot and dry, plus *fluvent*, the suborder of the Entisols that are on flood plains or alluvial fans).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the

subgroup that typifies the great group. An example is Typic Torrifuvents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle size, mineral content, soil temperature regime, soil depth, and reaction. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is coarse-loamy, mixed (calcareous), thermic Typic Torrifuvents.

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

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" (USDA, 1984). Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" (USDA, 1975). Unless otherwise indicated, colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Altar Series

The Altar series consists of very deep, well drained, moderately rapidly permeable soils on fan

terraces. These soils formed in alluvium derived dominantly from granite and schist. Slope is 2 to 8 percent. Elevation ranges from 3,000 to 3,600 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy-skeletal, mixed, thermic Ustochreptic Camborthids.

Typical pedon of Altar gravelly sandy loam in an area of Altar-Sasabe complex, 1 to 8 percent slopes, about 870 feet north and 1,750 feet west of the southeast corner of sec. 12, T.20 S., R.8 E.

- A—0 to 2 inches; yellowish brown (10YR 5/4) gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; weak moderately thick platy structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; common very fine tubular pores; 25 to 35 percent gravel and cobble on the surface and 20 percent gravel within the horizon; neutral; abrupt smooth boundary.
- Bw—2 to 17 inches; brown to dark brown (7.5YR 4/4) very gravelly sandy clay loam, dark brown (7.5YR 3.3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; common fine tubular pores; 40 percent gravel; neutral; gradual wavy boundary.
- BC—17 to 39 inches; brown (7.5YR 5/4) very cobbly sandy loam, dark brown (7.5YR 3/4) moist; weak fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common fine roots; common fine tubular pores; 25 percent gravel and 35 percent cobble; neutral; gradual wavy boundary.
- C—39 to 60 inches; light brown (7.5YR 6/4) extremely gravelly loamy sand, brown to dark brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; common very fine roots; 70 percent gravel and 10 percent cobble; neutral.

Reaction ranges from moderately acid in the upper part to mildly alkaline in the lower part. The A horizon has hue of 10YR or 7.5YR, value of 5 or 6 dry, and chroma of 3 through 6. The Bw and BC horizons have hue of 5YR or 7.5YR, value of 4 through 6 dry, and chroma of 3 through 6.

Texture ranges from very gravelly to extremely cobbly sandy loam or sandy clay loam. The C horizon has value of 5 to 6 dry, and chroma 4 through 8. Texture ranges from very gravelly to extremely cobbly sandy loam or loamy sand. In some pedons a buried Bt horizon is present in place of the C horizon.

This horizon has hue of 2.5YR or 5YR and has more clay than is typical for the C horizon.

Andrada Series

The Andrada series consists of very shallow and shallow, well drained, moderately permeable soils on hills and pediments. These soils formed in alluvium and colluvium derived dominantly from sandstone, shale, conglomerate, and related sedimentary rock. Slope is 5 to 35 percent. Elevation ranges from 3,500 to 5,000 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy-skeletal, mixed, thermic, shallow Ustollic Calciorthids.

Typical pedon of Andrada very gravelly loam in an area of Deloro-Andrada complex, 5 to 35 percent slopes about 2,100 feet north and 2,400 feet east of the southwest corner of sec. 27, T.17 S., R.16 E.

- A—0 to 8 inches; dark grayish brown (10YR 4/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; many fine roots; many fine interstitial pores; 60 percent lime-coated angular gravel; strongly effervescent; moderately alkaline; abrupt broken boundary.
- Bk—8 to 11 inches; light brownish gray (10YR 6/2) extremely gravelly loam, dark brown (10YR 4/3) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; many very fine roots; many fine interstitial pores; 75 percent lime-coated angular gravel; violently effervescent; moderately alkaline; abrupt irregular boundary.
- 2Crk—11 to 60 inches; light yellowish brown (2.5YR 6/4) weathered sandstone, olive brown (2.5YR 4/4) moist; common very fine roots in fractures; few coarse krotovinas; many thin lime coatings in fractures; common fine manganese stains on faces of fractures.

Depth to bedrock ranges from 6 to 20 inches. Thickness of the dark colored epipedon ranges from 5 to 14 inches. The calcic horizon includes portions of the A horizon in some pedons. Gravel and channers are 35 to 85 percent by volume. The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 dry, and chroma of 2 or 3. The Bk horizon has hue of 10YR or 2.5YR, value of 6 through 8 dry, and chroma of 1 through 6. Texture of the soil ranges from very gravelly to extremely cobbly sandy loam or loam.

Anklam Series

The Anklam series consists of shallow, well drained, moderately slowly permeable soils on hills and mountains. These soils formed in alluvium and colluvium derived dominantly from rhyolite, andesite, tuff agglomerate, schist and shale. Slope is 15 to 50 percent. Elevation ranges from 2,400 to 4,000 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are loamy-skeletal, mixed, thermic, shallow Typic Haplargids.

Typical pedon of Anklam extremely gravelly sandy loam in an area of Anklam-Cellar-Rock outcrop complex, 15 to 55 percent slopes about 1,900 feet north and 1,750 feet west of the southeast corner of sec. 28, T.14 S., R.13 E.

A—0 to 2 inches; brown (7.5YR 5/4) extremely gravelly sandy loam, dark reddish brown (5YR 3/4) moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many fine interstitial pores; 60 percent gravel; mildly alkaline; abrupt wavy boundary.

Bt1—2 to 7 inches; reddish brown (2.5YR 4/4) very gravelly clay loam, dark reddish brown (2.5YR 3/4) moist; weak medium subangular blocky structure; slightly hard, friable, very sticky and very plastic; many very fine roots; common fine interstitial pores; common faint clay films on faces of peds and coating gravel; 40 percent gravel; mildly alkaline; clear wavy boundary.

Bt2—7 to 13 inches; red (2.5YR 4/6) very gravelly clay loam, dark red (2.5YR 3/6) moist; weak coarse subangular blocky structure; hard, friable, sticky and plastic; many very fine roots; common fine interstitial pores; many distinct clay films on faces of peds and coating gravel; 50 percent gravel; mildly alkaline; clear irregular boundary.

2Crt—13 to 60 inches; pink (5YR 7/3) weathered trachyandesite, light reddish brown (5YR 6/3) moist; common very fine roots in fractures; common distinct clay films on faces of rock fractures; common thin lime coatings in fractures.

Depth to weathered bedrock ranges from 10 to 20 inches. Reaction ranges from neutral to moderately alkaline. Gravel and channers are 35 to 70 percent by volume.

The A horizon has hue of 5YR or 7.5YR, value of 5 or 6 dry, and chroma of 2 through 4. The Bt horizon

has hue of 5YR or 2.5YR, value of 4 or 5 dry, and chroma of 3 through 6. Texture of the Bt ranges from very gravelly to very cobbly clay loam or sandy clay loam.

Anthony Series

The Anthony series consists of very deep, well drained, moderately rapidly permeable soils on flood plains and drainageways. These soils formed in mixed alluvium. Slope is 0 to 3 percent. Elevation is 2,200 to 3,600 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are coarse-loamy, mixed (calcareous), thermic Typic Torrifluvents.

Typical pedon of Anthony fine sandy loam, 0 to 3 percent slopes about 670 feet south and 2,270 feet west of the northeast corner of sec. 35, T.17 S., R.9 E.

A—0 to 5 inches; light yellowish brown (10YR 6/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; thin strata of brown (10YR 5/3) coarse sandy loam, dark brown (10YR 3/3) moist; weak moderately thick platy structure; soft, loose, slightly sticky and slightly plastic; many very fine roots; common fine interstitial pores; 10 percent gravel; slightly effervescent; moderately alkaline; abrupt smooth boundary.

AC—5 to 16 inches; yellowish brown (10YR 5/4) very fine sandy loam with thin strata of loamy sand, dark yellowish brown (10YR 4/4) moist; moderately thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; common fine tubular pores; 10 percent gravel; slightly effervescent; moderately alkaline; abrupt smooth boundary.

C—16 to 23 inches; light yellowish brown (10YR 6/4) gravelly loamy sand, dark yellowish brown (10YR 4/4) moist; single grain; loose, nonsticky and nonplastic; common very fine roots; common fine tubular pores; 30 percent gravel; slightly effervescent; moderately alkaline; abrupt smooth boundary.

Ck—23 to 51 inches; yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 3/4) moist; massive; soft, very friable, slightly sticky and slightly plastic; common fine roots; common fine tubular pores; few fine lime coatings in pores; 10 percent gravel; strongly effervescent; moderately alkaline; clear wavy boundary.

C—51 to 60 inches; yellowish brown (10YR 5/4) gravelly loamy coarse sand, dark yellowish

brown (10YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few fine roots; common fine tubular pores; 20 percent gravel; strongly effervescent; moderately alkaline.

Reaction is mildly or moderately alkaline. The soil is stratified, and the 10- to 40-inch control section averages less than 18 percent clay and less than 35 percent gravel by volume. The A and AC horizons have hue of 10YR or 7.5YR, value of 5 through 7 dry, and chroma of 2 through 4. The C horizons have hue of 10YR or 7.5YR, value of 5 through 7 dry, and chroma of 2 through 4. Texture is dominantly sandy loam and some horizons are slightly coarser or finer.

Arivaca Series

The Arivaca series consists of moderately deep, well drained, slowly permeable soils on relict fan terraces. These soils formed in alluvium derived dominantly from basalt, conglomerate, and tuff. Slope is 2 to 15 percent. Elevation ranges from 3,400 to 4,600 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are fine, montmorillonitic, thermic Ustollic Haplargids.

Typical pedon of Arivaca very cobbly loam, 2 to 15 percent slopes about 2,140 feet south and 715 feet east of the northwest corner of sec. 29, T.19 S., R.11 E.

A—0 to 1 inch; reddish brown (5YR 4/3) very cobbly loam, dark reddish brown (5YR 3/3) moist; moderate thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common fine interstitial pores; 15 percent gravel and 20 percent cobble; neutral; abrupt wavy boundary.

Bt1—1 to 4 inches; dark reddish gray (5YR 4/2) gravelly clay loam, dark reddish brown (5YR 3/2) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; common faint clay films on faces of peds and lining pores; 10 percent cobble and 15 percent gravel; mildly alkaline; clear wavy boundary.

Bt2—4 to 8 inches; reddish brown (5YR 4/3) gravelly clay loam, dark reddish brown (5YR 3/3) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; common fine interstitial pores; common faint clay films on faces of peds and lining pores; 10

percent cobble and 25 percent gravel; mildly alkaline; abrupt wavy boundary.

Bt3—8 to 18 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; strong medium prismatic structure; very hard, very firm, very sticky and very plastic; many very fine roots expd; common very fine tubular pores expd; many prominent clay films on faces of peds and lining pores; many pressure faces; 5 percent cobble and 5 percent gravel; moderately alkaline; clear wavy boundary.

Btk—18 to 21 inches; reddish brown (5YR 5/4 and 4/4) cobbly clay, dark reddish brown (5YR 3/4) moist; moderate fine subangular blocky structure; hard, friable, sticky and very plastic, many very fine roots; common fine interstitial pores; common faint clay films on faces of peds and lining pores; few fine masses of calcium carbonate; strongly effervescent; moderately alkaline; abrupt wavy boundary.

R—21 inches; porphyritic tuff, with a 0.5-inch calcium carbonate cemented hardpan that has a thin laminar cap.

Bedrock is at a depth of 20 to 40 inches. The A horizon has hue of 5YR or 7.5YR, value of 3 through 5 dry, and chroma of 2 or 3. The Bt horizon has hue of 5YR or 7.5YR, value of 3 through 5 dry, and chroma of 2 or 3 in the upper part and 3 or 4 in the lower part. Texture is clay or clay loam with 5 to 35 percent gravel and cobble. The Btk horizon has hue of 5YR or 7.5YR, value of 4 through 6 dry, and chroma of 4 through 6. Texture is similar to the Bt horizon.

Arizo Series

The Arizo series consists of very deep, excessively drained, very rapidly permeable soils on flood plains, drainageways, and channel bottoms. These soils formed in mixed alluvium. Slope is 0 to 3 percent. Elevation ranges from 2,000 to 3,000 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are sandy-skeletal, mixed, thermic Typic Torriorthents.

Typical pedon of Arizo gravelly loamy sand in an area of Arizo-Riverwash complex, 0 to 3 percent slopes, from the Tohono O'odham Nation soil survey area about 1,320 feet south and 1,200 feet west of the northwest corner of sec. 30, T.11 S., R.3 E.

A—0 to 1 inch; yellowish brown (10YR 5/6) gravelly loamy sand, dark yellowish brown (10YR 4/4) moist; weak thick platy structure; loose, nonsticky and nonplastic; few fine roots; few fine vesicular pores; 20 percent gravel; noneffervescent; mildly alkaline; abrupt wavy boundary.

A/C—1 to 18 inches; yellowish brown (10YR 5/4) gravelly loamy sand, dark yellowish brown (10YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few fine roots; common fine interstitial pores; 20 percent gravel; noneffervescent; mildly alkaline; clear wavy boundary.

C1—18 to 33 inches; light yellowish brown (10YR 6/4) very gravelly loamy sand, yellowish brown (10YR 5/4) moist; single grain; loose, nonsticky and nonplastic; few fine roots; common fine interstitial pores; 35 percent gravel; slightly effervescent; mildly alkaline; clear wavy boundary.

C2—33 to 52 inches; light yellowish brown (10YR 6/4) very gravelly loamy sand, yellowish brown (10YR 5/4) moist; single grain; loose, nonsticky and nonplastic; few fine roots; common fine interstitial pores; 55 percent gravel; strongly effervescent; mildly alkaline; abrupt wavy boundary.

C3—52 to 60 inches; light yellowish brown (10YR 6/4) very gravelly loamy sand, yellowish brown (10YR 5/4) moist; single grain; loose, nonsticky and nonplastic; few fine roots; common fine interstitial pores; 45 percent gravel; strongly effervescent; moderately alkaline.

The control section averages 70 to 100 percent sand in the fine earth fraction and 35 to 85 percent gravel and cobble by volume. Disseminated lime is present in some subhorizon within the control section. The soil has hue of 10YR or 7.5YR, value of 5 through 7 dry, and chroma of 3 through 6.

Typical pedon is shared with the adjoining soil survey.

Bernardino Series

The Bernardino series consists of very deep, well drained, slowly permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 1 to 15 percent. Elevation is 3,500 to 5,000 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are fine, mixed, thermic Ustollic Haplargids.

Typical pedon of Bernardino gravelly sandy clay loam in an area of Bernardino-Tombstone association, 5 to 16 percent slopes about 700 feet south and 1,850 feet west of the northeast corner of sec. 13, T.21 S., R.8 E.

A—0 to 2 inches; reddish brown (5YR 4/4) gravelly sandy clay loam, dark reddish brown (5YR 3/4) moist; weak fine granular structure; slightly hard, friable, sticky and plastic; common fine roots; many very fine interstitial pores; 25 percent gravel; slightly effervescent; mildly alkaline; abrupt wavy boundary.

Bt1—2 to 5 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist, moderate fine subangular blocky structure; hard, friable, sticky and plastic; many very fine roots; common fine interstitial pores; common faint clay films on faces of peds and lining pores; slightly effervescent; moderately alkaline; clear wavy boundary.

Bt2—5 to 15 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; moderate medium prismatic structure; very hard, firm, very sticky and very plastic; many very fine roots; many fine tubular pores expd; common faint clay films on faces of peds and lining pores; strongly effervescent; moderately alkaline; clear wavy boundary.

Btk—15 to 29 inches; light brown (7.5YR 6/4) loam, brown to dark brown (7.5YR 4/4) moist; moderate coarse prismatic structure; very hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores, expd; common faint clay films on faces of peds; few coarse prominent lime masses; strongly effervescent; moderately alkaline; clear wavy boundary.

Bk—29 to 41 inches; pink (7.5YR 7/4) loam, brown (7.5YR 5/4) moist; moderate coarse subangular blocky structure; very hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; many coarse distinct masses and nodules of lime; violently effervescent; moderately alkaline; clear wavy boundary.

2Bk—41 to 60 inches; white (10YR 8/2) loam, light gray (10YR 7/2) moist; massive; hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine and few medium and coarse tubular pores; violently effervescent with lime disseminated; moderately alkaline.

Depth to the calcic horizon is 10 to 20 inches. Reaction ranges from neutral in the upper part to moderately alkaline in the lower part and ranges from

noneffervescent in the upper part to violently effervescent in the lower part. Coarse fragments in the upper 20 inches of the control section average less than 35 percent by volume. The A horizon has hue of 5YR through 10YR, value of 4 through 6 dry, and chroma of 2 through 4. The Bt horizons have hue of 2.5YR through 7.5YR, value of 3 through 5 dry, and chroma of 3 through 6. Texture is clay, clay loam or their gravelly counterparts. The Btk, Bk, and 2Bk horizons are mixed with white and pinkish masses of lime. Texture of these horizons ranges from nongravelly to very gravelly loam, sandy loam, clay loam, and sandy clay loam.

Boriana Series

The Boriana Series consists of very shallow and shallow, well drained, moderately permeable soils on hills and mountains. These soils formed in alluvium and colluvium derived dominantly from gneiss. Slope is 10 to 35 percent. Elevation ranges from 7,400 to 8,670 feet and includes areas on north-facing slopes as low in elevation as 6,800 feet. The mean annual precipitation is about 24 to 30 inches, the mean annual air temperature is 45 to 50 degrees F, and the frost-free period is 140 to 150 days.

These soils are loamy-skeletal, mixed mesic Lithic Haplustolls.

Typical pedon of Boriana very flaggy sandy loam in an area of Spudrock-Boriana complex, 10 to 35 percent slopes about 50 feet north and 1,200 feet west of the southeast corner of sec. 13, T.14 S., R.17 E.

- Oi—2 to 0 inches; dark grayish brown (10YR 4/2) slightly decomposed forest litter (ponderosa pine needles), dark brown (10YR 3/3) moist; medium acid; abrupt smooth boundary.
- A—0 to 4 inches; dark gray (10YR 4/1) very flaggy sandy loam, black (10YR 2/1) moist; moderate medium granular structure; soft, friable, slightly sticky and nonplastic; common medium roots; common fine tubular pores; 25 percent flagstones and 15 percent channers; slightly acid; abrupt irregular boundary.
- C—4 to 10 inches; light gray (10YR 7/2) very flaggy sandy loam, grayish brown (10YR 5/2) moist; massive; slightly hard, friable, slightly sticky and nonplastic; common medium roots; common fine tubular pores; 25 percent flagstones and 15 percent channers and gravel; slightly acid; abrupt irregular boundary.
- 2Cr—10 to 12 inches; variegated white (10YR 8/1) and very pale brown (10YR 8/4) partially

- weathered gneiss, light gray (10YR 7/1) moist; C horizon material in fractures; common fine roots in fractures; wavy broken boundary.
- 2R—12 inches; white (10YR 8/1) gneiss, pale brown (10YR 7/1) moist.

Depth to bedrock ranges from 4 to 12 inches. Reaction ranges from neutral to moderately acid. Gravel, channers, and flagstones average 35 to 70 percent by volume. The A horizon has hue of 10YR, value of 3 through 5 dry, and chroma of 1 through 3. The C horizon has hue of 10YR or 7.5YR, value of 5 through 8 dry, and chroma of 1 through 3. The C or Cr horizons are not present in all pedons.

Bucklebar Series

The Bucklebar series consists of very deep, well drained, moderately permeable soils on fan terraces and stream terraces. These soils formed in mixed alluvium. Slope is 0 to 3 percent. Elevation ranges from 2,200 to 3,300 feet. The mean annual precipitation is about 10 to 12 inches. The mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are fine-loamy, mixed, thermic Typic Haplargids.

Typical pedon of Bucklebar sandy loam from the Tohono O'odham Nation soil survey area located at about 500 feet east and 1,500 feet north of the southwest corner of sec. 16, T. 17 S., R. 4 E., in the Sells Livestock complex.

- A—0 to 3 inches; strong brown (7.5YR 4/6) sandy loam, dark brown (7.5YR 3/4) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; few fine roots; few fine vesicular, interstitial and tubular pores; noneffervescent; mildly alkaline; abrupt smooth boundary.
- Bt1—3 to 9 inches; strong brown (7.5YR 4/6) sandy loam, dark brown (7.5YR 3/4) moist; weak coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few fine roots; common fine tubular pores; few distinct continuous clay films on rock fragments, on faces of peds, in pores, and between sand grains; noneffervescent; mildly alkaline; abrupt smooth boundary.
- Bt2—9 to 22 inches; reddish brown (5YR 4/4) loam, dark reddish brown (5YR 3/4) moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and plastic; few fine roots;

common fine tubular pores; many distinct continuous clay films on rock fragments, on faces of peds, in pores, and between sand grains; noneffervescent; mildly alkaline; abrupt smooth boundary.

Btk1—22 to 37 inches; reddish brown (5YR 4/4) loam, dark reddish brown (5YR 3/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few fine and medium roots; common very fine tubular pores; few faint continuous clay films on faces of peds and in pores, between sand grains, and few distinct lime coats on faces of peds; violently effervescent; mildly alkaline; clear smooth boundary.

Btk2—37 to 52 inches; strong brown (7.5YR 4/6) loam, dark brown (7.5YR 3/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; few fine tubular pores; very few faint patchy clay films in root channels and pores, and few distinct continuous lime coats on faces of peds; common fine lime threads; strongly effervescent, mildly alkaline; clear smooth boundary.

Btk3—52 to 60 inches; strong brown (7.5YR 4/6) loam, dark brown (7.5YR 3/4) moist; weak fine subangular blocky structure; soft, very friable, sticky and nonplastic; few fine roots; few fine tubular pores; few faint patchy clay films between sand grains, and lime coats in root channels and pores; common fine lime threads; strongly effervescent; mildly alkaline.

The soil averages less than 35 percent gravel. The reaction ranges from neutral to moderately alkaline. The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 dry and 4 or 5 moist, and a chroma of 3 or 4, dry or moist. The Bt horizon has a hue of 5YR or 7.5YR, value of 5 or 6 dry and 4 or 5 moist, and a chroma of 4 through 6, dry or moist. Textures are dominantly sandy clay loam. The Bk horizon has hue of 7.5YR or 10YR, value of 5 or 6 dry and 4 or 5 moist, and a chroma of 4 through 6, dry or moist. Textures are dominantly sandy loam, but can be sandy clay loam or clay loam. Calcium carbonate equivalent is less than 15 percent.

Typical pedon is shared with the adjoining soil survey.

Caralampi Series

The Caralampi series consists of very deep, well drained, moderately slowly permeable soils on fan terraces and hills. These soils formed in mixed alluvium. Slope is 5 to 45 percent. Elevation ranges

from 3,100 to 5,200 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy-skeletal, mixed, thermic Ustollic Haplargids.

Typical pedon of Caralampi extremely gravelly sandy loam, 15 to 45 percent slopes about 2,300 feet north and 1,400 feet west of the southeast corner of sec. 35, T.18 S., R.16 E.

A—0 to 1 inch; dark brown (7.5YR 4/2) extremely gravelly sandy loam, dark reddish brown (5YR 3/2) moist; moderate fine granular structure; slightly hard, very friable, sticky and slightly plastic; many fine roots; many fine interstitial pores; 60 percent gravel; neutral; abrupt smooth boundary.

Bt1—1 to 8 inches; reddish brown (5YR 4/3) very gravelly clay loam, dark reddish brown (5YR 3/3) moist; moderate medium subangular blocky structure; hard, friable, sticky and plastic; many very fine roots; many fine interstitial pores; few faint clay films on faces of peds and lining pores; 50 percent gravel; neutral; clear smooth boundary.

Bt2—8 to 16 inches; reddish brown (5YR 5/4) extremely gravelly sandy clay loam, dark reddish brown (5YR 3/4) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; many very fine roots; common very fine tubular pores; common faint clay films lining pores and on faces of peds; 60 percent gravel; neutral; clear wavy boundary.

Bct—16 to 28 inches; reddish brown (5YR 5/4) extremely gravelly sandy clay loam, reddish brown (5YR 4/4) moist; common fine faint yellowish red (5YR 5/6) mottles, yellowish red (5YR 4/6) moist; weak coarse subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; few faint clay films bridging sandy grains and lining pores; 60 percent gravel; mildly alkaline; gradual wavy boundary.

2C—28 to 60 inches; light reddish brown (5YR 6/4) and yellowish red (5YR 5/6) extremely gravelly sandy loam, reddish brown (5YR 4/4) and yellowish red (5YR 4/6) moist; massive; hard, friable, slightly sticky and slightly plastic; few fine roots; few very fine tubular pores; 60 percent gravel; mildly alkaline.

Solum depth ranges from 20 to 45 inches. Reaction ranges from slightly acid in the upper part to mildly alkaline in the lower part. The soil is usually

noneffervescent but may contain some free carbonates in the lower part. The A horizon has hue of 5YR through 10YR, value of 4 or 5 dry, and chroma of 2 through 4. The Bt horizons have hue of 2.5YR through 5YR, value of 4 or 5 dry, and chroma of 3 through 6. Texture is very gravelly or very cobbly sandy clay loam or clay loam. The BC and C horizons have hue of 5YR or 7.5YR, value of 5 through 7 dry, and chroma of 2 through 6. Texture is usually very gravelly sandy loam or sandy clay loam but may include cobbly, stony, or bouldery size fragments.

Cave Series

The Cave series consists of very shallow and shallow to a petrocalcic horizon, well drained, moderately permeable soils on relict fan terraces. These soils formed in mixed alluvium. Slope is 0 to 8 percent. Elevation ranges from 2,300 feet to 3,200 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are loamy, mixed, thermic, shallow Typic Paleorthids.

Typical pedon of Cave gravelly fine sandy loam, in an area of Cave soils and Urban land, 0 to 8 percent slopes about 1,320 feet north and 10 feet east of the southeast corner of sec. 2. T.16 S., R.9 E.

A—0 to 1 inch; light brown (7.5YR 6/4) gravelly fine sandy loam, brown to dark brown (7.5YR 4/4) moist; weak thin platy structure parting to weak fine subangular blocky; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; many fine interstitial pores; 30 percent fine gravel; strongly effervescent; moderately alkaline; abrupt wavy boundary.

BA—1 to 4 inches; light brown (7.5YR 6/4) gravelly fine sandy loam, brown to dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; many fine interstitial pores; 30 percent fine gravel; strongly effervescent; moderately alkaline; clear wavy boundary.

Bk—4 to 7 inches; pinkish white (7.5YR 8/2) gravelly fine sandy loam, pinkish gray (7.5YR 6/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic, many very fine roots; many fine interstitial pores; many medium lime masses and lime coatings on gravel; 30 percent gravel; violently effervescent; moderately alkaline; abrupt wavy boundary.

2Bkm—7 to 20 inches; white (10YR 8/2) indurated

lime-cemented hardpan, pinkish gray (7.5YR 7/2) moist; massive; laminar surface on hardpan has troweled appearance; extremely hard, extremely firm; violently effervescent.

C—20 to 60 inches; pale brown (7.5YR 6/3) gravelly loamy sand, pale brown (7.5YR 6/4) moist; massive; soft, very friable, nonsticky and nonplastic; 25 percent gravel; violently effervescent; moderately alkaline.

Depth to the petrocalcic horizon ranges from 4 to 20 inches. The soil averages 10 to 35 percent fine and medium gravel by volume above the petrocalcic horizon. The A horizon has hue of 7.5YR to 10YR, value of 5 through 7 dry, and chroma of 3 or 4. The BA and Bk horizons have hue of 10YR to 7.5YR, value of 5 through 8 dry, and chroma of 2 through 4. Texture is gravelly sandy loam or sandy loam, fine sandy loam or loam. The 2Bkm horizon is indurated at the surface but has variable cementation below depths of 20 inches.

Cellar Series

The Cellar series consists of very shallow and shallow, somewhat excessively drained, moderately rapid permeable soils on pediments, hills, and mountains. These soils formed in alluvium and colluvium derived dominantly from granite and gneiss. Slope is 15 to 65 percent. Elevation ranges from 2,200 to 4,000 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are loamy-skeletal, mixed, nonacid, thermic Lithic Torriorthents.

Typical pedon of Cellar extremely gravelly sandy loam in an area of Cellar-Lehmans complex, 5 to 25 percent slopes about 1,200 feet north and 800 feet west of the southeast corner of sec. 24, T.11 S., R.13 E.

A1—0 to 1 inches; light yellowish brown (10YR 6/4) extremely gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; weak moderately thick platy structure; slightly hard, very friable, nonsticky and nonplastic; common fine roots; many fine interstitial pores; 60 percent fine gravel; neutral; abrupt smooth boundary.

A2—1 to 5 inches; brown (7.5YR 5/4) extremely gravelly sandy loam, brown to dark brown (7.5YR 4/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; many fine interstitial pores; 60 percent gravel; neutral; abrupt irregular boundary.

Bw—5 to 10 inches; brown (7.5YR 5/4) extremely gravelly sandy loam, brown to dark brown (7.5YR 4/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; many very fine roots; many fine interstitial pores; 20 percent cobble and 40 percent gravel; mildly alkaline; clear wavy boundary.

2R—10 inches; light brown (7.5 6/4) granite, brown (7.5YR 5/4) moist; very fine roots in fractures.

Depth to bedrock ranges from 4 to 20 inches.

Reaction ranges from neutral to moderately alkaline. The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 dry, and chroma of 3 through 6. The Bw horizon has hue of 10YR or 7.5YR, value of 4 through 6 dry, and chroma of 4 through 6. Texture is very gravelly or extremely gravelly sandy loam, fine sandy loam, or loam.

Chimenea Series

The Chimenea series consists of very shallow and shallow, well drained, moderately permeable soils on pediments and hills. These soils formed in alluvium and colluvium derived dominantly from granite and gneiss. Slope is 5 to 30 percent. Elevation ranges from 2,200 to 4,000 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 62 to 64 degree F, and the frost-free period is 220 to 280 days.

These soils are loamy, mixed, thermic, shallow Typic Haplargids.

Typical pedon of Chimenea very gravelly fine sandy loam, 5 to 15 percent slopes about 2,410 feet south and 60 feet east of the northwest corner of sec. 20, T.14 S., R.16 E.

A—0 to 2 inches; brown (7.5YR 5/4) very gravelly fine sandy loam, reddish brown (5YR 4/4) moist; weak medium platy structure parting to weak fine granular; slightly hard, very friable, slightly sticky and nonplastic; many very fine roots; common fine interstitial pores; 40 percent fine gravel; slightly effervescent; mildly alkaline; abrupt wavy boundary.

Bt1—2 to 8 inches; reddish brown (5YR 4/4) gravelly sandy clay loam, dark reddish brown (5YR 3/4) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; many very fine roots; many fine interstitial pores; common distinct clay films bridging sand grains and coating gravel; 20 percent fine gravel; mildly alkaline; clear wavy boundary.

Bt2—8 to 15 inches; reddish brown (2.5YR 4/4) gravelly sandy clay loam, dark reddish brown

(2.5YR 3/4) moist; massive; hard, friable, sticky and plastic; many very fine roots; many fine interstitial pores; many distinct clay films bridging sand grains and coating gravel; 30 percent fine gravel; mildly alkaline; gradual irregular boundary.

2Crt—15 to 60 inches; weathered granite (grus); variegated reddish brown (5YR 5/4) pink (5YR 7/3) and pinkish gray (5YR 7/2) reddish brown (5YR 5/3 and 5YR 4/4) moist; common distinct clay films in rock fractures.

Reaction is neutral to moderately alkaline. Depth to bedrock ranges from 6 to 20 inches. The A horizon has hue of 7.5YR or 5YR, value of 5 or 6 dry, and chroma of 3 or 4. The Bt horizons have hue of 5YR or 2.5YR, value of 4 or 5 dry, and chroma of 2 through 6. Texture ranges from coarse sandy loam to gravelly clay loam. The Crt horizon is weathered granite (grus) with clay in the fractures to a depth of 60 inches or more.

Chiricahua Series

The Chiricahua series consists of shallow, well drained, slowly permeable soils on hills and pediments. These soils formed in mixed alluvium and colluvium. Slope is 5 to 15 percent. Elevation ranges from 3,500 to 5,100 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are clayey, mixed, thermic, shallow Ustollic Haplargids.

Typical pedon of Chiricahua very gravelly fine sandy loam in an area of Chiricahua-Lampshire complex, 5 to 15 percent slopes about 1,600 feet south and 500 feet west of the northeast corner of sec. 19, T.22 S., R.8 E.

A—0 to 1 inch; strong brown (7.5YR 5/6) very gravelly fine sandy loam, strong brown (7.5YR 4/6) moist; weak medium platy structure; soft, very friable, slightly sticky and nonplastic; common very fine roots; common coarse vesicular pores; 40 percent gravel; neutral; abrupt smooth boundary.

Bt—1 to 11 inches; brown (7.5YR 5/4) clay, dark brown (7.5YR 3/4) moist; strong fine subangular blocky structure; hard, firm, very sticky and very plastic; common fine roots; common medium tubular pores; continuous distinct clay films lining pores and on face of peds; common thick organic coatings lining pores; neutral; clear wavy boundary.

2Bt—11 to 16 inches; brown (7.5YR 5/4) gravelly

clay, dark brown (7.5YR 3/4) moist; strong fine subangular blocky structure; hard, firm, very sticky and very plastic; common fine roots; common medium pores; continuous distinct clay films lining pores; 30 percent gravel; neutral; abrupt wavy boundary.

3Crt—16 to 23 inches; pale olive (5YR 6/3)

weathered granite, olive (5YR 4/3) moist; many prominent clay films coating rock fractures that decrease in amount and thickness with depth.

3R—23 inches; granite.

Depth to bedrock ranges from 10 to 20 inches. Reaction ranges from moderately acid to mildly alkaline. The A horizon has hue of 5YR or 7.5YR, value of 4 through 6 dry, and chroma of 2 through 4. The Bt horizon has hue of 7.5YR or 5YR, value of 4 or 5 dry, and chroma of 3 through 6. Texture is clay loam or clay with 0 to 35 percent gravel. The Crt horizon is variegated with clay coatings in fractures.

Combate Series

The Combate series consists of very deep, well drained, moderately rapid permeable soils on alluvial fans. These soils formed in alluvium derived dominantly from granite. Slope is 2 to 8 percent. Elevation is 2,900 to 4,600 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are coarse-loamy, mixed, nonacid, thermic Ustic Torrifuvents.

Typical pedon of Combate gravelly loamy coarse sand, 2 to 8 percent slopes, from the Tohono O'odham Nation soil survey area, located about 1,700 feet west and 1,800 feet south of the northwest corner of sec. 8, T.17 S., R.8 E.

A1—0 to 1 inch; brown (10YR 5/3) gravelly loamy coarse sand, dark brown (10YR 3/3) moist; weak very fine and fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine and few medium roots; noneffervescent; 30 percent gravel; neutral; clear smooth boundary.

A2—1 to 15 inches; dark grayish brown (10YR 4/2) gravelly loamy coarse sand, very dark brown (10YR 2/2) moist; weak very fine and fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and few medium roots; noneffervescent; 25 percent gravel; neutral; gradual wavy boundary.

C1—15 to 29 inches; brown to dark brown (10YR 4/3) gravelly coarse sandy loam, very dark brown

(10YR 2/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and few medium roots; noneffervescent; 30 percent gravel; slightly acid; gradual wavy boundary.

C2—29 to 60 inches; yellowish brown (10YR 5/4)

gravelly coarse sandy loam, dark yellowish brown (10YR 3/4) moist; massive; soft, very friable, nonsticky and nonplastic; many very fine and fine and few medium roots; noneffervescent; 35 percent gravel; neutral.

Reaction ranges from slightly acid to slightly alkaline. Rock fragments average less than 35 percent gravel in the control section. Organic matter is 1 to 3 percent in the surface and more than 0.35 percent at a depth of 50 inches.

The A horizon has hue of 10YR or 7.5YR, value of 3 through 5 dry, 2 through 4 moist, and chroma of 2 through 4, dry or moist. The C horizons have hue of 10YR or 7.5YR, value of 3 through 5 dry, 2 through 4 moist, and a chroma of 2 through 4, dry or moist.

Textures range from sandy loam, coarse sandy loam, and loamy sand with less than 18 percent clay. Some pedons have a buried paleosol in the lower substratum.

Typical pedon is shared with the adjoining soil survey.

Comoro Series

The Comoro series consists of very deep, well drained, moderately rapidly permeable soils on flood plains. These soils formed in mixed alluvium. Slope is 0 to 2 percent. Elevation ranges from 2,400 to 4,600 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are coarse-loamy, mixed (calcareous), thermic Ustic Torrifuvents.

Typical pedon of Comoro sandy loam in an area of Riveroad and Comoro soils, 0 to 2 percent slopes about 150 feet south and 250 feet west of the northeast corner of sec. 17, T.19 S., R.17 E.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) sandy loam, black (10YR 2/1) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine interstitial pores; many distinct organic coats on rock fragments; slightly effervescent; neutral; clear smooth boundary.

A2—4 to 18 inches; very dark grayish brown (10YR

3/2) sandy loam, black (10YR 2/1) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine and few medium and coarse roots; common fine interstitial and tubular pores; many distinct organic coats on ped faces, in pores, and on rock fragments; 5 percent gravel; slightly effervescent; neutral; clear smooth boundary.

C1—18 to 37 inches; dark grayish brown (10YR 4/2) sandy loam, black (10YR 2/1) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common fine tubular pores; many distinct organic coats on ped faces, in pores, and on rock fragments; 10 percent gravel; slightly effervescent; neutral; abrupt smooth boundary.

C2—37 to 60 inches; brown to dark brown (10YR 4/3) fine sandy loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine and medium roots; common fine tubular pores; few distinct lime coats on rock fragments; strongly effervescent; mildly alkaline.

Reaction ranges from neutral to moderately alkaline. The A horizon has hue of 10YR or 7.5YR, value of 3 through 5 dry, and chroma of 1 through 3. The C horizons have color similar to the A horizon but values range from 3 through 6, and chromas range from 1 through 4.

Cortaro Series

The Cortaro series consists of shallow, well drained, moderately rapidly permeable soils formed on hills and mountains from alluvium and colluvium dominantly derived from granite, gneiss, and schist. Slope is 15 to 45 percent. Elevation ranges from 5,400 to 6,200 feet. The mean annual precipitation is about 16 to 20 inches. The mean annual air temperature is 55 to 57 degrees F, and the frost-free period is 160 to 180 days.

These soils are loamy-skeletal, mixed, nonacid, mesic Lithic Ustorthents.

Typical pedon of Cortaro extremely gravelly sandy loam in an area of Cortaro-Rock outcrop-Faraway complex, 15 to 45 percent slopes about 150 feet south and 600 feet east of the northwest corner of sec. 31, T.14 S., R.17 E.

A—0 to 3 inches; brown (10YR 5/3) extremely gravelly sandy loam, dark brown (10YR 3/3) moist; weak medium granular structure; slightly

hard, friable, nonsticky and nonplastic; common fine roots; common fine tubular pores; 60 percent gravel, 10 percent flagstones and channers; neutral; clear smooth boundary.

C—3 to 12 inches; pale brown (10YR 6/3) very gravelly sandy loam, brown to dark brown (10YR 4/3) moist; massive; slightly hard, friable, nonsticky and nonplastic; common fine roots; common fine tubular pores; 45 percent gravel; slightly acid; abrupt wavy boundary.

R—12 inches; very pale brown (10YR 7/3) gneiss, brown (10YR 5/3) moist; few coarse roots in fractures.

Depth to bedrock ranges from 12 to 20 inches. Reaction ranges from neutral to moderately acid. Gravel, channers, and flagstones average 35 to 70 percent by volume. The A and C horizons have a hue of 10YR or 7.5YR, value of 5 through 7 dry, and chroma of 2 through 6.

Dateland Series

The Dateland series consists of very deep, well drained, moderately permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 1 to 3 percent. Elevation ranges from 1,700 to 2,000 feet. The mean annual precipitation is about 8 to 10 inches. The mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

These soils are coarse-loamy, mixed, hyperthermic Typic Camborthids.

Typical pedon of Dateland fine sandy loam in an area of Dateland-Denure association, 1 to 3 percent slopes, from the Tohono O'odham Nation soil survey area, located at about 1,350 feet east and 1,150 feet south of the northwest corner of sec. 25, T.11 S., R.3 E.

A—0 to 2 inches; yellowish brown (10YR 5/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak thin platy structure; soft, friable, nonsticky and nonplastic; few fine roots; common fine interstitial, and few fine tubular pores; noneffervescent; moderately alkaline; abrupt smooth boundary.

Bk1—2 to 7 inches; light yellowish brown (10YR 6/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak coarse subangular blocky structure; soft, friable, slightly sticky and nonplastic; few fine roots; common fine interstitial, and few fine tubular pores; common distinct continuous lime coats on lower surfaces

of peds; slightly effervescent; moderately alkaline; clear wavy boundary.

Bk2—7 to 15 inches; light yellowish brown (10YR 6/4) loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; few fine tubular pores; common distinct continuous lime coats in root channels and pores; strongly effervescent; moderately alkaline; clear wavy boundary.

Bk3—15 to 30 inches; light brown (7.5YR 6/4) loam, brown to dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; few fine tubular pores; common distinct continuous lime coats in root channels and pores; violently effervescent; moderately alkaline; clear wavy boundary.

Bk4—30 to 52 inches; light brown (7.5YR 6/4) silt loam, brown to dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; common distinct continuous lime coats in root channels and pores; violently effervescent; moderately alkaline; clear wavy boundary.

2Btkb—52 to 60 inches; brown (7.5YR 5/4) loam, strong brown (7.5YR 4/6) moist; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; few fine roots; few fine tubular pores; common distinct continuous lime coats in root channels and pores, common faint patchy clay films between sand grains and on faces of peds and in pores; violently effervescent; moderately alkaline.

These soils contain less than 35 percent rock fragments. Reaction ranges from mildly to moderately alkaline. Calcium carbonate equivalent is less than 10 percent throughout. Salinity ranges from none to very slight. The A horizon has hue of 7.5YR or 10YR, value of 5 through 7 dry and 4 through 6 moist, and a chroma of 3 or 4, dry or moist. The Bk horizon has hue of 7.5YR or 10YR, value of 5 through 7 dry and 4 through 6 moist, and a chroma of 4 or 6, dry or moist. Textures range from loam, silt loam, and fine sandy loam.

Typical pedon is shared with the adjoining soil survey.

Delnorte Series

The Delnorte series consists of very shallow and shallow to a petrocalcic horizon, somewhat excessively drained, moderately permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 1 to 20 percent. Elevation ranges from 2,300 to 3,400 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are loamy-skeletal, mixed, thermic, shallow Typic Paleorthids.

Typical pedon of Delnorte extremely cobbly fine sandy loam in an area of Delnorte-Stagecoach complex, 1 to 20 percent slopes about 2,480 feet north and 1,765 feet east of the southwest corner of sec. 29, T.15 S., R.13 E.

A1—0 to 4 inches; pale brown (10YR 6/3) extremely cobbly fine sandy loam, brown to dark brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many fine roots; many fine interstitial pores; 30 percent cobble, 10 percent stones, and 30 percent gravel; strongly effervescent; moderately alkaline; clear wavy boundary.

A2—4 to 9 inches; pale brown (10YR 6/3) extremely cobbly loam, brown to dark brown (10YR 4/3) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; common medium tubular pores; 10 percent stone, 30 percent cobble, and 20 percent gravel; strongly effervescent; moderately alkaline; gradual wavy boundary.

2Bkm1—9 to 12 inches; white (10YR 8/1) indurated lime-cemented hardpan; extremely hard; very few medium roots in fractures; violently effervescent; gradual irregular boundary.

2Bkm2—12 to 60 inches; stratified hard and soft layers of dark grayish brown (10YR 4/2), dark gray (N4/), weak red (2.5YR 4/2) and white (10YR 8/1) very gravelly sandy loam to extremely gravelly sand and lime-cemented basalt cobble and stones; extremely hard; very few medium roots in fractures; violently effervescent.

Depth to petrocalcic horizon ranges from 6 to 20 inches. Gravel and cobble average 35 to 75 percent

by volume. The A horizon has hue of 10YR or 7.5YR, value of 5 through 7 dry, and chroma of 3 or 4. The Bkm horizons are indurated in the upper part and have variable cementation in the lower part.

Deloro Series

The Deloro series consists of shallow, well drained, slowly permeable soils on pediments, hills, and mountains. These soils formed in mixed alluvium and colluvium. Slope is 1 to 45 percent. Elevation ranges from 3,300 to 5,400 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are clayey-skeletal, mixed, thermic, shallow Ustollic Haplargids.

Typical pedon of Deloro extremely channery loam in an area of Deloro-Rock outcrop complex, 15 to 60 percent slopes about 1,200 feet south and 900 feet west of the northeast corner of sec. 9, T.17 S., R.17 E.

A—0 to 2 inches; brown (7.5YR 4/4) extremely channery loam, dark reddish brown (5YR 3/4) moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine interstitial pores; 65 percent channers; neutral; clear wavy boundary.

Bt—2 to 11 inches; reddish brown (5YR 4/3) extremely channery clay, dark reddish brown (5YR 3/4) moist; moderate fine granular structure; hard, friable, sticky and plastic; many fine roots; many fine interstitial pores; common faint clay films lining pores and coating channers; 75 percent channers; neutral; abrupt wavy boundary.

2Crt—11 to 60 inches; olive (5Y 5/3) highly fractured, weathered phyllite, dark olive (5Y 4/3) moist; many coarse fractures in rock; dark red (10R 3/6) clay coatings on fractures faces; common very fine roots in fractures.

Depth to the bedrock ranges from 10 to 20 inches. Reaction ranges from slightly acid to mildly alkaline. The A horizon has hue of 5YR through 10YR, value of 4 or 5 dry, and chroma of 2 through 4. The Bt horizon has hue of 2.5YR or 5YR, value of 4 through 6 dry, and chroma of 2 through 6. Texture is clay loam or clay with 35 to 85 percent channers or gravel. The Crt horizon is varicolored with clay coatings in fractures.

Delthorny Series

The Delthorny series consists of very shallow and shallow to a petrocalcic horizon, well drained, moderately rapidly permeable soils on relict fan terraces, mountains, and hills. These soils formed in colluvium and mixed slope alluvium. Slope is 15 to 30 percent. Elevation ranges from 2,200 to 4,000 feet. The mean annual precipitation is about 10 to 12 inches. The mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 240 to 280 days.

These soils are loamy-skeletal, mixed, thermic, shallow Typic Paleorthids.

Typical pedon of Delthorny very gravelly sandy loam from the Tohono O'odham Nation soil survey area, located about 2,640 feet north and 100 feet west of the southeast corner of sec. 17, T.14 S., R.2 E., 3 miles west and north of the Quijotoa Trading Post.

A—0 to 2 inches; brown (7.5YR 5/4) very gravelly sandy loam, brown to dark brown (7.5YR 4/4) moist; weak thin platy structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; common fine tubular pores; common distinct white (10YR 8/2) continuous lime coats on rock fragments; 55 percent gravel; strongly effervescent; mildly alkaline; abrupt smooth boundary.

Bk—2 to 9 inches; light brown (7.5YR 6/4) very gravelly sandy loam, brown (7.5YR 5/4) moist; massive; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common fine tubular pores; many distinct white (10YR 8/2) continuous lime coats on rock fragments; 55 percent gravel; violently effervescent; mildly alkaline; abrupt wavy boundary.

2Bkm—9 to 16 inches; white (10YR 8/2); extremely hard, indurated hardpan cemented with lime; violently effervescent.

R—16 inches; unweathered conglomerate.

These soils have 35 to 70 percent gravel. Depth to petrocalcic horizon is 6 to 20 inches, and in some pedons it is composed of individual layers. Depth to bedrock is 15 to 30 inches. Reaction ranges from mildly to moderately alkaline. The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 2 through 4, dry or moist. The textures are fine sandy loam and sandy loam.

Calcium carbonate equivalent ranges from 0 to 10 percent. The Bk horizon has hue of 7.5YR or 10YR,

value of 5 through 8 dry and 4 through 7 moist, and chroma of 2 through 4, dry or moist. The textures are fine sandy loam, sandy loam, and loam. Calcium carbonate equivalent ranges from 5 to 20 percent. The Bkm horizon has a strongly cemented lime hardpan.

Typical pedon is shared with the adjoining soil survey.

Denure Series

The Denure series consists of very deep, somewhat excessively drained, moderately rapidly permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 1 to 5 percent. Elevation ranges from 1,700 to 2,200 feet. The mean annual precipitation is about 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

These soils are coarse-loamy, mixed, hyperthermic Typic Camborthids.

Typical pedon of Denure gravelly sandy loam, 1 to 5 percent slopes, about 400 feet south and 2,400 feet east of the northwest corner of sec. 12, T.11 S., R.6 E.

A—0 to 4 inches; strong brown (7.5YR 5/6) gravelly sandy loam, strong brown (7.5YR 4/6) moist; weak thin to moderately thick platy structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; few fine tubular pores; 15 percent fine gravel; neutral; clear smooth boundary

Bw—4 to 17 inches; strong brown (7.5YR 5/6) gravelly sandy loam, strong brown (7.5YR 4/6) moist; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few fine tubular pores; 20 percent fine gravel; neutral; clear smooth boundary.

C—17 to 41 inches; reddish yellow (7.5YR 6/6) very gravelly sandy loam, strong brown (7.5YR 4/6) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; few fine tubular pores; 35 percent gravel; slightly effervescent; moderately alkaline; clear smooth boundary.

2Btb—41 to 60 inches; yellowish red (5YR 5/6) very gravelly sandy loam, yellowish red (5YR 4/6) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine tubular and few very fine interstitial pores; common faint clay films bridging sand grains; 40 percent gravel; slightly effervescent; moderately alkaline.

The 10-to 40-inch control section averages less than 35 percent coarse fragments. The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 dry, and chroma of 3 through 6. The Bw and C horizons have hue of 7.5YR or 10YR, value of 4 through 6 dry, and chroma of 3 through 6. Texture ranges from nongravelly to very gravelly sandy loam or coarse sandy loam.

Diaspar Series

The Diaspar series consists of very deep, well drained, moderately rapid over moderately permeable soils on fan terraces. These soils formed in alluvium derived dominantly from granite and schist. Slope is 1 to 5 percent. Elevation ranges from 3,200 to 3,600 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are coarse-loamy, mixed, thermic Ustalfic Haplargids.

Typical pedon of Diaspar sandy loam, 1 to 5 percent slopes, about 550 feet north and 100 feet west of the southeast corner of sec. 35, T.19 S., R.8 E.

A—0 to 2 inches; light brown (7.5YR 6/4) sandy loam, brown to dark brown (7.5YR 4/4) moist; weak thin platy structure; loose, very friable, nonsticky and nonplastic; many very fine roots; common very fine interstitial pores; 10 percent gravel; slightly acid; abrupt smooth boundary.

BA—2 to 9 inches; brown (7.5YR 5/4) gravelly sandy loam, dark brown (7.5YR 3/4) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; common very fine tubular pores; 30 percent gravel; slightly acid; clear wavy boundary.

Bt1—9 to 21 inches; yellowish red (5YR 5/6) gravelly sandy loam, yellowish red (5YR 4/6) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; many very fine roots; common very fine tubular pores; common faint clay films lining pores and bridging sand grains; 30 percent gravel; mildly alkaline; clear wavy boundary.

Bt2—21 to 28 inches; yellowish red (5YR 5/6) gravelly sandy loam, yellowish red (5YR 4/6) moist; weak medium prismatic structure; hard, firm, sticky and plastic; many very fine roots; common very fine tubular pores; 30 percent gravel; common faint clay films bridging sand grains and lining pores; moderately alkaline; clear wavy boundary.

- 2Bt—28 to 41 inches; reddish yellow (5YR 6/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak medium prismatic structure; hard, firm, sticky and plastic; common very fine roots; common very fine tubular pores, expd; 10 percent gravel; many distinct clay films on faces of peds and lining pores; many fine iron and manganese stains and masses; slightly effervescent; moderately alkaline; clear wavy boundary.
- 3BCt—41 to 46 inches; light yellowish brown (10YR 6/4) gravelly loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few faint clay films lining pores; 30 percent gravel; moderately alkaline; clear wavy boundary.
- 3C—46 to 60 inches; light yellowish brown (10YR 6/4) very gravelly loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; 50 percent gravel; slightly effervescent moderately alkaline.

The control section averages less than 35 percent coarse fragments. The A horizon has hue of 7.5YR or 5YR, value of 4 through 6 dry, and chroma of 3 or 4. The B horizons have hue of 7.5YR or 5YR, value of 4 through 6 dry, and chroma of 4 through 6. Texture is sandy loam, loam, or sandy clay loam with 5 to 35 percent gravel. Clay content averages less than 18 percent. The BC and C horizons have hue of 5YR through 10YR, value of 4 through 6 dry, and chroma of 2 through 6. In places, a buried argillic horizon is below the C horizon.

Far Series

The Far series consists of very shallow and shallow, well drained, moderately rapidly permeable soils on hills and mountains. These soils formed in alluvium and colluvium derived dominantly from granite, gneiss, and schist. Slope is 25 to 65 percent. Elevation ranges from 5,300 to 7,800 feet. The mean annual precipitation is about 20 to 24 inches. The mean annual air temperature is 45 to 54 degrees F, and the frost-free period is 140 to 170 days.

These soils are loamy-skeletal, mixed, mesic Lithic Haplustolls.

Typical pedon of Far gravelly fine sandy loam in an area of Spudrock-Far-Rock outcrop complex, 25 to 65 percent slopes about 2,400 feet south and 25 feet west of the northeast corner of sec. 24, T.14. S., R.17. E. At the junction of the Manning Camp and

Spud Rock Canyon trails, Saguaro National Monument East.

- Oi—2 to 1 inches; brown (10YR 5/3) slightly decomposed forest litter of ponderosa pine needles, brown to dark brown (10YR 4/3) moist; abrupt smooth boundary.
- Oe—1 to 0 inches; dark brown (10YR 3/3) intermediately decomposed forest litter of ponderosa pine needles and bark, very dark brown (10YR 2/2) moist; abrupt smooth boundary.
- A—0 to 2 inches; grayish brown and dark grayish brown (10YR 5/2 and 10YR 4/2) gravelly fine sandy loam, very dark brown (10YR 2/2) moist; weak very fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine, common fine and few medium roots; common very fine interstitial pores; 30 percent gravel; strongly acid; abrupt wavy boundary.
- C—2 to 8 inches; grayish brown (10YR 5/2) very gravelly fine sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, very friable, slightly sticky and nonplastic; many very fine and fine and few medium roots; few very fine interstitial pores; 40 percent gravel; strongly acid; clear wavy boundary.
- R—8 inches; gneiss, fractures more than 3 inches apart.

Depth to bedrock ranges from 5 to 20 inches. Reaction ranges from slightly acid to strongly acid. Gravel and/or cobble average 35 to 60 percent by volume.

Organic matter ranges from 2 to 4 percent. The A and C horizons have hue of 10YR or 7.5YR, value of 2 through 5, dry or moist, and chroma of 1 through 3, dry or moist. Textures are fine sandy loam or loam.

Faraway Series

The Faraway series consists of very shallow and shallow, well drained, moderately permeable soils on hills and mountains. These soils formed in alluvium and colluvium derived dominantly from granite, gneiss, and similar rock. Slope is 15 to 45 percent. Elevation ranges typically from 5,400 to 6,200 feet. The mean annual precipitation is about 16 to 20 inches, the mean annual air temperature is 55 to 57 degrees F, and the frost-free period is 160 to 180 days.

These soils are loamy-skeletal, mixed, mesic Lithic Haplustolls.

Typical pedon of Faraway extremely gravelly sandy loam in an area of Cortaro-Rock outcrop-Faraway complex, 15 to 45 percent slopes about 50 feet north and 650 feet east of the southwest corner of sec. 30, T.14 S., R.17 E.

- A—0 to 8 inches; very dark grayish brown (10YR 3/2) extremely gravelly sandy loam, very dark brown (10YR 2/2) moist; weak medium granular structure; slightly hard, friable, nonsticky and nonplastic; common fine roots; common fine tubular pores; 65 percent gravel and 10 percent cobble; neutral; abrupt smooth boundary.
- 2R—8 inches; gneiss, few coarse roots in fractures. Depth to bedrock ranges from 5 to 20 inches.

Reaction ranges from neutral to moderately acid. Gravel and cobble average 35 to 60 percent by volume. The A horizon has hue of 10YR to 7.5YR, value of 3 through 5 dry, and chroma of 1 through 3.

Glendale Series

The Glendale series consists of very deep, well drained, moderately slowly permeable soils on stream terraces. These soils formed in mixed alluvium. Slope is 0 to 3 percent. Elevation is 2,200 to 2,800 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are fine-silty, mixed (calcareous), thermic Typic Torrfluvents.

Typical pedon of Glendale silt loam, 0 to 3 percent slopes about 35 feet east and 100 feet south of the northwest corner of sec. 26, T.15 S., R.10 E.

- A—0 to 4 inches; light yellowish brown (10YR 6/4) silt loam, dark yellowish brown (10YR 4/4) moist; moderate thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and common fine roots; few very fine tubular pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.
- C—4 to 18 inches; pale brown (10YR 6/3) stratified clay loam, brown to dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine roots; common very fine tubular pores; common moderately thick and thick very pale brown (10YR 7/4) strata of silt loam, yellowish brown (10YR 5/4) moist; common faint brown to dark brown (10YR 4/3) organic coatings lining pores and on faces of peds; slightly effervescent; mildly alkaline; abrupt smooth boundary.

- C2—18 to 30 inches; yellowish brown (10YR 5/4) clay loam, dark yellowish brown (10YR 3/4) moist; moderate medium prismatic structure; hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; many faint brown to dark brown (10YR 4/3) organic coatings lining pores and on faces of peds; mildly alkaline; clear smooth boundary.
- C3—30 to 60 inches; light yellowish brown (10YR 6/4) loam, dark yellowish brown (10YR 4/4) moist; massive; soft, very friable, slightly sticky and nonplastic; few very fine roots; few very fine tubular pores; slightly effervescent; mildly alkaline.

Thickness of the solum ranges from 15 to 40 inches. Reaction is mildly or moderately alkaline. The control section is typically clay loam with less than 15 percent fine and coarser sand. The A and C horizons have hue of 10YR or 7.5YR, value of 4 through 6 dry, and chroma of 3 or 4. Textures are loam, silt loam, clay loam, and less commonly, silty clay loam. Thin strata of fine sandy loam is present in some pedons.

Graham Series

The Graham series consists of very shallow and shallow, well drained, slowly permeable soils on hills and mountains. These soils formed in alluvium and colluvium derived dominantly from basalt, andesite, and rhyolite. Slope is 2 to 25 percent. Elevation ranges from 3,400 to 5,300 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are clayey, montmorillonitic, thermic Lithic Ustollic Haplargids.

Typical pedon of Graham very cobbly clay loam in an area of Graham-Pantak-Rock outcrop complex, 15 to 45 percent slopes about 10 feet north and 300 feet west of the southeast corner of sec. 27, T.18 S., R.12 E.

- A—0 to 2 inches; dark grayish brown (10YR 4/2) very cobbly clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable, sticky and plastic; many very fine and common fine roots; many fine interstitial pores; 20 percent gravel and 30 percent cobble; moderately alkaline; clear wavy boundary.
- Bt1—2 to 4 inches; dark reddish brown (5YR 3/2) dry and moist cobbly clay; moderate fine subangular blocky structure; hard, firm, sticky and plastic;

many very fine and few fine roots; common fine interstitial pores; 10 percent gravel and 20 percent cobble; moderately alkaline; clear wavy boundary.

Bt2—4 to 14 inches; dark reddish brown (5YR 3/2) dry and moist clay; moderate coarse angular blocky structure; very hard, firm, very sticky and very plastic; few fine and common very fine roots; common medium cracks; 5 percent gravel and 5 percent cobble; slightly effervescent in the lower part; moderately alkaline; abrupt wavy boundary.

2Rt—14 inches; gray (10YR 5/1) vesicular basalt, very dark gray (10YR 3/1) moist; few faint clay films in fractures; few roots in fractures.

The depth to bedrock ranges from 8 to 20 inches. Reaction ranges from neutral to moderately alkaline. The A horizon has hue of 10YR through 5YR, value of 3 through 5 dry, and chroma of 2 or 3. The Bt horizons have hue of 7.5YR or 5YR, value of 3 through 5 dry, and chroma of 2 or 3. Texture ranges from nongravelly to cobbly clay or clay loam.

Granolite Series

The Granolite series consists of shallow, well drained, slowly permeable soils on hilly pediments at the base of mountains. These soils formed in mixed slope alluvium and residuum from rhyolite. Slope is 5 to 25 percent. Elevation ranges from 2,000 to 3,600 feet. The mean annual precipitation is about 10 to 12 inches. The mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are clayey-skeletal, mixed, thermic, shallow Typic Haplargids.

Typical pedon of Granolite extremely gravelly sandy loam in an area of Pantano-Granolite complex, 5 to 25 percent slopes, from the Tohono O'odham Nation soil survey area, located at about 2,600 feet west and 1,400 feet north of the southeast corner of sec. 20, T.14 S., R.10 E.

A—0 to 2 inches; reddish brown (5YR 4/4) extremely gravelly sandy loam, dark reddish brown (5YR 3/4) moist; weak thin platy structure; loose, friable, nonsticky and nonplastic; few very fine roots; many very fine and fine vesicular and tubular pores; 50 percent gravel, 15 percent cobble, and 2 percent stones; noneffervescent; mildly alkaline; abrupt smooth boundary.

Bt1—2 to 7 inches; dark reddish brown (2.5YR 3/4) extremely gravelly sandy clay, dark reddish

brown (2.5YR 3/4) moist; moderate fine subangular blocky structure; hard, friable, very sticky and very plastic; common fine and medium roots; few very fine, fine, and common tubular pores; few faint patchy clay films in root channels and pores; 50 percent gravel and 10 percent cobble; noneffervescent; mildly alkaline; clear wavy boundary.

Bt2—7 to 16 inches; dark yellowish brown (10YR 4/4) extremely gravelly sandy clay, dark yellowish brown (10YR 3/4) moist; moderate fine subangular blocky structure; very hard, firm, very sticky and very plastic; few to common fine and medium roots; common very fine and fine tubular pores; few faint patchy clay films in root channels and pores, and common continuous pressure faces on vertical and horizontal faces of peds; 60 percent gravel and 10 percent cobble; noneffervescent; mildly alkaline; abrupt wavy boundary.

2Crk—16 to 19 inches; light gray (5YR 7/1) weathered rhyolite, light gray to gray (5YR 6/1) moist; few fine to coarse roots in cracks; common prominent red (2.5YR 4/6) patchy clay films on rock fragments, and distinct lime coats on rock fragments; strongly effervescent; clear wavy boundary.

2Crk—19 to 24 inches; light gray (5YR 7/1) weathered rhyolite; light gray to gray (5YR 6/1) moist; few fine to coarse roots in cracks; common distinct lime coats on rock fragments; strongly effervescent.

2R—24 inches; rhyolite.

The soil averages 35 to 85 percent gravel, cobble, and stones. The reaction ranges from neutral to mildly alkaline. The depth to bedrock is 10 to 20 inches. The A horizon has hue of 5YR or 7.5YR, value of 4 or 5 dry and 3 or 4 moist, and chroma of 3 or 4, dry or moist. Texture ranges from fine sandy loam to sandy loam. The Bt horizon has hue of 5YR through 10YR, value of 3 through 5, dry or moist, and chroma of 3 through 6, dry or moist. Textures are dominantly sandy clay, clay, and clay loam. Some pedons may have lime coats on the bedrock and weak effervescence in the lower part of the solum.

Typical pedon is shared with the adjoining soil survey.

Guest Series

The Guest series consists of very deep, well drained, slowly permeable soils on swales,

drainageways and flood plains. These soils formed in mixed alluvium. Slope is 0 to 1 percent. Elevation ranges from 3,000 to 4,600 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are fine, mixed (calcareous), thermic Ustertic Torrfluvents.

Typical pedon of Guest fine sandy loam, 0 to 1 percent slopes, about 10 feet north and 1,000 feet west of the southeast corner of sec. 3, T.19 S., R.17 E.

- A—0 to 4 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many fine and very fine interstitial pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.
- C1—4 to 18 inches; dark brown (7.5YR 3/2) clay, black (7.5YR 2/0) moist; moderate medium subangular blocky structure; slightly hard, firm, sticky and plastic; common medium slickensides; common fine and medium roots; common very fine tubular and interstitial pores; few lime filaments; slightly effervescent; mildly alkaline; clear smooth boundary.
- C2—18 to 42 inches; dark brown (7.5YR 3/2) clay, black (7.5YR 2/0) moist; moderate medium subangular blocky structure; slightly hard, firm, very sticky and very plastic; common medium slickensides; few fine and medium roots; few very fine tubular and interstitial pores; common lime filaments; strongly effervescent; moderately alkaline; abrupt wavy boundary.
- Btkb—42 to 60 inches; reddish brown (5YR 5/4) sandy clay loam, dark reddish brown (5YR 3/3) moist; strong medium subangular blocky structure; slightly hard, very friable, sticky and plastic; few very fine roots; few fine tubular pores; common faint clay films on the faces of peds; many medium lime masses; violently effervescent; moderately alkaline.

The 10-to 40-inch control section averages 35 to 50 percent clay. The A and C horizons have hue of 7.5YR or 10YR, value of 3 through 5 dry, 2 through 4 moist, and chroma of 0 through 4. Texture of the C horizons is clay or silty clay. The Btkb horizons have hue of 5YR or 7.5YR, value of 5 or 6 dry, and chroma of 3 through 6. Texture is sandy clay loam, sandy clay, or clay loam.

Hantz Series

The Hantz series consists of very deep, well drained, slowly permeable soils on flood plains and alluvial fans. These soils formed in mixed alluvium. Slope is 0 to 1 percent. Elevation ranges from 2,400 to 3,600 feet. The mean annual precipitation is about 10 to 12 inches. The mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are fine, mixed (calcareous), thermic Vertic Torrfluvents.

Typical pedon of Hantz loam, 0 to 1 percent slopes, about 100 feet north and 600 feet east of the southwest corner of sec. 30, T.15 S., R.16 E.

- A1—0 to 5 inches; brown (10YR 5/3) loam, brown to dark brown (10YR 4/4) moist; weak medium platy structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; few very fine and fine pores; slightly effervescent; moderately alkaline; clear smooth boundary.
- A2—5 to 12 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 4/2) moist; weak fine subangular blocky, parting to moderate fine granular structure; few small pressure faces; slightly hard, friable, sticky and plastic; common very fine and few fine roots; few very fine and fine tubular pores; slightly effervescent; moderately alkaline; clear smooth boundary.
- C1—12 to 45 inches; grayish brown (10YR 5/2) clay, very dark grayish brown (10YR 4/2) moist; massive; few small pressure faces; hard, friable, sticky and plastic; common very fine roots to 30 inches and few very fine roots below; few very fine and fine tubular pores; slightly effervescent; moderately alkaline; gradual wavy boundary.
- C2—45 to 61 inches; brown (10YR 5/3) clay, very dark grayish brown (10YR 4/2) moist; massive; common small pressure faces; hard, friable, sticky and plastic; very few fine roots; few very fine tubular pores; few fine faint white (10YR 8/2) lime filaments; strongly effervescent; moderately alkaline.

The soil averages 0 to 15 percent gravel. The reaction ranges from mildly to moderately alkaline. The A horizon has hue of 7.5YR or 10YR, value of 4 through 6 dry and 4 or 5 moist, and a chroma of 3 or 4, dry or moist. The C horizon has hue of 7.5YR or 10YR, value of 4 through 6 dry and 3 or 4 moist, and

a chroma of 2 through 4, dry or moist. Textures are dominantly clay and clay loam and average 35 to 50 percent clay. These soils crack when dry and swell when wet.

Hayhook Series

The Hayhook series consists of very deep, well drained, moderately rapidly permeable soils on fan terraces. These soils formed in alluvium derived dominantly from granite. Slope is 1 to 5 percent. Elevation ranges from 2,200 to 3,600 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are coarse-loamy, mixed, thermic Typic Camborthids.

Typical pedon of Hayhook sandy loam, 1 to 5 percent slopes, about 1,200 feet north and 1,700 feet west of the southeast corner of sec. 29, T.16 S., R.9 E.

A1—0 to 2 inches; yellowish brown (10YR 5/4) sandy loam, brown to dark brown (10YR 4/3) moist; weak thick platy structure; soft; very friable, nonsticky and nonplastic; many fine and very fine roots; few fine tubular and many fine interstitial pores; 10 percent fine gravel; neutral; abrupt wavy boundary.

A2—2 to 5 inches; yellowish brown (10YR 5/4) sandy loam, brown to dark brown (10YR 4/3) moist; weak coarse granular structure; soft, very friable, nonsticky and nonplastic; common fine and many very fine roots; many fine interstitial pores; 10 percent fine gravel; neutral; abrupt wavy boundary.

Bw—5 to 24 inches; brown (7.5YR 5/4) sandy loam, dark brown (7.5YR 3/4) moist; weak coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few fine and many very fine roots; few fine tubular and many very fine interstitial pores; 10 percent fine gravel; mildly alkaline; clear wavy boundary.

C1—24 to 38 inches; yellowish brown (10YR 5/4) gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; many very fine and few fine roots; few fine and many very fine interstitial pores; 20 percent gravel; neutral; clear wavy boundary.

2C2—38 to 60 inches; light yellowish brown (10YR 6/4) gravelly loamy sand, dark yellowish brown (10YR 4/4) moist; single grain; soft, very friable, nonsticky and nonplastic; few very fine and fine

roots; many very fine interstitial pores; 25 percent gravel; mildly alkaline.

The 10-to 40-inch control section averages less than 35 percent rock fragments. Reaction ranges from neutral in the upper part to moderately alkaline in the lower part. The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 dry, and chroma of 2 through 4. The Bw and C horizons have hue of 7.5YR or 10YR, value of 5 or 6 dry, and chroma of 3 through 6. Texture ranges from nongravelly to gravelly sandy loam, sandy clay loam, or coarse sandy loam. The 2C horizon has texture of loamy sand to gravelly loamy coarse sand.

Jaynes Series

The Jaynes series consists of very deep, well drained, moderately rapid over very slowly permeable soils on relict fan terraces. These soils formed in alluvium derived dominantly from gneiss and schist. Slope is 2 to 8 percent. Elevation ranges from 2,200 to 3,200 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are coarse-loamy, mixed (calcareous), thermic Durorthidic Torriorthents.

Typical pedon of Jaynes gravelly sandy loam in an area of Palos Verdes-Jaynes complex, 2 to 8 percent slopes, about 150 feet west of the southeast corner of sec. 10, T.13 S., R.13 E.

A—0 to 5 inches; light yellowish brown (10YR 6/4) gravelly sandy loam, dark yellowish brown (10YR 4/4) moist; weak moderate platy structure parting to weak fine granular; slightly hard, very friable, nonsticky and nonplastic; many fine and very fine and few medium and coarse roots; many fine and very fine and few medium and coarse interstitial and few medium and coarse tubular pores; 25 percent gravel; violently effervescent; moderately alkaline; clear wavy boundary.

Bw—5 to 10 inches; pale brown (10YR 6/3) gravelly sandy loam, brown (7.5YR 5/4) moist; weak fine and medium granular structure; slightly hard, very friable, nonsticky and nonplastic; few medium and many very fine and fine roots; many fine and very fine and few medium interstitial and few medium and coarse tubular pores; 25 percent gravel; violently effervescent; moderately alkaline; abrupt wavy boundary.

2Cdkl—10 to 33 inches; light brown (7.5YR 6/4) loamy fine sand, yellowish red (5YR 4/6) moist;

strong thick plates separated by calcium carbonate; very hard, firm and brittle, nonsticky and nonplastic; few very fine roots in fractures; common very fine cracks between horizontal plates; violently effervescent lime coatings on plates; moderately alkaline; abrupt wavy boundary.

2Cdk2—33 to 46 inches; reddish yellow (5YR 6/6) loamy fine sand, yellowish red (5YR 4/6) moist; massive; very hard, firm and brittle, nonsticky and nonplastic; few very fine roots in fractures; common very fine tubular pores; few fine and medium pinkish white (7.5YR 8/2) lime veins; slightly effervescent; moderately alkaline; abrupt broken boundary.

3Cd—46 to 60 inches; pinkish white (5YR 8/2) loamy fine sand, light reddish brown (5YR 6/4) moist; massive; extremely hard, extremely firm and brittle, nonsticky and nonplastic; few very fine roots in fractures; violently effervescent; moderately alkaline.

Depth to the compacted unconsolidated sediments ranges from 4 to 16 inches. The A horizon has hue of 7.5YR or 10YR, value of 5 through 7 dry, and chroma of 3 or 4. The Bw horizon has hue of 7.5YR or 10YR, value of 6 through 8 dry, and chroma of 2 through 4. Texture is gravelly sandy loam or fine sandy loam. The Cd horizons have hue of 5YR or 7.5YR, value of 6 through 8 dry, and chroma of 2 through 6. It is brittle and firm, very firm, or extremely firm when moist.

Keysto Series

The Keysto series consists of very deep, well drained, moderately rapid over moderately slowly permeable soils on stream terraces. These soils formed in mixed alluvium. Slope is 2 to 8 percent. Elevation ranges from 3,000 to 4,500 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy-skeletal, mixed, nonacid, thermic Ustic Torrifuvents.

Typical pedon of Keysto extremely gravelly fine sandy loam, 2 to 8 percent slopes, about 2,200 feet north and 500 feet west of the southeast corner of sec. 1, T.19 S., R.11 E.

A1—0 to 1 inch; brown (10YR 5/3) extremely gravelly fine sandy loam, dark brown (10YR 3/3) moist; weak thin platy structure parting to moderate very fine granular; slightly hard, very friable, slightly sticky and slightly plastic; common very

fine and fine roots; many fine interstitial and few fine tubular pores; 60 percent gravel; mildly alkaline; clear smooth boundary.

A2—1 to 17 inches; dark grayish brown (10YR 4/2) extremely gravelly loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; many very fine and common fine roots; common fine interstitial and few fine and medium tubular pores; 65 percent gravel; mildly alkaline; clear wavy boundary.

A3—17 to 23 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common fine interstitial and many very fine tubular pores; 40 percent gravel; moderately alkaline; clear wavy boundary.

AC—23 to 41 inches; brown (10YR 5/3) extremely gravelly loam, dark brown (10YR 3/3) moist; massive; hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; many very fine tubular pores; 60 percent gravel; moderately alkaline; abrupt wavy boundary.

2Btb—41 to 60 inches; brown (7.5YR 5/4) extremely gravelly sandy clay loam, dark brown (7.5YR 3/4) moist; massive; hard, friable, slightly sticky and slightly plastic; few fine roots; many very fine tubular pores; few faint clay films lining pores and bridging sandy grains; 70 percent gravel; moderately alkaline.

Reaction ranges from neutral to moderately alkaline and is typically noncalcareous to 40 inches or more. The A to AC horizons have hue of 10YR or 7.5YR, value of 3 through 5 dry, and chroma of 1 through 3. The buried Bt horizon is at a depth of 40 or more inches and is absent in some pedons.

Kimrose family

The Kimrose family consists of very shallow and shallow to a petrocalcic horizon, well drained, moderately permeable soils on hills. These soils formed in mixed alluvium. Slope is 10 to 15 percent. Elevation ranges from 3,300 to 4,900 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy-skeletal, mixed, thermic, shallow Ustollic Paleorthids.

Typical pedon of Kimrose family extremely gravelly loam in an area of Powerline-Kimrose family complex,

10 to 35 percent slopes, about 625 feet north and 2,050 feet west of the southeast corner of sec. 9, T.17 S., R.18 E.

A—0 to 7 inch; dark grayish brown (10YR 4/2) extremely gravelly loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; soft, friable, slightly sticky and slightly plastic; common very fine roots; common fine tubular pores; 10 percent stones, 10 percent cobble, and 55 percent gravel; strongly effervescent; moderately alkaline; abrupt wavy boundary.

Bkm—7 to 12 inches; white (10YR 8/1) indurated lime-cemented hardpan.

R—12 to 60 inches; sandy fanglomerate.

Depth to the petrocalcic horizon and the thickness of the dark colored epipedon range from 7 to 18 inches. The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 dry, and chroma of 1 through 3.

Lajitas Series

The Lajitas series consists of very shallow and shallow, well drained, moderately permeable soils on hills and mountains. These soils formed in alluvium and colluvium derived dominantly from basalt. Slope is 25 to 60 percent. Elevation ranges from 2,200 to 4,000 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are loamy-skeletal, mixed, nonacid, thermic Lithic Torriorthents.

Typical pedon of Lajitas extremely cobbly loam in an area of Lehman-Delthorny-Lajitas complex, 15 to 50 percent slopes, about 1,050 feet north and 1,710 feet west of the southeast corner of sec. 15 to T.14 S., R.13 E.

A1—0 to 1 inch; yellowish brown (10YR 5/4) extremely cobbly loam, dark yellowish brown (10YR 4/4) moist; weak thick platy structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common very fine vesicular pores; 65 percent scoria cobble and 15 percent gravel; mildly alkaline; clear smooth boundary.

A2—1 to 4 inches; yellowish brown (10YR 5/4) extremely cobbly loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; 70 percent cobble; mildly alkaline; abrupt irregular boundary.

2R—4 inches; very dark gray (N3/) basalt scoria, black (N2/) moist; common coarse Fe-Mn stains on rock.

Depth to bedrock ranges from 4 to 12 inches. Reaction ranges from neutral to moderately alkaline. Gravel and cobble average 35 to 85 percent by volume. The A horizons have hue of 10YR or 7.5YR, value of 5 or 6 dry, and chroma of 2 through 4. Some pedons have thin lime coatings in joints in the basalt.

Lampshire Series

The Lampshire series consists of very shallow and shallow, well drained, moderately rapid permeable soils on pediments, hills and mountains. These soils formed in alluvium and colluvium derived dominantly from granite, rhyolite, tuff, andesite, and gneiss. Slope is 5 to 65 percent. Elevation ranges from 3,400 to 5,500 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy-skeletal, mixed, nonacid, thermic Lithic Ustic Torriorthents.

Typical pedon of Lampshire very gravelly loam in an area of Lampshire-Romero-Rock outcrop complex, 10 to 65 percent slopes, about 3,100 feet north and 700 feet west of the southeast corner of sec. 15, T.14 S., R.16 E.

A1—0 to 3 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 3/3) moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; many fine interstitial pores; 50 percent gravel; moderately alkaline; abrupt smooth boundary.

A2—3 to 10 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 3/3) moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and many very fine roots; many fine interstitial pores; 55 percent gravel; moderately alkaline; abrupt irregular boundary.

2R—10 inches; gneiss; brown (10YR 5/3) loam in fractures; common very fine and few fine and medium roots in fractures.

Depth to the bedrock ranges from 7 to 20 inches. Reaction ranges from slightly acid to moderately alkaline. The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 dry, and chroma of 2 or 3.

Lehmans Series

The Lehmans series consists of shallow, well drained, slowly permeable soils on pediments and hills. These soils formed in mixed alluvium and colluvium. Slope is 5 to 30 percent. Elevation ranges from 2,200 to 4,000 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are clayey, montmorillonitic, thermic Lithic Haplargids.

Typical pedon of Lehmans extremely cobbly clay loam in an area of Lehmans-Delthorny-Lajitas complex, 15 to 50 percent slopes, about 810 feet north and 1,240 feet west of the southwest corner of sec. 15, T.14 S., R.13 E.

- A—0 to 5 inches; yellowish brown (10YR 5/4) extremely cobbly clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium granular structure; hard, friable, sticky and plastic; common fine roots; common fine tubular pores; 10 percent gravel, 10 percent stones, and 60 percent cobble; mildly alkaline; abrupt irregular boundary.
- Bt1—5 to 9 inches; brown (7.5YR 5/3) clay, brown to dark brown (7.5YR 4/3) moist; moderate medium subangular blocky structure; very hard, firm, very sticky and very plastic; common fine roots; common fine tubular pores; common faint clay films on faces of peds; mildly alkaline; clear smooth boundary.
- Bt2—9 to 13 inches; brown (7.5YR 5/3) clay, brown to dark brown (7.5YR 4/3) moist; moderate medium subangular blocky structure; very hard, very firm, very sticky, and very plastic; common fine roots; common fine tubular pores; many pressure faces; slightly effervescent; mildly alkaline; abrupt wavy boundary.
- 2R—13 inches; basalt, few medium roots in fractures; common faint lime coatings on faces of rock fractures.

Depth to the bedrock ranges from 10 to 20 inches. Reaction ranges from neutral to moderately alkaline. The A horizon has hue of 5YR through 10YR, value of 4 through 6 dry, and chroma of 2 through 6.

Texture is extremely cobbly clay loam or gravelly sandy clay loam. The Bt horizon has hue of 2.5YR through 7.5YR, value of 4 or 5 dry, and chroma of 3 through 6. Texture is clay or clay loam with thin layers that may be gravelly or very gravelly.

The soils mapped as Lehmans in map unit 13 have

mixed mineralogy, formed on granite, and are a taxadjunct to the series.

Lemmon Series

The Lemmon series consists of moderately deep, well drained, slowly permeable soils on hills and mountains. These soils formed in alluvium and colluvium derived dominantly from schist. Slope is 15 to 35 percent. Elevation ranges from 5,400 to 8,100 feet. The mean annual precipitation is about 20 to 24 inches. The mean annual air temperature is 45 to 54 degrees F, and the frost-free period is 140 to 170 days.

These soils are fine, mixed, mesic Typic Haplustalfs.

Typical pedon of Lemmon flaggy loam in an area of Spudrock-Lemmon complex, 15 to 45 percent slopes, about 1,400 feet south and 1,250 feet west of the northeast corner of sec. 19, T.14 S., R.18 E.

- Oi—2 to 0 inches; yellowish brown (10YR 5/4) slightly decomposed forest litter of ponderosa pine needles and bark, brown to dark brown (10YR 4/3) moist; abrupt smooth boundary.
- A—0 to 1 inch; black (10YR 2/1) flaggy loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable, slightly sticky and nonplastic; many very fine roots; many very fine tubular pores; 10 percent flagstones and 5 percent channers; strongly acid; abrupt wavy boundary.
- E—1 to 7 inches; very pale brown (10YR 7/4) channery loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; 10 percent channers and 5 percent flagstones; moderately acid; clear wavy boundary.
- E/B—7 to 20 inches; (E) pink (7.5YR 7/4) channery loam, brown (7.5YR 5/4) moist; (Bt) small blocks of reddish yellow (5YR 6/6) clay, yellowish red (5YR 4/6) moist; moderate fine subangular blocky structure; hard, firm, very sticky and plastic; common medium roots; common medium tubular pores; common distinct organic coatings lining pores and on faces of peds; 15 percent channers; moderately acid; clear wavy boundary.
- Bt—20 to 32 inches; reddish yellow (5YR 6/6) clay, yellowish red (5YR 4/6) moist; moderate coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; few medium roots; few medium tubular pores; common faint clay films on faces of peds and lining pores;

common faint organic coatings lining pores; moderately acid; abrupt wavy boundary.

Cr—32 inches; pale yellow (2.5YR 7/4) weathered mica-schist, light olive brown (2.5YR 5/4) moist; few coarse roots in fractures.

Organic matter ranges from 1 to 2 percent. Rock fragments range from 0 to 35 percent flagstones and/or channers. The A horizon has value of 2 through 4 dry and chroma of 1 or 2, dry or moist. The E horizon has hue of 10YR and 7.5YR, value of 7 or 8 dry, 5 or 6 moist, and chroma of 2 through 4, dry or moist. Textures are fine sandy loam and loam. The Bt horizon has hue of 5YR through 10YR, value of 4 through 6 dry, 3 or 4 moist, and chroma of 4 through 6, dry or moist. Textures are clay and sandy clay.

Mabray Series

The Mabray series consists of very shallow and shallow, well drained, moderately permeable soils on mountains. These soils formed in alluvium and colluvium derived dominantly from limestone. Slope is 20 to 65 percent. Elevation ranges from 3,400 to 5,300 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy-skeletal, carbonatic, thermic Lithic Ustic Torriorthents.

Typical pedon of Mabray very cobbly loam in an area of Mabray-Deloro-Rock outcrop complex, 20 to 65 percent slopes, about 100 feet north and 600 feet west of the southeast corner of sec. 7, T.18 S., R.17 E.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) very cobbly loam, black (10YR 2/1) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few fine roots; few fine interstitial pores; 25 percent gravel and 25 percent cobble; strongly effervescent; moderately alkaline; clear smooth boundary.

C—4 to 14 inches; light gray (10YR 7/2) very gravelly loam, dark grayish brown (10YR 4/2) moist; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common fine and medium roots; common fine interstitial pores; 45 percent gravel; violently effervescent; strongly alkaline; abrupt smooth boundary.

2R—14 inches; dark gray (N4/) limestone, very dark gray (N3/) moist; continuous thick white (10YR 8/2) lime coating on bedrock.

Depth to the bedrock ranges from 4 to 20 inches. Calcium carbonate equivalent averages 40 to 75 percent above the bedrock. Organic matter content averages greater than 1 percent. The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 dry, and chroma of 1 through 3. The C horizon has hue of 10YR or 7.5YR, value of 6 or 7 dry, and chroma of 1 through 4. Texture is very gravelly or very cobbly loam or sandy loam. Lime coatings and masses are immediately above the bedrock.

Mohall Series

The Mohall series consists of very deep, well drained, moderately slowly permeable soils on basin floors and fan terraces. These soils formed in mixed alluvium. Slope is 0 to 5 percent. Elevation ranges from 1,675 to 1,900 feet. The mean annual precipitation is about 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

These soils are fine-loamy, mixed, hyperthermic Typic Haplargids.

Typical pedon of Mohall loam, 0 to 2 percent slopes, about 1,050 feet north and 200 feet west of the southeast corner of sec. 16, T.11 S., R.6 E.

A—0 to 3 inches; light brown (7.5YR 6/4) loam, brown to dark brown (7.5YR 4/4) moist; weak moderately thick platy structure parting to weak fine granular; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; common very fine interstitial pores; slightly effervescent; moderately alkaline; abrupt wavy boundary.

Bt1—3 to 11 inches; reddish brown (5YR 5/4) clay loam, dark reddish brown (5YR 3/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky and plastic; common very fine roots; common very fine tubular pores; common faint clay films on faces of peds, bridging sand grains and lining pores; moderately alkaline; clear wavy boundary.

Bt2—11 to 24 inches; reddish brown (5YR 5/4) clay loam, dark reddish brown (5YR 3/4) moist; moderate medium prismatic structure; hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; common distinct clay films on faces of peds, bridging sand grains and lining pores; 5 percent gravel; slightly effervescent; moderately alkaline; clear wavy boundary.

Btk—24 to 45 inches; mixed reddish brown (5YR 5/6)

and white (5YR 8/1) loam, yellowish red (5YR 4/6) and pink (5YR 7/3) moist; very weak coarse prismatic structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; few faint clay films on faces of peds; common coarse lime masses and filaments; 10 percent gravel; violently effervescent; moderately alkaline; clear wavy boundary.

2C—45 to 60 inches; mixed pink (7.5YR 7/4) and white (5YR 8/1) sandy clay loam, brown (7.5YR 5/4) and pink (5YR 7/3) moist; massive; hard, very friable, slightly sticky and slightly plastic; few very fine interstitial pores; many coarse lime masses; 10 percent gravel; violently effervescent; strongly alkaline.

Depth to the calcic horizon ranges from 20 to 40 inches. The A horizon has hue of 10YR or 7.5YR, value of 5 through 7 dry, and chroma of 2 through 6. Texture of the A horizon is loam or gravelly fine sandy loam. The Bt horizons have hue of 10YR through 5YR, value of 4 through 6 dry, and chroma of 3 through 8. The 2C horizon has hue of 5YR or 7.5YR, value of 5 through 8 dry, and chroma of 1 through 6. In some areas, the solum has moderate amounts of soluble salts and exchangeable sodium.

Mohave Series

The Mohave series consists of very deep, well drained, moderately slowly permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 1 to 8 percent. Elevation ranges from 2,200 to 3,300 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are fine-loamy, mixed, thermic Typic Haplargids.

Typical pedon of Mohave loam, in an area of Mohave soils and Urban land, 1 to 8 percent slopes, about 75 feet south and 2,350 feet east of the northwest corner of sec. 3, T.15 S., R.11 E.

A—0 to 3 inches; yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 4/4) moist; weak thick platy structure; slightly hard, friable, nonsticky and slightly plastic; common fine and very fine roots; few fine and very fine tubular pores; mildly alkaline; clear wavy boundary.

BA—3 to 6 inches; brown (7.5YR 5/4) sandy loam, brown to dark brown (7.5YR 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine and few

coarse roots; few fine and very fine tubular pores; neutral; abrupt wavy boundary.

Bt1—6 to 11 inches; brown (7.5YR 5/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and plastic; common fine and medium roots; common fine tubular pores; common faint clay films lining pores and bridging sand grains; few fine distinct pink (7.5YR 7/4) lime filaments, light brown (7.5YR 6/4) moist; slightly effervescent; mildly alkaline; clear wavy boundary.

Bt2—11 to 18 inches; brown (7.5YR 5/4) clay loam, brown to dark brown (7.5YR 4/4) moist; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; common fine and medium roots; common fine tubular and interstitial pores; common faint clay films bridging sand grains and lining pores; common fine distinct pink (7.5YR 7/4) lime filaments and seams, light brown (7.5YR 6/4) moist; effervescent; mildly alkaline; clear wavy boundary.

Btk—18 to 24 inches; light brown (7.5YR 6/4) clay loam, brown to dark brown (7.5YR 4/4) moist; moderate fine and medium subangular blocky structure; hard, friable; slightly sticky and plastic; few fine medium and coarse roots; common fine interstitial and tubular pores; common faint clay films bridging sand grains and lining pores; many fine, medium, and coarse distinct pink (7.5YR 6/4) lime filaments, seams and masses, light brown (7.5YR 6/4) lime filaments, seams, and masses, light brown (7.5YR 6/4) moist; strongly effervescent; moderately alkaline; gradual wavy boundary.

2Btk—24 to 32 inches; reddish brown (5YR 4/4) sandy clay loam, reddish brown (5YR 3/4) moist; weak fine and medium subangular blocky structure; hard, friable, slightly sticky and plastic; few fine, medium and coarse roots; common very fine and fine tubular pores; few faint clay films bridging sand grains and lining pores; many medium and coarse distinct pink (5YR 7/4) lime filaments and masses, light brown (7.5YR 6/4) moist; common very fine Fe-Mn concretions; strongly effervescent; moderately alkaline; clear wavy boundary.

2Bk—32 to 40 inches; mixed light reddish brown (5YR 6/4) and pink (5YR 7/4) clay loam, reddish brown (5YR 5/4) and light reddish brown (5YR 5/4) moist; weak medium and coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few

fine tubular pores; few faint clay films on faces of pedis; few fine Fe-Mn concretions and stains; violently effervescent; moderately alkaline; clear wavy boundary.

3C—40 to 60 inches; light reddish brown (5YR 6/4) and white (N/8) loam, reddish brown (5YR 5/4) and pinkish gray (7.5YR 6/2) moist; massive; very hard, friable, sticky and slightly plastic; common fine and very fine roots; few fine, medium and coarse tubular pores; light reddish brown (5YR 6/4) soil material filling coarse pores; violently effervescent; strongly alkaline.

Depth to the calcic horizon ranges from 20 to 40 inches. The A horizon has hue of 7.5YR or 10YR, value of 5 through 7 dry, and chroma of 2 through 4. The B horizons have hue of 5YR or 7.5YR, value of 4 through 6 dry, and chroma of 3 through 6. Texture is sandy clay loam or clay loam with transition B horizons of sandy loam or loam. The C horizon has hue of 5YR or 7.5YR, value of 5 through 8, and chroma of 2 through 6. Texture ranges from loamy coarse sand to clay loam. The C horizon is weakly cemented in some pedons.

Momoli Series

The Momoli series consists of very deep, somewhat excessively drained, moderately rapidly permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 1 to 10 percent. Elevation ranges from 1,800 to 2,200 feet. The mean annual precipitation is about 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

These soils are loamy-skeletal, mixed, hyperthermic Typic Camborthids.

Typical pedon of Momoli very gravelly sandy loam in an area of Pinamt-Momoli complex, 1 to 10 percent slopes, about 1,620 feet north and 2,535 feet east of the southwest corner of sec. 33, T.11 S., R.7 E.

A—0 to 10 inches; light brown (7.5YR 6/4) very gravelly sandy loam, brown to dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; common fine interstitial and few fine and medium tubular pores; strongly effervescent; moderately alkaline; abrupt wavy boundary.

Bw—10 to 17 inches; light brown (7.5YR 6/4) very gravelly sandy loam, brown to dark brown (7.5YR 4/4) moist; weak medium subangular blocky

structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and few fine roots; few fine and medium tubular and many very fine interstitial pores; violently effervescent; moderately alkaline; abrupt wavy boundary.

2C1—17 to 38 inches; light brown (7.5YR 6/4) very gravelly sandy loam, brown to dark brown (7.5YR 4/4) moist; single grain; loose, nonsticky, and nonplastic; few fine and many very fine roots; many fine interstitial pores; strongly effervescent; moderately alkaline; abrupt wavy boundary.

2C2—38 to 60 inches; light brown (7.5YR 6/4) very gravelly loamy coarse sand, brown to dark brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; common very fine and few fine roots; many fine and medium interstitial pores; strongly effervescent; moderately alkaline.

The soil to a depth of 60 inches has hue of 7.5YR or 10YR, value of 4 through 6 dry, and chroma of 3 through 5. Texture is very gravelly or extremely gravelly sandy loam or coarse sandy loam. The C horizon has calcium carbonate masses and textures of extremely gravelly loamy coarse sand in some pedons.

Nahda Series

The Nahda series consists of moderately deep to a petrocalcic horizon, well drained, slowly permeable soils on fan terraces. These soils formed in alluvium derived dominantly from volcanic rock. Slope is 1 to 15 percent. Elevation is 1,800 to 3,600 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are clayey-skeletal, mixed, thermic Petrocalcic Paleargids.

Typical pedon of Nahda very cobbly loam, 2 to 8 percent slopes, about 1,100 feet west and 50 feet south of the northeast corner of sec. 25, T.15 S., R.9 E.

A—0 to 1 inch; brown (7.5YR 5/4) very cobbly loam, dark brown (7.5YR 4/4) moist; weak medium platy structure with a 1/2-inch vesicular crust (E horizon); slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; many fine interstitial pores; 10 percent stones, 30 percent cobble, and 20 percent gravel; neutral; abrupt wavy boundary.

BA—1 to 5 inches; reddish brown (5YR 5/4) very cobbly loam, reddish brown (5YR 4/4) moist; moderate medium subangular blocky structure;

slightly hard, friable, sticky and plastic; many fine roots; common very fine tubular pores; 10 percent stones, 15 percent cobble, and 20 percent gravel; neutral; clear wavy boundary.

Bt—5 to 18 inches; reddish brown (5YR 4/4) dry and moist, very gravelly clay; moderate medium subangular blocky structure; hard, friable, very sticky and very plastic; many very fine roots; common fine interstitial pores; many distinct clay films coating gravel and on faces of peds; 10 percent cobble and 35 percent gravel; moderately alkaline; clear wavy boundary.

Btk1—18 to 23 inches; reddish brown (5YR 4/4) dry and moist, very gravelly clay; weak fine subangular blocky structure; hard, friable, very sticky and very plastic; common very fine roots; many fine interstitial pores; common distinct clay films lining pores; common fine lime veins; 10 percent cobble and 45 percent gravel; strongly effervescent; moderately alkaline; clear wavy boundary.

Btk2—23 to 29 inches; reddish brown (5YR 5/4) very gravelly clay loam, reddish brown (5YR 4/4) moist; massive; hard, friable, sticky and plastic; common very fine roots; many fine interstitial pores; few distinct clay films lining pores; common fine lime veins; 5 percent stones, 5 percent cobble and 50 percent gravel; strongly effervescent; moderately alkaline; abrupt wavy boundary.

Bkm—29 to 60 inches; pinkish white (5YR 8/2) and pinkish gray (5YR 7/1) indurated petrocalcic, light reddish brown (5YR 6/3) and reddish brown (5YR 5/3) moist; massive; extremely hard, extremely firm; few fractures; strongly effervescent; moderately alkaline.

Depth to the strongly cemented or indurated petrocalcic horizon ranges from 20 to 40 inches. Gravel, cobble, and stones average 35 to 65 percent by volume above the hardpan. Reaction ranges from neutral to moderately alkaline. The A horizon(s) has hue of 5YR or 7.5YR, value of 5 or 6 dry, and chroma of 3 or 4. The Bt horizons have hue of 2.5YR or 5YR, value of 4 through 6 dry, and chroma of 4 through 6. Texture is cobbly, very cobbly, or very gravelly clay loam, clay, sandy clay loam or sandy clay. The Bkm horizon is commonly pinkish white and gray. It is gravelly and cobbly soil which has been strongly cemented or indurated by lime. Heavy equipment can rip through it.

Nolam Series

The Nolam series consists of very deep, well drained, moderately permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 8 to 15 percent. Elevation ranges from 3,500 to 5,000 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy-skeletal, mixed, thermic Ustollic Haplargids.

Typical pedon of Nolam extremely gravelly fine sandy loam in an area of Nolam-Tombstone complex, 8 to 30 percent slopes, about 1,150 feet north and 1,285 feet west of the southwest corner of sec. 33, T.16 S., R.17 E.

A—0 to 1 inch; brown (7.5YR 5/4) extremely gravelly fine sandy loam, reddish brown (5YR 4/4) moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many fine interstitial pores; 60 percent gravel; strongly effervescent; moderately alkaline; clear wavy boundary.

Bt—1 to 11 inches; reddish brown (5YR 5/4) very gravelly sandy clay loam, dark reddish brown (5YR 3/4) moist; moderate medium subangular blocky structure; hard, friable, very sticky and very plastic; many very fine and common fine and medium roots; common very fine tubular pores; 35 percent gravel; common faint clay films on faces of peds and lining pores; strongly effervescent; moderately alkaline; clear wavy boundary.

Btk—11 to 19 inches; light reddish brown (5YR 6/4) very gravelly sandy clay loam, reddish brown (5YR 4/4) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; many very fine, common fine, and few medium roots; common very fine tubular pores; common fine distinct white (5YR 8/1) lime filaments in pores; 50 percent gravel; common distinct clay films on faces of peds and lining pores; violently effervescent; moderately alkaline; clear wavy boundary.

Bk1—19 to 32 inches; pink (5YR 7/4) extremely gravelly sandy loam, light reddish brown (5YR 6/4) moist; massive; very hard, friable, sticky and plastic; weakly cemented in places; common very fine and fine and few medium roots; few fine and many very fine tubular pores; 60 to 65

percent gravel; thick continuous pinkish white (7.5YR 8/2) lime coating gravel and as soft and hard masses; violently effervescent; moderately alkaline; clear wavy boundary.

Bk2—32 to 60 inches; pink (7.5YR 7/4) extremely gravelly sandy loam, light reddish brown (7.5YR 6/4) moist; massive; very hard, friable, slightly sticky and slightly plastic; weakly cemented in places; few very fine and medium roots; common fine interstitial and few fine and very fine tubular pores; 60 to 65 percent gravel; many medium and coarse lime masses; violently effervescent; moderately alkaline.

Depth to the calcic horizon ranges from 10 to 40 inches. The A horizon has hue of 7.5YR or 5YR, value of 4 through 6 dry, and chroma of 2 through 4. The Bt horizons have hue of 2.5YR or 5YR, value of 4 through 6 dry, and chroma of 3 through 6. Texture is very gravelly or extremely gravelly sandy clay loam, clay loam, or sandy loam. The Bk horizons have hue of 5YR through 10YR, value of 6 through 8 dry, and chroma of 2 through 4. Texture is very gravelly or extremely gravelly sandy loam, or sandy clay loam that has many lime masses and concretions. It is weakly cemented in places.

Oracle Series

The Oracle series consists of shallow, well drained, moderately slowly permeable soils on pediments and hills. These soils formed in alluvium and colluvium derived dominantly from granite and granodiorite. Slope is 5 to 45 percent. Elevation ranges from 3,400 to 5,400 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy, mixed, thermic, shallow Ustollic Haplargids.

Typical pedon of Oracle very gravelly loam in an area of Romero-Oracle complex, 25 to 60 percent slopes, about 50 feet south and 2,640 feet east of the northwest corner of sec. 29, T.17 S., R.8 E.

A—0 to 1 inch; dark grayish brown (10YR 4/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; many fine interstitial pores; 10 percent stones, 10 percent cobble and 20 percent gravel; slightly acid; abrupt wavy boundary.

A2—1 to 5 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR

3/2) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine and few fine roots; common fine interstitial and few very fine and fine tubular pores; 5 percent stones, 5 percent cobble, and 20 percent gravel; slightly acid; abrupt wavy boundary.

Bt—5 to 18 inches; brown (7.5YR 5/4) gravelly clay loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine interstitial and few fine and very fine tubular pores; many distinct clay films on faces of peds, lining pores and bridging sand grains; 30 percent gravel; neutral; clear wavy boundary.

2Crt—18 to 60 inches; variegated pink, brown and dark brown (7.5YR 7/4, 4/4, 3/2) dry and moist; partially weathered granite (grus); common very fine and few fine roots in fractures; many distinct clay films on faces of fractures. Depth to bedrock ranges from 10 to 20 inches. Reaction ranges from slightly acid to moderately alkaline. The A horizon has hue of 5YR through 10YR, value of 4 or 5 dry, and chroma of 2 through 4. The Bt horizons have 5YR or 7.5YR, value of 3 through 5 dry, and chroma of 2 through 4. Texture is gravelly or nongravelly sandy clay loam or clay loam.

Pahaka Series

The Pahaka series consists of very deep, well drained, moderately rapid over moderately slowly permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 1 to 5 percent. Elevation ranges from 1,650 to 1,900 feet. The mean annual precipitation is about 8 to 10 inches. The mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

These soils are coarse-loamy, mixed, hyperthermic Typic Camborthids.

Typical pedon of Pahaka sandy loam in an area of Mohall-Pahaka complex, 1 to 3 percent slopes, from the Tohono O'odham Nation soil survey area, located at about 2,400 feet west and 1,700 feet north of the southwest corner of sec. 11, T.10 S, R.3 E.

A—0 to 3 inches; yellowish brown (10YR 5/6) sandy loam, dark yellowish brown (10YR 4/4) moist; weak fine platy structure; soft, friable, nonsticky and nonplastic; common fine roots; common very fine interstitial and tubular pores; noneffervescent; mildly alkaline; abrupt smooth boundary.

- Bw1**—3 to 14 inches; brown (7.5YR 5/4) sandy loam, brown to dark brown (7.5YR 4/4) moist; weak coarse subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common very fine roots; common very fine interstitial and tubular pores; few faint clay films bridging sand grains; noneffervescent; mildly alkaline; clear smooth boundary.
- Bw2**—14 to 19 inches; yellowish brown (10YR 5/6) sandy loam, dark yellowish brown (10YR 4/4) moist; weak coarse subangular blocky structure; soft, friable, slightly sticky and slightly plastic; few fine roots; common very fine interstitial and tubular pores; few faint clay films bridging sand grains; noneffervescent; mildly alkaline; clear smooth boundary.
- Bk**—19 to 25 inches; yellowish brown (10YR 5/6) sandy loam, dark yellowish brown (10YR 4/4) moist; weak coarse subangular blocky structure; soft, friable, slightly sticky and slightly plastic; few fine roots; common very fine interstitial and tubular pores; few faint clay films bridging sand grains, and lime coats on lower surfaces of peds; strongly effervescent; mildly alkaline; clear smooth boundary.
- 2Btkb1**—25 to 30 inches; strong brown (7.5YR 5/6) sandy loam, strong brown (7.5YR 4/6) moist; weak coarse subangular blocky structure; slightly hard, friable, sticky and plastic; few fine roots; few fine tubular pores; few faint clay films bridging sand grains, and lime coats on lower surfaces of peds; strongly effervescent; moderately alkaline; clear wavy boundary.
- 2Btkb2**—30 to 36 inches; yellowish red (5YR 5/6) clay loam, yellowish red (5YR 4/6) moist; moderate coarse subangular blocky structure parting to moderate fine subangular blocky; slightly hard, friable, sticky and plastic; few fine roots; few fine tubular pores; few distinct continuous clay films on faces of peds; common coarse irregular soft masses of lime; slightly effervescent; moderately alkaline; clear wavy boundary.
- 2Btkb3**—36 to 42 inches; light brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; moderate coarse subangular blocky structure parting to moderate fine subangular blocky; hard, friable, sticky and plastic; few fine roots; common fine tubular pores; few distinct continuous clay films on faces of peds; common coarse irregular soft masses of lime; violently effervescent; moderately alkaline; clear wavy boundary.
- 2Btkb4**—42 to 60 inches; light brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; moderate coarse

subangular blocky structure; hard, friable, sticky and plastic; few fine roots; common fine tubular pores; few prominent continuous clay films on faces of peds; common coarse irregular soft masses of lime; violently effervescent; moderately alkaline.

These soils have 5 to 55 percent rock fragments in any one horizon, but average less than 35 percent in the control section. Reaction ranges from neutral to moderately alkaline. Calcium carbonate equivalent is less than 15 percent throughout. Depth to the buried argillic horizon is 20 to 35 inches. The salinity is none to very slight. The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 dry and 4 through 6 moist, and a chroma of 4 through 6, dry or moist. Textures are sandy loam and fine sandy loam. The B horizon has hue of 7.5YR or 10YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 4 through 6, dry or moist. Textures are sandy loam or fine sandy loam. The buried Btk horizon has hue of 5YR or 7.5YR, value of 4 through 7 dry and 4 or 5 moist, and chroma of 4 through 6, dry or moist. Textures are loam, clay loam, and sandy clay loam.

Typical pedon is shared with the adjoining soil survey.

Palos Verdes Series

The Palos Verdes series consists of very deep, well drained, moderately slow over very slowly permeable soils on relict fan terraces. These soils formed in mixed alluvium. Slope is 2 to 15 percent. Elevation ranges from 2,200 to 3,600 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are fine-loamy, mixed, thermic Duric Haplargids.

Typical pedon of Palos Verdes gravelly sandy loam in an area of Palos Verdes-Jaynes complex, 2 to 8 percent slopes, about 400 feet south and 500 feet west of the northeast corner of sec. 34, T.12 S., R.13 E.

A—0 to 1 inch; brown (7.5YR 5/4) gravelly sandy loam, brown to dark brown (7.5YR 4/4) moist; weak moderately thick platy structure; slightly hard, very friable, nonsticky and nonplastic; few fine roots; many fine interstitial pores; 30 percent gravel; noneffervescent; mildly alkaline; abrupt smooth boundary.

Bt1—1 to 3 inches; brown (7.5YR 5/4) gravelly sandy loam, brown to dark brown (7.5YR 4/4) moist; weak thick platy structure parting to weak

medium and fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; common fine interstitial pores; 20 percent fine gravel; few faint clay films bridging sand grains and lining pores; noneffervescent; neutral; abrupt wavy boundary.

Bt2—3 to 8 inches; reddish brown (5YR 4/4) gravelly sandy clay loam, dark reddish brown (5YR 3/4) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; many very fine and fine and few medium roots; many fine interstitial and common fine and medium tubular pores; 30 percent fine gravel; common faint clay films on faces of peds and lining pores; neutral; clear wavy boundary.

Bt3—8 to 15 inches; reddish brown (5YR 4/4) gravelly sandy clay loam, dark reddish brown (5YR 3/4) moist; moderate medium subangular blocky structure; hard, friable, sticky and plastic; many very fine and few medium and fine roots; few fine and medium tubular and common fine interstitial pores; 30 percent fine gravel; many faint clay films on faces of peds and few distinct clay films lining pores; mildly alkaline; clear wavy boundary.

Btk—15 to 19 inches; yellowish red and reddish brown (5YR 5/6 and 4/4) gravelly sandy loam, yellowish red and reddish brown (5YR 4/6 and 4/3) moist; moderate coarse platy structure; very hard, firm, slightly sticky and slightly plastic; many very fine roots between plates and few very fine and fine roots in peds; many very fine tubular and common very fine interstitial pores; 30 percent gravel; common faint clay films coating and bridging gravel; many medium distinct pinkish white (5YR 8/2) lime masses; violently effervescent; moderately alkaline; abrupt wavy boundary.

2Cd1—19 to 38 inches; pinkish white and pink (7.5YR 8/2 and 8/4) sandy loam, light brown (7.5YR 6/4) moist; massive; very hard, very firm and brittle, nonsticky and nonplastic; many very fine roots in fractures; common very fine and few medium and coarse tubular pores; violently effervescent; moderately alkaline; clear wavy boundary.

2Cd2—38 to 64 inches; pinkish white and pink (7.5YR 8/2 and 8/4) gravelly loamy coarse sand, light brown (7.5YR 6/4) moist; massive; very hard, very firm and brittle, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine interstitial and tubular pores; 30 percent gravel; violently effervescent; moderately alkaline.

Depth to compacted unconsolidated sediments ranges from 8 to 20 inches. Reaction ranges from neutral to strongly alkaline. The A horizon has hue of 5YR or 7.5YR, value of 5 or 6 dry, and chroma of 2 through 4. The Bt horizons have 5YR or 7.5YR, value of 4 through 6 dry, and chroma of 3 through 6. Texture is gravelly or nongravelly sandy clay loam, clay loam, or sandy loam. The Cd horizons have hue of 5YR or 7.5YR, value of 7 or 8 dry, and chroma of 2 through 4. It is brittle and firm or very firm when moist.

Pantak Series

The Pantak series consists of very shallow and shallow, well drained, moderately permeable soils on pediments, volcanic hills, and mountains. These soils formed in alluvium and colluvium derived dominantly from conglomerate, tuff-ash, andesite, and rhyolite. Slope is 8 to 60 percent. Elevation is 3,330 to 5,550 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy-skeletal, mixed, thermic Lithic Ustollic Haplargids.

Typical pedon of Pantak very gravelly loam in an area of Pantak-Deloro complex, 8 to 35 percent slopes, about 800 feet north and 1 foot west of the southeast corner of sec. 22, T.18 S., R.12 E.

A—0 to 1 inch; brown (7.5YR 5/2) very gravelly loam, dark brown (7.5YR 3/2) moist; weak platy structure parting to moderate fine granular; slightly hard, very friable, slightly sticky and nonplastic; common very fine roots; many fine interstitial pores; 50 percent gravel; mildly alkaline; abrupt wavy boundary.

Bt—1 to 8 inches; dark brown (7.5YR 4/2) extremely gravelly clay loam, dark brown (7.5YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few faint clay films on ped faces and lining pores; many very fine roots; many fine interstitial pores; 60 percent gravel; mildly alkaline; abrupt wavy boundary.

R—8 inches; pale red (10YR 6/2) and white (N8/) highly fractured andesite-tuff breccia; dark brown (7.5YR 4/2) clay loam Bt material in fractures; many very fine roots in fractures.

Depth to bedrock ranges from 6 to 20 inches. Gravel, cobble, and stones average 35 to 65 percent by volume. Reaction ranges from slightly acid to mildly alkaline. Clay content ranges from 20 to 35 percent. The A and Bt horizons have hue of 10 YR or

7.5YR, value of 4 or 5 dry, and chroma of 1 through 3. The Bt horizon has texture of very gravelly to very stony clay loam or sandy clay loam.

Pantano Series

The Pantano series consists of shallow, well drained, moderately permeable soils on pediments, hills, and mountains. These soils formed in mixed alluvium and colluvium. Slope is 5 to 50 percent. Elevation ranges from 2,200 to 3,800 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are loamy-skeletal, mixed, thermic, shallow Typic Calciorthids.

Typical pedon of Pantano extremely gravelly loam in an area of Pantano-Granolite complex, 5 to 25 percent slopes, about 1,300 feet south and 25 feet east of the northwest corner of sec. 29, T.14 S., R.16 E.

A—0 to 1 inch; pale brown (10YR 6/3) extremely gravelly loam, brown to dark brown (10YR 4/3) moist; weak thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; many fine interstitial pores; 70 percent fine angular gravel; strongly effervescent; moderately alkaline; abrupt smooth boundary.

Bw—1 to 10 inches; brown (10YR 5/3) very gravelly loam, brown to dark brown (10YR 4/3) moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; many fine interstitial pores; 40 percent angular gravel; violently effervescent; moderately alkaline; clear wavy boundary.

Bk—10 to 16 inches; white and pale brown (10YR 8/2 and 6/3) extremely gravelly loam, light gray and dark brown (10YR 7/2 and 4/3) moist; massive and weakly lime-cemented, slightly hard, friable, slightly sticky and slightly plastic; many very fine and few fine roots; many fine interstitial pores; 70 percent angular gravel; common faint lime coatings on gravel; violently effervescent; moderately alkaline; abrupt irregular boundary.

2Crk—16 to 60 inches; highly fractured schist; common faint patchy white (N 8/) calcium carbonate in fractures.

Depth to bedrock ranges from 10 to 20 inches. The A horizon has hue of 5YR through 10YR, value of 5 through 7 dry, and chroma of 3 or 4. The Bw horizon has hue of 5YR through 10YR, value of 4 through 6 dry, and chroma of 2 through 4. Texture is very

gravelly or very cobbly sandy loam and loam. The Bk horizon has hue of 5YR through 10YR, value of 7 or 8 dry, and chroma of 2 through 4. It is weakly cemented by lime in places and has texture of very gravelly or extremely gravelly loam and sandy loam.

Pinaleno Series

The Pinaleno series consists of very deep, well drained, moderately slowly permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 1 to 35 percent. Elevation ranges from 1,800 to 3,600 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are loamy-skeletal, mixed, thermic Typic Haplargids.

Typical pedon of Pinaleno very cobbly sandy loam in an area of Pinaleno-Stagecoach complex, 5 to 16 percent slopes, about 2,145 feet north and 1,570 feet west of the southwest corner of sec. 31, T.12 S., R.14 E.

A—0 to 2 inches; brown (7.5YR 5/4) very cobbly sandy loam, dark brown (7.5YR 3/4) moist; weak moderately thick platy structure parting to moderate fine granular; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; many fine interstitial pores; 10 percent stones, 30 percent cobble, and 10 percent gravel; neutral; abrupt wavy boundary.

Bt1—2 to 6 inches; reddish brown (2.5YR 4/4) extremely cobbly sandy clay loam, dark reddish brown (2.5YR 3/4) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; many very fine, common fine, and few medium and coarse roots; few fine and very fine tubular pores; common faint clay films bridging sand grains; 5 percent stones, 30 percent cobble, and 30 percent gravel; neutral; clear wavy boundary.

Bt2—6 to 20 inches; reddish brown (2.5YR 4/4) extremely cobbly sandy clay loam, dark reddish brown (2.5YR 3/4) moist; moderate medium subangular blocky structure; hard, friable, sticky and plastic; common very fine and few fine and medium roots; many very fine tubular pores; common faint clay films on faces of peds and bridging sand grains; 20 percent cobble and 40 percent gravel; mildly alkaline; clear wavy boundary.

Bt3—20 to 30 inches; red (2.5YR 4/6) extremely cobbly sandy clay loam, dark red (2.5YR 3/6) moist; weak medium subangular blocky structure;

hard, friable, sticky and plastic; common very fine and few fine and medium roots; few very fine and fine tubular pores; common faint clay films coating gravel, lining pores, and on faces of peds; 30 percent cobble and 30 percent gravel; moderately alkaline; abrupt wavy boundary.

2Bk—30 to 60 inches; pink (5YR 8/3 and 7/3) extremely gravelly sandy clay loam, pink, light reddish brown and yellowish red (5YR 7/3, 6/3 and 5/6) moist; weak fine subangular blocky structure; very hard, firm, sticky and plastic; weakly cemented in places; few very fine and fine roots; common very fine and fine tubular pores; patchy faint clay films lining pores and on faces of peds; many coarse white (5YR 8/1) lime masses; 5 percent stones, 20 percent cobble and 50 percent gravel; violently effervescent; moderately alkaline.

Depth to the calcic horizon ranges from 20 to 40 inches. The A horizon has hue of 7.5YR or 5YR, value of 4 through 6 dry, and chroma of 2 through 4. The Bt horizons have hue of 2.5YR through 7.5YR, value of 4 through 6 dry, and chroma of 4 or 6. Texture ranges from very gravelly to extremely cobbly sandy clay loam or clay loam. The Bk horizon has hue of 5YR or 7.5YR, value of 5 through 7 dry, and chroma of 2 through 4. Texture is similar to the Bt horizon. It has common or many lime masses and concretions.

Pinamt Series

The Pinamt series consists of very deep, well drained, moderately slowly permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 1 to 10 percent. Elevation ranges from 1,800 to 2,200 feet. The mean annual precipitation is about 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

These soils are loamy-skeletal, mixed, hyperthermic Typic Haplargids.

Typical pedon of Pinamt very gravelly sandy loam in an area of Pinamt-Momoli complex, 1 to 10 percent slopes, about 1,800 feet south and 1,400 feet west of the northeast corner of sec. 13, T.11 S., R.7 E.

A—0 to 2 inches; brown (7.5YR 5/4) very gravelly sandy loam, brown to dark brown (7.5YR 4/4) moist; weak moderately thick platy structure; slightly hard, very friable, nonsticky and nonplastic; common fine and very fine roots; many fine interstitial pores; 40 percent gravel; mildly alkaline; clear smooth boundary.

Bt—2 to 5 inches; reddish brown (5YR 5/4) extremely gravelly sandy clay loam, dark reddish brown (5YR 3/4) moist; moderate fine subangular blocky structure; hard, friable slightly sticky and plastic; many very fine, common fine, and few medium and coarse roots; few fine and medium tubular and many fine interstitial pores and on faces of peds; common faint clay films on ped faces and lining pores; 5 percent cobble and 65 percent gravel; mildly alkaline; clear wavy boundary.

Btk1—5 to 24 inches; red (2.5YR 4/6) extremely gravelly sandy clay loam, dark red (2.5YR 3/6) moist; weak fine subangular blocky structure; hard, friable, sticky and plastic; many very fine, common fine and few medium roots; few fine and medium tubular and many fine interstitial pores; many distinct clay films on faces of peds and lining pores; 5 percent cobble and 65 percent gravel; many fine distinct pink (5YR 7/3) lime coatings on gravel; strongly effervescent; moderately alkaline abrupt wavy boundary.

Btk2—24 to 40 inches; reddish brown (5YR 5/4) very gravelly sandy loam, reddish brown (5YR 4/4) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; common very fine and few fine, medium and coarse roots; few fine tubular and many fine interstitial pores; few faint clay films bridging sand grains and lining pores; 5 percent cobble and 55 percent gravel; common fine distinct pink (5YR 7/3) lime coatings on gravel; strongly effervescent; moderately alkaline; clear wavy boundary.

2Bk—40 to 52 inches; light brown (7.5HR 6/4) very gravelly sandy loam, reddish brown (5YR 4/4) moist; massive; very hard, firm, nonsticky and nonplastic; weakly cemented in places; few very fine roots; common very fine and fine tubular pores; many coarse white (5YR 8/1) lime masses; 5 percent cobble and 55 percent gravel; strongly effervescent; moderately alkaline; abrupt smooth boundary.

2C—52 to 60 inches; light brown (7.5YR 6/4) very gravelly loamy coarse sand, brown (7.5YR 5/4) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; many fine interstitial pores; 5 percent cobble and 55 percent fine gravel; effervescent; moderately alkaline.

The A horizon has hue of 7.5YR, value of 4 through 6 dry, and chroma of 3 through 6. The B horizons have hue of 5YR or 7.5YR, value of 4 through 6 dry, and chroma of 4 or 6. Texture ranges from very gravelly to extremely cobbly sandy clay loam, sandy loam, or clay loam. The C horizon has

value of 5 through 7 dry, and chroma of 2 through 6. Texture is very gravelly sandy loam and very gravelly loamy coarse sand.

Powerline Series

The Powerline series consists of moderately deep, well drained, moderately permeable soils on hills. These soils formed in mixed alluvium and colluvium derived dominantly from calcareous sedimentary rock. Slope is 10 to 35 percent. Elevation ranges from 3,300 to 4,900 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy-skeletal, mixed, thermic Ustollic Calciorthids.

Typical pedon of Powerline very gravelly sandy loam in an area of Powerline-Kimrose family complex, 10 to 35 percent slopes, about 1,800 feet north and 300 feet east of the southwest corner of sec. 12, T.17 S., R.17 E.

A—0 to 3 inches; pale brown (10YR 6/3) very gravelly sandy loam, brown to dark brown (10YR 4/3) moist; weak moderately thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; common fine tubular pores; 40 percent gravel; strongly effervescent; moderately alkaline; clear smooth boundary.

Bk1—3 to 17 inches; very pale brown (10YR 7/3) gravelly loam, light yellowish brown (10YR 6/4) moist; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine and fine roots; common very fine tubular pores; 25 percent gravel and 5 percent cobble; few moderately thick lime coatings on gravel and lining pores; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk2—17 to 29 inches; very pale brown (10YR 7/3) very gravelly sandy loam, light yellowish brown (10YR 6/4) moist; massive; hard, firm, slightly sticky and slightly plastic; common fine and medium and few very fine roots; common fine and medium tubular pores; common moderately thick lime coatings on gravel and lining pores 50 percent gravel and 5 percent cobble; violently effervescent; moderately alkaline; abrupt smooth boundary.

R—29 to 60 inches; very pale brown (10YR 7/4) sandy fanglomerate; thin discontinuous lime-silica cemented capping on bedrock; common fine roots in fracture; many moderately thick lime coatings in rock fractures; strongly effervescent.

The depth to bedrock ranges from 20 to 40 inches. The calcic horizon has 15 to 35 percent calcium carbonate equivalent. The A and Bk horizons have hue of 10YR or 7.5YR, value of 5 through 7 dry, and chroma of 2 through 4. Texture ranges from gravelly to very gravelly sandy loam, loam or fine sandy loam.

Redington Series

The Redington series consists of very deep, somewhat excessively drained, rapidly permeable in the upper part and moderately rapidly permeable in the lower part. These soils formed in mixed alluvium. Slope is 3 to 50 percent. Elevation ranges from 2,200 to 3,800 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are sandy, mixed, thermic, Typic Torriorthents.

Typical pedon of Redington very gravelly fine sand, 3 to 50 percent slopes, located at 850 feet west and 710 feet south of the northeast corner of sec. 2, T.12 S., R.18 E.

A—0 to 2 inches; brown (7.5YR 5/4) very gravelly fine sand, dark brown (7.5YR 4/4) moist; moderate fine granular structure; loose, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine interstitial pores; 40 percent gravel; strongly effervescent; mildly alkaline; abrupt smooth boundary.

C—2 to 10 inches; brown (7.5YR 5/4) fine sand, dark brown (7.5YR 4/4) moist; single grain; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine interstitial pores; 5 percent gravel; slightly effervescent; mildly alkaline; abrupt smooth boundary.

Cd—10 to 14 inches; light brown (7.5YR 6/4) sand, brown (7.5YR 5/4) moist; massive; hard, firm, nonsticky and nonplastic; 5 percent gravel; noneffervescent; moderately alkaline; abrupt smooth boundary.

C'—14 to 28 inches; light brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) moist; massive; soft, friable, nonsticky and nonplastic; 5 percent gravel; noneffervescent; mildly alkaline; abrupt smooth boundary.

C'd—28 to 40 inches; light brown (7.5YR 6/4) sand; brown (7.5YR 5/4) moist; massive; very hard, firm, nonsticky and nonplastic; 5 percent gravel; noneffervescent; strongly alkaline; abrupt smooth boundary.

C"—40 to 60 inches; light brown (7.5YR 6/4) stratified gravelly coarse sand and sand; massive; loose, very friable, nonsticky and nonplastic; 30 percent gravel; strongly effervescent; moderately alkaline.

The A horizon has a hue of 10YR or 7.5YR, value of 5 through 7 dry, 4 or 5 moist and chroma of 3 through 6, dry or moist. The C horizon has hue of 10YR or 7.5YR, value of 5 through 7 dry, 4 through 6 moist and chroma of 3 through 6, dry or moist. The Cd horizon has hue 7.5YR or 5YR, value of 5 or 6 dry, 4 or 5 moist, chroma of 4 or 6, dry or moist.

Redo Series

The Redo series consists of very deep, excessively drained, rapidly permeable soils on hills. These soils formed from mixed alluvium. Slope is 15 to 50 percent. Elevation ranges from 2,600 to 3,800 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are sandy-skeletal, mixed, thermic Typic Calciorthids.

Typical pedon of Redo very gravelly sand, 15 to 50 percent slopes, located in the northwest corner of sec. 11, T.12 S., R.18 E.

A—0 to 2 inches; brown to dark brown (7.5YR 4/4) very gravelly sand, dark brown (7.5YR 3/4) moist; moderate fine granular structure; loose, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; 30 percent gravel and 20 percent cobble; slightly effervescent; mildly alkaline; abrupt smooth boundary.

Bk1—2 to 14 inches; brown to dark brown (7.5YR 4/4) very gravelly sand, dark brown (7.5YR 3/4) moist; single grain; loose, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine interstitial pores; 30 percent gravel and 10 percent cobble; many distinct continuous carbonate coats on rock fragments; 6 percent calcium carbonate equivalent; strongly effervescent; abrupt smooth boundary.

Bk2—14 to 60 inches; light brown (7.5YR 6/4) extremely gravelly sand, brown (7.5YR 5/4) moist; single grain; loose, very friable, nonsticky and nonplastic; common very fine and fine roots and few coarse roots; many very fine and fine interstitial pores; 40 percent gravel and 20 percent cobble; many distinct continuous

carbonate coats on rock fragments; 6 percent calcium carbonate equivalent; violently effervescent; moderately alkaline.

The A horizon has value 3 or 4, dry or moist. The B horizon has value of 4 through 6 dry and 3 through 5 moist.

Riveroad Series

The Riveroad series consists of very deep, well drained, moderately slowly permeable soils on flood plains. These soils formed in mixed alluvium. Slope is 0 to 2 percent. Elevation ranges from 2,400 to 4,600 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are fine-silty, mixed (calcareous), thermic Ustic Torrifuvents.

Typical pedon of Riveroad clay loam in an area of Riveroad and Comoro soils, 0 to 2 percent slopes, about 1,660 feet south and 200 feet east of the northwest corner of sec. 26, T.18 S., R.9 E.

A—0 to 4 inches; brown (10YR 5/3) stratified clay loam, dark brown (10YR 3/3) moist; thick pale brown (10YR 6/3) finely stratified silt loam and very fine sandy loam (C horizon material) on the surface, brown to dark brown (10YR 4/3) moist; weak thick platy structure; slightly hard, friable, sticky and plastic; common very fine roots; common very fine interstitial pores; common thin sand coatings on faces of peds; mildly alkaline; abrupt smooth boundary.

C1—4 to 21 inches; brown to dark brown (10YR 4/3) clay loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; many very fine interstitial pores; few thin very fine sand coatings on faces of peds; few fine lime filaments in pores; slightly effervescent; mildly alkaline; clear wavy boundary.

C2—21 to 33 inches; dark grayish brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; mildly alkaline; clear wavy boundary.

C3—33 to 60 inches; brown to dark brown (7.5YR 4/4) clay loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; very hard, friable, sticky and plastic; few very fine roots; common fine tubular pores; few fine lime filaments in pores; common faint

organic stains on faces of peds and lining pores; slightly effervescent; mildly alkaline.

Reaction ranges from neutral to moderately alkaline. The A and C horizons have hue of 10YR or 7.5YR, value of 3 through 6 dry, and chroma of 1 through 4. Texture is commonly clay loam with less than 15 percent fine and coarser sand but includes textures of silty clay loam, silt loam, and thin layers of coarser material.

Romero Series

The Romero series consists of very shallow and shallow, well drained, moderately rapidly permeable soils formed on pediments, hills, and mountains. These soils formed in alluvium and colluvium derived dominantly from granite, granodiorite, and pegmatite. Slope is 10 to 60 percent. Elevation ranges from 3,400 to 5,400 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy-skeletal, mixed, nonacid, thermic shallow Ustic Torriorthents.

Typical pedon of Romero very gravelly sandy loam in an area of Oracle-Romero-Rock outcrop complex, 5 to 35 percent slopes, about 1,625 feet south and 1,495 feet west of the northeast corner of sec. 1, T.18 S., R.11 E.

- A1—0 to 2 inches; dark grayish brown (10YR 4/2) very gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; weak moderately thick platy structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and few fine roots; many fine interstitial pores; 40 percent fine gravel; neutral; abrupt smooth boundary.
- A2—2 to 10 inches; very dark grayish brown (10YR 3/2) very gravelly fine sandy loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and few fine and medium roots; many fine interstitial pores; 40 percent fine gravel; neutral; abrupt wavy boundary.
- 2Crt1—10 to 17 inches; brown and light gray (10YR 5/3 and 7/2) weathered granite (grus), brown to dark brown and light brownish gray (10YR 4/3 and 6/2) moist; many fine and few medium and coarse fractures; very dark grayish brown (10YR 3/2) fine sandy loam, very dark brown (10YR 2/2) moist in coarse fractures; many very fine and few fine and medium roots in fractures; few faint and

distinct dark reddish brown (5YR 3/2) clay films on faces of rock fractures, dark reddish brown (5YR 2/2) moist; diffuse wavy boundary.

- 2Crt2—17 to 60 inches; light brownish gray to very pale brown (10YR 6/2 and 7/4) weathered granite (grus); many fine and few medium and coarse roots in fractures; few faint dark reddish brown (5YR 5/4) clay films on faces of rock fractures, dark reddish brown (5YR 3/4) moist.

Depth to bedrock ranges from 4 to 20 inches. Reaction ranges from slightly acid to mildly alkaline. The A horizon has hue of 10YR or 7.5YR, value of 3 through 5 dry, and chroma of 1 through 3. The Crt horizon has hue of 5YR through 10YR, value of 4 through 7 dry, and chroma of 2 through 4. It has few to many clay films on faces of rock fractures.

Saguaro Series

The Saguaro series consists of very shallow and shallow, well drained, moderately rapidly permeable soils on hills and mountains. These soils formed in alluvium and colluvium derived dominantly from limestone and marble. Slope is 15 to 45 percent. Elevation ranges from 2,000 to 3,800 feet. The mean annual precipitation is about 10 to 12 inches; the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are loamy-skeletal, carbonatic, thermic Lithic Torriorthents.

Typical pedon of Saguaro extremely gravelly fine sandy loam in an area of Saguaro-Rock outcrop complex, 15 to 45 percent slopes, about 100 feet south and 2,500 feet east of the northwest corner of sec. 23, T.12 S., R.11 E.

- A—0 to 1 inch; pale brown (10YR 6/3) extremely gravelly fine sandy loam, brown to dark brown (10YR 4/3) moist; weak fine granular structure; soft, very friable, slightly sticky and nonplastic; few fine roots; few fine interstitial pores; 60 percent gravel and 20 percent cobble; strongly effervescent; moderately alkaline; abrupt smooth boundary.
- C—1 to 4 inches; light yellowish brown (10YR 6/4) extremely gravelly fine sandy loam, dark yellowish brown (10YR 4/4) moist; massive; soft, very friable, slightly sticky and nonplastic; few fine roots; few fine interstitial pores; 60 percent gravel and 25 percent cobble; strongly effervescent; moderately alkaline; abrupt irregular boundary.
- R—4 inches; light gray (10YR 7/1) limestone, gray

(10YR 5/1) moist; few fine fractures; few very fine roots in fractures.

Depth to bedrock ranges from 4 to 18 inches. Secondary lime masses, concretions, and coatings on gravel is less than 5 percent by volume. The A and C horizons have hue of 10YR to 7.5YR, value of 6 through 8 dry, and chroma of 1 through 3.

Sahuarita Series

The Sahuarita series consists of very deep, well drained, moderate over moderately slowly permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 0 to 8 percent. Elevation ranges from 2,200 to 3,200 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are coarse-loamy, mixed, thermic Typic Camborthids.

Typical pedon of Sahuarita very gravelly fine sandy loam in an area of Sahuarita soils, Mohave soils, and Urban land, 1 to 5 percent slopes, about 460 feet north and 1,060 feet west of the southeast corner of sec. 7, T.17 S., R.15 E.

A—0 to 3 inches; light yellowish brown (10YR 6/4) very gravelly fine sandy loam, dark yellowish brown (10YR 4/4) moist; weak moderately thick platy structure; soft, very friable, nonsticky and nonplastic; few fine roots; common very fine tubular pores; 45 percent gravel; strongly effervescent; moderately alkaline; abrupt wavy boundary.

Bk—3 to 19 inches; light yellowish brown (10YR 6/4) fine sandy loam, brown to dark brown (10YR 4/3) moist; weak coarse subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common fine roots; common fine tubular pores; common fine lime filaments on faces of peds; few faint lime coatings on the underside of gravel; 10 percent gravel; strongly effervescent; moderately alkaline; gradual smooth boundary.

C—19 to 28 inches; light yellowish brown (10YR 6/4) fine sandy loam, dark yellowish brown (10YR 4/4) moist; massive; soft, very friable, slightly sticky and nonplastic; common fine roots; few fine tubular pores; 10 percent gravel; strongly effervescent; moderately alkaline; clear wavy boundary.

2Btkb—28 to 45 inches; brown (7.5YR 5/4) loam, brown to dark brown (7.5YR 4/4) moist; weak medium prismatic structure; hard, firm, sticky

and plastic; common fine roots; common fine and very fine tubular pores; common faint clay films coating sand grains and lining pores; few faint lime filaments on faces of peds; 10 percent gravel; strongly effervescent; moderately alkaline; clear wavy boundary.

2Btb—45 to 60 inches; brown (7.5YR 5/4) very gravelly sandy clay loam, brown to dark brown (7.5YR 4/4) moist; weak medium prismatic structure; hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; many faint clay films coating sand grains and lining pores; 35 percent gravel; strongly effervescent; moderately alkaline.

The depth to the buried soil ranges from 20 to 40 inches. Organic matter content in the upper 15 inches is less than 1 percent. Reaction is mildly or moderately alkaline in the upper part and ranges to strongly alkaline in the buried soil. The soil ranges from slightly effervescent in the A and Bk horizons to violently effervescent in the buried soil. The 10- to 40-inch control section averages less than 18 percent clay. The A and Bk or Bw horizons have hue of 10YR or 7.5YR, value of 5 or 6 dry, and chroma of 3 through 6. Texture of the Bw or Bk and C horizon(s) are sandy loam, loam, fine sandy loam, or less commonly very fine sandy loam. The buried horizons have hue of 5YR or 7.5YR, value of 4 through 6 dry, and chroma of 3 through 6. Texture is commonly sandy clay loam or clay loam but includes loam.

Sasabe Series

The Sasabe series consists of very deep, well drained, slowly permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 1 to 5 percent. Elevation ranges from 3,000 to 3,700 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are fine, mixed, thermic Ustalfic Paleargids.

Typical pedon of Sasabe sandy loam in an area of Altar-Sasabe complex, 1 to 8 percent slopes, about 1,400 feet north and 1,300 feet east of the southwest corner of sec. 6, T.20 S., R.9 E.

A—0 to 5 inches; strong brown (7.5YR 5/6) sandy loam, yellowish red (5YR 4/6) moist; weak thin and moderately thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine and common very fine roots;

many fine interstitial pores; noneffervescent; 10 percent gravel; slightly acid; abrupt smooth boundary.

- Bt1—5 to 15 inches; yellowish red (5YR 4/6) clay loam, red (2.5YR 4/6) moist; moderate fine subangular blocky structure; hard, friable, sticky and plastic; many very fine and common fine roots; common fine tubular pores; few faint clay films coating sand grains and lining pores; noneffervescent; 5 percent gravel; mildly alkaline; clear wavy boundary.
- Bt2—15 to 22 inches; red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; moderate fine and medium prismatic structure; very hard, firm, very sticky and very plastic; many very fine and few fine roots; few very fine and many fine tubular pores; many distinct clay films lining pores; 10 percent gravel; slightly effervescent; moderately alkaline; clear wavy boundary.
- Bt3—22 to 31 inches; yellowish red (5YR 4/6) gravelly clay loam, dark red (2.5YR 3/6) moist; weak medium subangular blocky structure; very hard, firm, sticky and plastic; common very fine roots; common very fine tubular pores; common faint clay films coating gravel and lining pores; 30 percent gravel; slightly effervescent; moderately alkaline; clear wavy boundary.
- Bt4—31 to 41 inches; yellowish red (5YR 4/6) gravelly sandy clay loam, red (2.5YR 4/6) moist; weak coarse subangular blocky structure; very hard, firm, sticky and plastic; common very fine and fine roots; common very fine tubular pores; common faint clay films on faces of peds; 25 percent gravel; slightly effervescent; moderately alkaline; clear wavy boundary.
- 2Btk—41 to 60 inches; yellowish red (5YR 5/8) very gravelly sandy clay loam, yellowish red (5YR 4/6) moist; weak medium subangular blocky structure; very hard, firm, sticky and plastic; common very fine roots; common very fine tubular and few fine interstitial pores; few faint clay films coating sand grains and gravel and lining pores; many fine pinkish white (5YR 8/2) lime measures in pores and coating gravel; 40 percent gravel; strongly effervescent; moderately alkaline.

The A horizon has hue of 5YR through 10YR, value of 5 or 6 dry, and chroma of 3 through 6. Reaction ranges from slightly acid to mildly alkaline. The Bt horizons have hue of 2.5YR or 5YR, value of 3 through 5 dry, and chroma of 3 through 8. Texture is clay, sandy clay, clay loam, or sandy clay loam. Reaction ranges from neutral in the upper part to moderately alkaline in the lower part. The Btk or Bk

horizon has hue of 5YR or 7.5YR, value of 5 through 7 dry, and chroma of 4 through 8. Texture ranges from gravelly to very cobbly clay loam, sandy clay loam, loam, or sandy loam.

Schrap Series

The Schrap series consists of very shallow and shallow, well drained, moderately permeable soils on pediments. These soils formed in mixed alluvium and colluvium derived dominantly from shale, schist, and sandstone. Slope is 5 to 30 percent. Elevation ranges from 3,200 to 5,000 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy-skeletal, mixed, nonacid, thermic, shallow Ustic Torriorthents.

Typical pedon of Schrap very channery loam, 5 to 30 percent slopes, about 100 feet north and 675 feet west of the southeast corner of sec. 11, T.21 S., R.8 E.

- A—0 to 2 inches; light reddish brown (5YR 6/4) very channery loam, reddish brown (5YR 4/4) moist; weak thin platy structure; loose, very friable, nonsticky and nonplastic; common very fine roots; common fine interstitial pores; slightly acid; clear smooth boundary.
- C—2 to 11 inches; yellowish red (5YR 5/6) very channery loam, yellowish red (5YR 4/6) moist; massive; soft, very friable, slightly sticky and slightly plastic; common very fine, fine and medium roots; common very fine and fine interstitial pores; neutral; abrupt wavy boundary.
- 2Cr—11 to 60 inches; red and pinkish gray (2.5YR 4/6 and 5YR 6/2) fractured schist; common very fine and fine roots in fractures; few fine filaments of lime in rock fractures.

Depth to bedrock ranges from 4 to 12 inches. Reaction ranges from slightly acid to mildly alkaline. The A horizon has hue of 5YR through 10YR, value of 5 or 6 dry, and chroma of 2 through 4. The Cr horizon is variegated schist. Color ranges from olive to red.

Spudrock Series

The Spudrock series consists of moderately deep, well drained, moderately rapidly permeable soils on hills and mountains. These soils formed in alluvium and colluvium derived dominantly from granite, gneiss, and schist. Slope is 15 to 65 percent. Elevation ranges from 5,400 to 8,670 feet. The mean annual precipitation is about 20 to 30 inches, the

mean annual air temperature is 45 to 54 degrees F, and the frost-free period is 140 to 170 days.

These soils are loamy-skeletal, mixed, mesic Typic Ustochrepts.

Typical pedon of Spudrock very flaggy sandy loam in an area of Spudrock-Far-Rock outcrop complex, 25 to 65 percent slopes, about 1,800 feet north and 2,450 feet east of the southwest corner of sec. 24, T.14 S., R.17 E.

Oi—1 to 0 inches; dark grayish brown (10YR 4/2) slightly decomposed forest litter (Mexican pinyon needles and Arizona white oak leaves), very dark grayish brown (10YR 3/2) moist; moderately acid; abrupt smooth boundary.

A—0 to 5 inches; brown (10YR 5/3) very flaggy sandy loam, dark brown (10YR 3/3) moist; moderate fine granular structure; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; common fine tubular pores; 25 percent flagstones and 10 percent channers; neutral; clear smooth boundary.

Bw—5 to 17 inches; pale brown (10YR 6/3) very channery fine sandy loam, brown to dark brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common medium roots; common medium tubular pores; few thin organic coatings on faces of peds; 35 percent channers and gravel; moderately acid; gradual smooth boundary.

BC—17 to 24 inches; light yellowish brown (10YR 6/4) very channery fine sandy loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; common medium roots; common medium tubular pores; 35 percent channers and gravel; slightly acid; abrupt smooth boundary.

2Cr—24 to 60 inches; variegated very pale brown (10YR 7/3) and yellow (10YR 7/6) partially weathered gneiss (grus), brown (10YR 5/3) and yellowish brown (10YR 5/6) moist; few fine roots in fractures.

Depth to bedrock ranges from 20 to 40 inches. Reaction ranges from neutral to moderately acid. Flagstones, channers, and gravel average 35 to 60 percent by volume. The A horizon has hue of 10YR or 7.5YR, value of 4 through 6 dry, and chroma of 2 through 4. The Bw and BC horizons have hue of 10YR or 7.5YR, value of 5 through 7 dry, and chroma of 2 through 4. Texture ranges from channery fine sandy loam through channery sandy loam.

Stagecoach Series

The Stagecoach series consists of very deep, well drained, moderately permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 1 to 35 percent. Elevation ranges from 2,200 to 3,600 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are loamy-skeletal, mixed, thermic Typic Calciorthids.

Typical pedon of Stagecoach very gravelly sandy loam in an area of Stagecoach-Sahuarita association, 1 to 8 percent slopes, about 25 feet north and 2,640 feet east of the southwest corner of sec. 25, T.15 S., R.14 E.

A—0 to 4 inches; light brown (7.5YR 6/4) very gravelly sandy loam, brown to dark brown (7.5YR 4/4) moist; weak moderately thick platy structure; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; many fine interstitial and common fine, medium and coarse tubular pores; 35 percent gravel; strongly effervescent; moderately alkaline; abrupt smooth boundary.

Bw—4 to 10 inches; light brown (7.5YR 6/4) very gravelly sandy loam, brown to dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; many very fine and few fine and medium roots; common very fine, fine and medium tubular and interstitial pores; 45 percent gravel; common fine distinct pinkish white (7.5YR 8/2) lime veins; violently effervescent; moderately alkaline; clear wavy boundary.

Bk1—10 to 19 inches; pink (7.5YR 7/4) very gravelly loam, brown (7.5YR 5/4) moist; massive; hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many fine interstitial and tubular pores; 50 percent gravel; thin continuous pinkish white (7.5YR 8/2) lime coating on gravel and as soft and hard masses; violently effervescent; moderately alkaline; clear wavy boundary.

Bk2—19 to 40 inches; pinkish gray (7.5YR 7/2) and pinkish white (7.5YR 8/2) extremely gravelly loam, light brown (7.5YR 6/4) and pinkish gray (7.5YR 7/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly cemented in places; common fine and very fine and few medium and coarse roots; common fine

interstitial and few fine and medium tubular pores; 60 percent gravel; many medium and coarse lime masses; violently effervescent; moderately alkaline; clear wavy boundary.

2C—40 to 60 inches; light brown (7.5YR 6/4) very gravelly loamy sand, brown (7.5YR 5/4) moist; single grain; loose, nonsticky and nonplastic; few fine and very fine roots; many fine interstitial pores; common thin lime coatings on gravel; 45 percent gravel; violently effervescent; moderately alkaline.

Depth to the calcic horizon ranges from 10 to 20 inches. The soil to a depth of 60 inches has hue of 7.5YR or 10YR, value of 6 or 7 dry, and chroma of 2 through 4. Texture is very gravelly or extremely gravelly loam, sandy loam, or coarse sandy loam. The Bk horizons have many lime masses and is weakly cemented in places. The C horizon has texture of very gravelly loamy coarse sand or loamy sand in some pedons.

Tombstone Series

The Tombstone series consists of very deep, well drained, moderately rapidly permeable soils on fan terraces. These soils formed in mixed alluvium and colluvium. Slope is 5 to 50 percent. Elevation ranges from 3,500 to 5,200 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66 degrees F, and the frost-free period is 180 to 230 days.

These soils are loamy-skeletal, mixed, thermic Ustollic Calciorthids.

Typical pedon of Tombstone very gravelly loam in an area of Nalam-Tombstone complex, 8 to 30 percent slopes, about 1,400 feet north and 2,500 feet east of the southwest corner of sec. 6, T.19 S., R.13 E.

A1—0 to 1 inch; grayish brown (10YR 5/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; many fine interstitial pores; 50 percent gravel; strongly effervescent; moderately alkaline; clear wavy boundary.

A2—1 to 13 inches; dark grayish brown (10YR 4/2) very gravelly loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine and medium and many very fine roots; many fine interstitial pores; 50

percent gravel; violently effervescent; moderately alkaline; abrupt wavy boundary.

Bk1—13 to 40 inches; white and light gray (10YR 8/2 and 7/2) extremely gravelly loam, light gray and light brownish gray (10YR 7/2 and 6/2) moist; massive; weakly cemented; very hard, firm, nonsticky and nonplastic; common fine and very fine roots; few very fine tubular pores; 60 percent gravel; violently effervescent; moderately alkaline; clear wavy boundary.

Bk2—40 to 60 inches; white and light gray (10YR 8/2 and 7/2) extremely gravelly loam, light gray and light brownish gray (10YR 7/2 and 6/2) moist; massive; weakly cemented; hard, firm, nonsticky and nonplastic; few very fine roots; few fine medium and coarse tubular pores; 60 percent gravel; violently effervescent; moderately alkaline.

Depth to the calcic horizon ranges from 7 to 16 inches. The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 dry, and chroma of 2 or 3. The Bk horizons have hue of 7.5YR or 10YR, value of 6 through 8 dry, and chroma of 2 through 4. Texture is very gravelly or very cobbly, sandy loam, or loam. Calcium carbonate masses, concretions, and weak cementation are common.

Trix Series

The Trix series consists of very deep, well drained, moderately over moderately slowly permeable soils on alluvial fans. These soils formed in mixed alluvium. Slope is 0 to 1 percent. Elevation ranges from 1,675 to 1,900 feet. The mean annual precipitation is about 8 to 10 inches. The mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

These soils are fine-loamy, mixed (calcareous), hyperthermic Typic Torrifuvents.

Typical pedon of Trix very fine sandy loam in an area of Mohall-Trix complex, 0 to 1 percent slopes, from the Tohono O'odham Nation soil survey area, located at about 1,300 feet south and 1,000 feet west of the northeast corner of sec. 6, T.16 S., R.1 E.

C1—0 to 5 inches; strong brown (7.5YR 5/6) very fine sandy loam, brown to dark brown (7.5YR 4/4) moist; moderate thin platy structure; soft, very friable, nonsticky and slightly plastic; few fine roots; few fine tubular pores; noneffervescent; mildly alkaline; abrupt smooth boundary.

C2—5 to 11 inches; strong brown (7.5YR 5/6) very

fine sandy loam, brown to dark brown (7.5YR 4/4) moist; weak coarse platy structure; soft, very friable, nonsticky and slightly plastic; common fine roots; common fine tubular pores; very few faint patchy lime filaments throughout; slightly effervescent; mildly alkaline; abrupt wavy boundary.

AC—11 to 22 inches; brown (7.5YR 5/4) loam, brown to dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; hard, very friable, sticky and plastic; common fine roots; common fine tubular pores; few faint patchy lime filaments; slightly effervescent; moderately alkaline; clear wavy boundary.

Btkb1—22 to 38 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and plastic; few fine roots; few fine tubular pores; few faint patchy lime filaments, and common distinct continuous clay films on faces of peds and in pores; slightly effervescent; moderately alkaline; clear wavy boundary.

2Btkb2—38 to 45 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure; hard, friable, very sticky and very plastic; few fine tubular pores; common distinct continuous clay films on faces of peds and in pores; few fine lime filaments; strongly effervescent; moderately alkaline; clear wavy boundary.

2Btkb3—45 to 60 inches; reddish yellow (5YR 6/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate coarse subangular blocky structure; hard, friable, very sticky and very plastic; few distinct continuous clay films on faces of peds and in pores; common medium rounded soft masses of lime; violently effervescent; moderately alkaline.

These soils have less than 5 percent rock fragments. Reaction ranges from mildly to moderately alkaline. Calcium carbonate equivalent is less than 15 percent in the upper part and greater than 15 percent in the lower part. Depth to buried argillic horizon is 20 to 30 inches. The A and C horizons have hue of 7.5YR or 10YR, value of 5 or 6 dry and 3 through 5 moist, and a chroma of 3 through 6, dry or moist. The 2B horizon has hue of 5YR or 7.5YR, value of 5 through 7 dry and 3 through 6 moist, and chroma of 3 through 6, dry or moist. Textures range from clay loam to sandy clay loam.

Typical pedon is shared with the adjoining soil survey.

Tubac Series

The Tubac series consists of very deep, well drained, slowly permeable soils on basin floors and fan terraces. These soils formed in mixed alluvium. Slope is 0 to 8 percent. Elevation ranges from 2,200 to 3,400 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is 64 to 70 degrees F, and the frost-free period is 220 to 280 days.

These soils are fine, mixed, thermic Typic Paleargids.

Typical pedon of Tubac sandy loam, 0 to 2 percent slopes, about 1,760 feet south and 100 feet west of the northeast corner of sec. 34, T.19 S., R.12 E.

A1—0 to 2 inches; brown (7.5YR 5/4) sandy loam, reddish brown (5YR 4/4) moist; weak medium platy structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine interstitial and few fine tubular pores; 10 percent fine gravel; moderately acid; abrupt smooth boundary.

A2—2 to 12 inches; reddish brown (5YR 5/4) loam, dark reddish brown (2.5YR 3/4) moist; weak medium granular structure; slightly hard, friable, slightly sticky and plastic; common fine roots; many very fine interstitial pores; 10 percent fine gravel; slightly acid; abrupt wavy boundary.

E—12 to 14 inches; pinkish gray (7.5YR 7/2) loam, reddish brown (5YR 4/4) moist; massive; slightly hard, friable, slightly sticky and plastic; common very fine roots; many fine vesicular and tubular pores; 10 percent fine gravel; slightly acid; abrupt wavy boundary.

Bt—14 to 21 inches; reddish brown (5YR 4/4) clay, dark red (2.5YR 3/6) moist; strong medium prismatic structure parting to moderate fine and medium angular blocky; hard, friable, sticky and very plastic; common fine roots; many very fine tubular pores; many distinct clay films on ped faces; mildly alkaline; clear wavy boundary.

Btk—21 to 31 inches; reddish brown (5YR 4/4) clay, dark red (2.5YR 3/6) moist; strong medium prismatic structure parting to moderate medium angular blocky; very hard, friable, sticky and very plastic; common fine roots; few fine tubular pores; continuous distinct clay films on faces of peds and lining pores; common pinkish white (5YR 8/2) lime masses; few fine Fe-Mn stains on faces of peds; strongly effervescent in spots but matrix dominantly noneffervescent; mildly alkaline; clear wavy boundary.

2Btk1—31 to 54 inches; reddish brown (5YR 5/4) gravelly sandy clay loam, reddish brown (5YR 4/4) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and plastic; few fine roots; many very fine irregular pores; many faint clay films bridging sand grains and lining pores; many coarse pinkish white (5YR 8/2) lime masses and filaments; violently effervescent; moderately alkaline; gradual smooth boundary.

2Btk2—54 to 66 inches; brown (7.5YR 5/4) gravelly sandy clay loam, dark brown (7.5YR 4/4) moist; massive; hard, friable, slightly sticky and plastic; many very fine interstitial and few very fine tubular pores; slightly to violently effervescent; mildly alkaline.

Reaction ranges from moderately acid in the upper part to moderately alkaline in the lower part. The upper 20 inches of the argillic horizon averages more than 35 percent clay and less than 15 percent fine gravel. The A horizons have hue of 5YR or 7.5YR, value of 4 through 6 dry, and chroma of 2 through 4. Texture is sandy loam or gravelly loam. The E horizon has hue of 5YR or 7.5YR, value of 5 through 7 dry, and chroma of 2 through 4. Texture is loam, sandy loam, gravelly loam, or gravelly sandy loam. The Bt horizons have hue of 2.5YR or 5YR, value of 4 or 5 dry, and chroma of 4 through 6. The Btk horizons have hue of 2.5YR through 7.5YR, value of 5 through 8 dry, and chroma of 2 through 6. Texture ranges from sandy clay loam to clay loam and gravel content ranges from 5 to 60 percent.

Vecont Series

The Vecont series consists of very deep, well drained, slowly permeable soils in drainageways and swales on basin floors. These soils formed in mixed alluvium. Slope is 0 to 1 percent. Elevation is 1,650 to 1,800 feet. The mean annual precipitation is about 8 to 10 inches, the mean annual air temperature is 70 to 72 degrees F, and the frost-free period is 250 to 300 days.

These soils are fine, mixed, hyperthermic Typic Haplargids.

Typical pedon of Vecont clay loam, 0 to 1 percent slopes, about 410 feet west and 140 feet north of the southeast corner of sec. 9, T.11 S., R.6 E.

A—0 to 3 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; weak fine and medium platy structure parting to weak medium granular; slightly hard, friable, very sticky and very plastic; many fine and very fine roots; many very fine

interstitial pores; mildly alkaline; clear smooth boundary.

Bt1—3 to 15 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; weak coarse subangular blocky structure; hard, firm, very sticky and very plastic; common fine and many very fine roots; common very fine tubular and many very fine interstitial pores; few faint clay films on faces of ped; slightly effervescent with disseminated lime; mildly alkaline; clear smooth boundary.

Bt2—15 to 28 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; weak coarse prismatic structure parting to moderate fine subangular blocky; very hard, very firm, very sticky and very plastic; common very fine and few fine roots; common fine tubular and few very fine interstitial pores; common distinct clay films on faces of peds; mildly alkaline; clear wavy boundary.

2Bt3—28 to 42 inches; red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) moist, weak coarse prismatic structure; hard, firm, sticky and plastic; few very fine roots; common very fine and fine interstitial pores; few faint clay films on faces of peds; moderately alkaline; clear wavy boundary.

2Bk—42 to 60 inches; pink (5YR 7/4) loam, yellowish red (5YR 5/6) moist; massive; soft, friable, slightly sticky and slightly plastic; few very fine interstitial pores; few fine distinct pinkish white (5YR 8/2) lime masses; strongly effervescent; moderately alkaline.

Reaction is mildly alkaline or moderately alkaline and ranges from noneffervescent in the upper part to violently effervescent in the lower part. Coarse fragments average less than 15 percent by volume. The A horizon(s) have hue of 5YR through 10YR, value of 5 or 6 dry, and chroma of 2 through 4. The Bt horizons have hue of 2.5YR through 7.5YR, value of 4 or 5 dry, and chroma of 2 through 6. Texture is clay, clay loam or sandy clay loam with clay content averaging greater than 35 percent. The Bk horizon is mottled with pinkish white lime masses. Texture is loam or clay loam.

White House Series

The White House series consists of very deep, well drained, slowly permeable soils on fan terraces. These soils formed in mixed alluvium. Slope is 1 to 15 percent. Elevation ranges from 3,200 to 5,200 feet. The mean annual precipitation is about 12 to 16 inches, the mean annual air temperature is 59 to 66

degrees F, and the frost-free period is 180 to 230 days.

These soils are fine, mixed, thermic Ustollic Haplargids.

Typical pedon of White House gravelly loam in an area of Bernardino-White House complex, 1 to 15 percent slopes, about 1,980 feet south and 2,200 feet west of the northeast corner of sec. 36, T.19 S., R.16 E.

A—0 to 1 inch; reddish brown (5YR 4/4) gravelly loam, reddish brown (5YR 4/3) moist; weak thin platy structure parting to moderate fine granular; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many fine interstitial pores; 25 percent gravel; slightly acid; abrupt smooth boundary.

BA—1 to 3 inches; dark reddish gray (5YR 4/2) clay loam, dark reddish brown (5YR 3/2) moist; moderate medium subangular blocky structure; hard, friable, sticky and plastic; many fine roots; common fine tubular pores; 10 percent gravel; slightly acid; clear wavy boundary.

Bt1—3 to 8 inches; reddish brown (5YR 4/3) clay, dark reddish brown (5YR 3/2) moist; weak coarse prismatic structure; very hard, friable, very sticky and very plastic; common fine roots; many fine tubular pores expd; common faint clay films on faces of peds; 5 percent gravel; neutral; clear wavy boundary.

Bt2—8 to 18 inches; dark reddish brown (2.5YR 3/4) clay, dark reddish brown (2.5YR 2.5/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, friable, sticky and very plastic; common fine roots; common very fine tubular pores; common faint clay films on faces of peds; 5 percent gravel; moderately alkaline; clear wavy boundary.

Bt3—18 to 36 inches; red (2.5YR 5/6) clay, red (2.5YR 4/6) moist; weak coarse prismatic structure; very hard, friable, very sticky and very plastic; common very fine roots; few fine tubular pores; common faint clay films on faces of peds; few medium Fe-Mn stains on faces of peds; 5 percent gravel; moderately alkaline; clear wavy boundary.

C—36 to 60 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; massive; hard, friable, sticky and plastic; few very fine roots; common very fine tubular pores; 5 percent gravel; moderately alkaline.

Reaction ranges from moderately acid in the upper part to moderately alkaline in the lower part. The soil is noneffervescent in the upper 20 inches. Below 20

inches it ranges from noneffervescent to strongly effervescent as depth increases. The calcium carbonate equivalent is less than 15 percent to a depth of 40 more inches. Buried soils are present in some areas below a depth of 40 inches. The A and BA horizons have hue of 5YR through 7.5YR, value of 4 through 6 dry, and chroma of 2 through 4. The Bt horizons have hue of 2.5YR through 7.5YR, value of 4 or 5 dry, and chroma of 3 through 6. Texture is clay or clay loam with 5 to 35 percent by volume gravel and cobble. The C horizon has color similar to the Bt horizons. Texture ranges from sandy clay loam to clay loam with 5 to 50 percent by volume gravel and cobble.

Yaqui Series

The Yaqui series consists of very deep, well drained, moderate over moderately slowly permeable soils on alluvial fans. These soils formed in mixed alluvium. Slope is 1 to 3 percent. Elevation ranges from 2,200 to 3,600 feet. The mean annual precipitation is about 10 to 12 inches, the mean annual air temperature is about 64 to 70 degrees F, and the frost-free period is about 220 to 280 days.

These soils are fine-loamy, mixed, thermic Fluventic Camborthids.

Typical pedon of Yaqui fine sandy loam, 1 to 3 percent slopes, about 10 feet north and 2,600 feet east of the southwest corner of sec. 15, T.17 S., R.14 E.

A—0 to 4 inches; strong brown (7.5YR 5/6) fine sandy loam, strong brown (7.5YR 4/6) moist; weak moderately thick platy structure parting to weak fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; many fine vesicular pores; 5 percent gravel; slightly effervescent; moderately alkaline; gradual wavy boundary.

Bw1—4 to 18 inches; brown (7.5YR 5/4) sandy clay loam, brown to dark brown (7.5YR 4/4) moist; weak and medium prismatic structure parting to moderate fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; common very fine and fine and few medium roots; common very fine and fine tubular pores; common fine lime filaments on faces of peds; few thin lime coatings on the underside of gravel; 5 percent gravel; strongly effervescent; moderately alkaline; gradual smooth boundary.

Bw2—18 to 31 inches; brown to dark brown (7.5YR 4/4) sandy clay loam, dark brown (7.5YR 3/4)

moist; moderate medium prismatic structure parting to weak fine and medium subangular blocky; slightly hard, friable, sticky and plastic; common fine and very fine roots; many very fine and few fine tubular pores; patchy thin dark brown (7.5YR 3/4) organic coatings on faces of peds; common fine lime filaments on faces of peds; few thin lime coatings on gravel; 5 percent gravel; strongly effervescent; moderately alkaline; clear wavy boundary.

2Btb—31 to 43 inches; yellowish red (5YR 5/6) clay loam, yellowish red (5YR 4/6) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, very sticky and very plastic; common very fine and fine roots; common fine and few medium tubular pores; patchy faint clay films coating sand grains and lining pores; few thin lime coatings on gravel; strongly effervescent; moderately alkaline; clear wavy boundary.

2Bkb—43 to 60 inches; pink (7.5YR 7/4) gravelly loam, brown (7.5YR 5/4) moist; massive; slightly hard, very friable, sticky and slightly plastic;

common very fine roots; many medium soft lime masses; 25 percent gravel; violently effervescent; moderately alkaline.

The depth to the buried soil ranges from 20 to 40 inches. Organic matter content in the upper 15 inches averages less than 1 percent and decreases irregularly with depth. Reaction is mildly to strongly alkaline and ranges from slightly effervescent in the A and Bw horizons to violently effervescent in the buried soil. The 10- to 40-inch control section averages 18 to 27 percent clay and less than 15 percent coarse fragments. The A and Bw horizons have hue of 10YR or 7.5YR, value of 4 through 6 dry, and chroma of 3 through 6. Texture of the Bw horizon(s) is sandy clay loam, loam, fine sandy loam, or sandy loam. The Btb horizons have hue of 5YR or 7.5YR, value of 4 through 6 dry, and chroma of 3 through 6. Texture is commonly sandy clay loam or clay loam but includes loam and sandy loam. The Bkb horizon has hue of 10YR or 7.5YR, value of 6 or 7 dry, and chroma of 2 through 4. Texture is sandy loam, loam, gravelly loam, or gravelly sandy loam.

Formation of the Soils

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This section discusses the five factors that affect soil formation in the survey area.

Factors of Soil Formation

The modern concept of soil is "the collection of natural bodies on the earth's surface, in places modified or even made by man of earthy materials, containing living matter and supporting or capable of supporting plants out-of-doors. Its upper limit is air or shallow water. At its margins it grades to deep water or to barren areas of rock or ice. Its lower limit to the not-soil beneath is perhaps the most difficult to define. Soil includes the horizons near the surface that differ from the underlying rock material as a result of interactions, through time, of climate, living organisms, parent materials, and relief. In the few places where it contains thin cemented horizons that are impermeable to roots, soil is as deep as the deepest horizon. More commonly soil grades at its lower margin to hard rock or to earthy materials virtually devoid of roots, animals, or marks of other biologic activity. The lower limit of soil, therefore, is normally the lower limit of biologic activity, which generally coincides with the common rooting depth of native perennial plants" (USDA, 1975, 1984).

Climate

Climate, both past and present, has had a profound influence on soil formation. Climate influences the kind of living organisms present, the rate of organic decomposition and accumulation, and the rate of weathering of minerals in the soil and in bedrock. Climate also indirectly influences the amount of runoff and erosion which, through time, may keep pace with or surpass soil formation.

The deserts of the world are dominated by subtropical highs. These regions are characterized by

light winds, fair weather, and low rainfall. Convective summer storms, however, can be extremely violent. Dust is picked up in the air and appears to roll over the landscape. This is commonly followed by strong wind and driving rain. Flash floods usually accompany these storms, and loss of life may occur when warnings go unheeded. Winter storms are gentle by comparison. Rain is usually less intense and more widespread. Precipitation in the survey area is bimodal, that is, the total summer precipitation nearly equals the total winter precipitation.

Precipitation and temperature within the survey area tend to be orographic in character, that is, higher elevations tend to be cooler and more moist, and lower elevations tend to be relatively drier and hotter. For instance, it has been observed that within the survey area the mean annual air temperature decreases about 4 degrees F, and the average annual precipitation increases about 3.5 inches per 1,000 feet of increased elevation.

There are five major prevailing climatic zones in the survey area that influence soil formation: (1) areas that have a mean annual precipitation of about 8 to 10 inches, a mean annual air temperature of 70 to 72 degrees F, and sparse desert shrub vegetation; (2) areas that have a mean annual precipitation of about 10 to 13 inches, mean annual air temperature of 64 to 70 degrees F, and desert shrub vegetation; (3) areas that have a mean annual precipitation of about 12 to 16 inches, mean annual air temperature of 59 to 66 degrees F, and semi-desert grassland vegetation; (4) areas that have a mean annual precipitation of about 16 to 20 inches, mean annual air temperature of 55 to 57 degrees F, and Mexican oak-pinyon pine woodland or oak savannah vegetation; and (5) areas that have a mean annual precipitation of about 20 to 30 inches, mean annual temperature of 45 to 54 degrees F, and ponderosa pine, Douglas fir, and white fir forest vegetation. These areas are elevation-dependent, as described in the preceding paragraph, and are discussed in detail in the "Rangeland" and in the "Woodland" sections.

Past climate of the Pleistocene and early Holocene is said to have been much cooler and more moist

than present. In addition, the early Holocene tended to have a dominant winter precipitation bias. Evidence of pinyon pine (*Pinus monophylla*), turbinella oak (*Quercus turbinella*), and big sagebrush (*Artemisia tridentata*) were found in packrat middens in the Tucson Mountains (elev. 2,435 ft.) and Picacho Mountains (elev. 2,155 ft.). Radiocarbon dating on these midden samples indicates that this type of vegetation was probably typical in these now desert areas, from 21,000 to 11,100 years B.P. The end of these early Holocene woodlands, estimated to be about 8,000 years B.P., is thought to have been rapid and widespread (Van Dender and Spaulding, 1979).

The more developed soils, such as those with argillic, calcic, and petrocalcic horizons are thought to have begun forming in this earlier, more mesic climate. With lower temperatures and higher precipitation, evapotranspiration was lower, and available soil water was higher than in today's climate. Illuviation of silica, calcium carbonate, and silicate clays with the downward percolation of soil water formed some of the horizons mentioned above. In contrast, the mid to late Holocene climate of hot temperatures and low precipitation, in major climatic zones 1, 2, and to a lesser extent 3 mentioned in the above paragraph, has had less of an impact on soil development within the survey area. Lower precipitation and higher temperatures result in higher evaporative losses and less available soil water for movement of calcium carbonate and silicate clays. This, coupled with the relatively short period of time for soil development attributed to the modern climate, tended to inhibit illuviation of silicate clays, calcium carbonate, and other soluble materials. Soil development, if any, in materials deposited during the mid to late Holocene (less than 4,000 years B.P.) has been primarily restricted to the formation of cambic horizons.

Living Organisms

Living organisms affecting soil formation include the plants and animals that occupy the soil landscape. The types of organisms that live in and on the soil are, in turn, dependent on the climate, topography, parent material, and, to a lesser degree, the age of the soil.

Plants such as grass provide cover which helps stabilize the soil surface. When vegetation dies, organic material accumulates on the surface. Likewise, the roots of these plants accumulate in the soil. Fungi, bacteria, and even termites work to break down and decompose the dead vegetative matter.

The decomposed organic matter loosens the soil, increases base saturation and water holding capacity, and darkens the soil in the primary root zone. Consequently, soils that historically have good grass covers have the darker surfaces. For example, the Far soil is in an area of oak savannah and has a dark surface which is called a mollic epipedon. It is in the order Mollisols. Conversely, soils which support vegetation that produces primarily surface litter, such as shrubs or trees, generally have light-colored surfaces called ochric epipedons (USDA, 1975). The Sahaurita series is such a soil and is in the order Aridisols. At higher elevations in the survey area, decomposing pine needles on the forest floor help acidify the soil. The Lemmon soil, in the order Alfisols, is strongly acid in the surface layer immediately below the forest litter.

Some of the other living organisms that affect soil development include kangaroo rats, ground squirrels, and pocket gophers. These animals burrow and tunnel, bringing subsoil material to the surface. Humans also affect soil development through farming, mining, and building.

Parent Material

Alluvium is the major parent material for soil formation in the survey area. Bedrock and eolian material are less common but are direct sources for the alluvium and some of the secondary calcium carbonate enrichment of the soils, respectively.

Alluvium in the survey area is derived primarily from granite, gneiss, rhyolite, and andesite. Other important but less extensive sources for alluvium in the survey area include limestone, basalt, schist, conglomerate, and sandstone.

There are essentially three methods in which alluvium is carried and deposited: stream, fan, and slope.

Stream alluvium is carried by a defined stream, often in a channel. Fragments tend to be rounded, and deposited alluvium is often stratified.

Fan alluvium often begins as stream alluvium at the base of mountains. The water, moving rapidly as a mountain stream, picks up a great deal of sediment. The stream eventually reaches a local "base level," such as a valley floor or stream terrace, where streamflow spreads out and infiltrates. The alluvium is spread out over the surface in a fan shape, thus the name fan alluvium.

Slope alluvium is alluvium deposited by unconcentrated surface runoff. Soils on mountains and hills have usually developed in slope alluvium.

Alluvial texture is generally related either to the

proximity of the alluvium to a mountain front or the relative position of the alluvium in relation to a main stream channel. For example, Pinaleno soils, which commonly are near mountain fronts, form in coarse-textured alluvium. Tubac soils, which are on distal ends of fan terraces, form in fine-textured alluvium. Arizo soils, which are in or near stream channels, form in coarse-textured alluvium; and Riveroad soils, which are on flood plains away from the main channel, form in fine or silty alluvium.

Parent material influences the chemical as well as the physical nature of a soil. Soils that have high levels of disseminated calcium carbonate, such as Anthony soils, formed in alluvium that had initially high levels of calcium carbonate. Conversely, soils that have low levels of calcium carbonate, such as Hayhook soils, formed in alluvium derived from gneiss that has a low level of calcium carbonate.

In some cases, soils that formed in alluvium having a low calcium carbonate content, such as the Palos Verdes soil, may exhibit a prominent accumulation of authigenic calcium carbonate lower in the profile. Gile and Grossman studied atmospheric additions of calcium carbonate and concluded that precipitation and dust accumulations on the surface, or precipitation alone, could be a probable source for calcium carbonate (Gile and Grossman, 1979). Others feel that atmospheric additions of calcium carbonate are minimal, and accumulations are most likely groundwater-related from a previously wetter climate.

Time and Topography

In this section, time and topography factors and their effect on soil formation will be discussed for each major landform in the survey area.

Stream terraces and flood plains

These two landforms are discussed concurrently since the process of their formation and subsequent degradation are closely interdependent.

Seven major drainage systems are within the survey area. Six of these systems—Canada del Oro, Cienega Creek, Altar Wash, Sopori Wash, Pantano Wash, and Rillito Creek—flow directly or indirectly into the Santa Cruz River, which bisects the survey area. The San Pedro River is in a separate watershed in the northeastern part of the survey area and flows directly to the Gila River.

A common trait shared by all of these creeks, rivers, and washes is that flood waters flowing through these systems incised or trenched their once broad, undissected flood plains. Valley floors, once

covered with grasses and sedges and an occasional stand of cottonwood trees or willows, are now desiccated flood plains that suffer periodic losses caused by arroyo encroachment and rare, overbank flooding. Their flood plains have been reduced to a channel or gully with flat sandy bottoms and very steep or vertical walls of cohesive fine sediments (Cooke and Reeves, 1976).

The cause of this trenching has been a much debated topic in scientific literature pertaining to the desert southwest.

One cause commonly cited is the impact humans have had on the environment. Roads, irrigation ditches, infiltration galleries used to intercept the once shallow water table, and the introduction of too many cattle, which subsequently overgrazed the range and caused increase runoff, are but a few of man's cited indiscretions (Cooke and Reeves, 1976; Hastings and Turner, 1972).

Another cause cited is regional climatic change and its effect on vegetation. Leopold, Bull, and others argue that a change in hydraulic behavior that results in flood plain aggradation or degradation is a function of climatic change (Leopold and Bull, 1979; McFaddin, 1981).

Mid to late Tertiary volcanism and extensional tectonism formed the Tucson Mountains and the Tortolita and Santa Catalina mountains respectively and their basins (i.e. Tucson Valley and Canada del Oro Valley). A few scientists have suggested that regional tectonism of the Tertiary Period has continued well into the Quaternary, thus upsetting hydrologic patterns (McFaddin, 1981).

The real cause or "why" of the entrenchment of the rivers, creeks, and washes, whether it is a result of some or all of the above, will be debated for some time to come. Fortunately, the "when" of entrenchment on these drainage systems is known and has been well documented through eyewitness and newspaper accounts, and through photographs of the area prior to and after trenching (figs. 9 and 10).

Surveyors' notebooks prior to 1880 describe the Santa Cruz River as having a discontinuous channel. Places with channels had very low banks, and in some places there were no banks at all. Unchanneled, marshy cienegas were located at Tucson and San Xavier as well as in other places along the river. The irrigation of farmland was accomplished by diverting surface water from the then-perennial river through the use of brush dams and shallow ditches. In the late 1860's or early 1870's, infiltration galleries were used to capture shallow ground water as a supplement to the overdrawn surface supply for the expanding farm



Figure 9.—Headcut on the Santa Cruz River at Congress Street in 1889. Credit: Special Collections, University of Arizona Library.

community. Use of well water for irrigation did not become widespread until after 1915 (Hastings and Turner, 1972).

Figure 11 is a photograph of the Tucson Valley from Sentinel Peak taken in 1891. Figure 12 shows the modern channel for the Santa Cruz River as seen from the same location in 1985. By 1900, the headcut finally had moved south to the dam at Silver Lake and breached it. By 1915, almost all of the trenching along the San Pedro River and the Santa Cruz River and its tributaries was complete (Hastings and Turner, 1972) (figs. 11, 12).

Knowing “when” these former flood plains became terraces helps approximate “time zero” for soil development in the last major increment of alluvium. The above information indicates that “time zero” for the last increment of alluvium occurred as little as 70 to 100 years ago on a significant portion of flood plains in the survey area. “Time zero” on the modern channeled flood plain, however, begins anew with

each new addition of alluvium every time it floods (Jenny, 1941).

Aggradation (deposition) and degradation (trenching or cutting) occur concurrently. That is, for each part of a channel that is cut, there is usually a subsequent deposition elsewhere. During the course of landscape evolution one may take precedence over the other, for a period of time, in any given regional locality. Fossil pollen records, from vertical sections on flood plains throughout southeast Arizona and southwest New Mexico, indicate that four major episodes of aggradation and degradation have occurred in the Holocene on the major drainage systems in the southwest. The cutting and filling that occurred on valley floors as the glacial age was terminating helped define the channels in which the ancestral flood plains are located (Martin, 1970).

The first episode of aggradation (deposition) in Holocene time lasted about 3,000 years. It followed a long period of entrenchment which occurred during

the late Pleistocene. The alluvial beds associated with this aggradation contain the last record of the late Pleistocene megafauna (i.e., mammoths, horses, camels, etc.) inhabiting the area. The following episode of degradation (trenching) was extensive. This event was marked by the end of the early Holocene woodland mentioned in the "Climate" section above. It lasted from about 2,000 to 3,600 years (Martin, 1970).

The second episode of stream aggradation began about 4,600 to 4,000 years B.P. Samples of charcoal recovered from an alluvial layer in the bank of the Altar Wash, 14.5 feet below the surface, indicated a C-14 date of 3,750 (90 years B.P.). The charcoal was in the fourth recognizable tier of alluvium. This correlates very well with Gile and Hawley's "Organ I" alluvium. Much of this alluvium and the alluvium mentioned above is buried under younger stream or fan alluvium. Some of the modern soils which formed in this alluvium include the Bucklebar, Mohave,

Mohall, and Vecont soils on stream terrace land forms. These soils have layers that exhibit properties of an argillic horizon and are in the great group Haplargids (Gile et al., 1981; Martin, 1970). An episode of stream degradation which followed is thought to have lasted about 500 years.

The third episode of aggradation began about 2,200 years B.P. This event is contemporaneous with the first appearance of Hohokam pottery in flood plain artifacts. Corn pollen is also recorded in this layer, indicating the presence of flood plain agriculture. The episode of degradation which followed occurred around 1200 A.D. This episode was short, lasting less than 300 years. It is thought not to have been too widespread. However, the abandonment of the Pueblos and the disappearance of the Hohokam that occurred at about the same time may indicate that this episode of trenching may have severely disrupted flood plain agriculture practiced by these early people (Martin, 1970).



Figure 10.—Santa Cruz River with river banks stabilized with soil cement at Congress Street in 1985.



Figure 11.—Santa Cruz River flood plain in 1891. Credit: Special Collections, University of Arizona Library.

The last major episode of aggradation began 1,100 to 600 years B.P. In 1914, Huntington examined the tree rings on the trunk of a paloverde (*Cercidium floridum*). The trunk had been buried on a flood plain under a total of five feet of alluvium prior to entrenchment, then reexposed in a sidecut along the Santa Cruz River just north of Tucson. He determined that the tree had begun growing between the years of 1670 A.D. and 1680 A.D. (Bryan, 1922). Pollen analysis of samples collected from a buried alluvial

layer in the sidewall of Cienega Creek indicated that the upper 4 to 7 feet of the low stream terrace was deposited since 1200 A.D. (Martin, 1970). The most recent episode of degradation in this longstanding geologic process began about 110 to 150 years ago and continues to the present. Aggradation that occurs today is confined to narrow flood plains and to alluvial fans.

Most of the soils mapped in this survey area on flood plain landforms along the major drainage



Figure 12.—Entrenched flood plain of the Santa Cruz River in 1985.

systems were developed in sediments deposited during the last two episodes of aggradation. The scale and intensity of mapping precluded the separation of these two deposits within the survey area.

Glendale, Riverroad, and Comoro series are typical of soils mapped on flood plain landforms. Some of these soils seem to exhibit the beginnings of a structural horizon. The rapid formation of these structural horizons can be attributed to the nearly level slope, the aggregating nature of the parent

material, and the micro-climate of excessive moisture available when the water table was seasonally high and flooding on these surfaces was a frequent event. This combination of factors undoubtedly provided a good medium for eluviation of some of the more soluble salts, calcium carbonate, and the accumulation of organic matter. These soils usually have dark, very thick surface layers in addition to the structural B horizons. Dark surface layers or horizons usually indicate a high organic matter content. Decomposition of living organisms,

such as the annual and perennial grasses and sedges that grew on some of these soils, is responsible for darkening the surface layers. Other soils having surface layers or dark layers that occur well below the surface indicate that the soil inherited the organic matter from alluvium.

Arizo soils and Riverwash are on flood plains and occupy bar and channel physiography, respectively. Arizo soils which are very young have textures of sand and gravel and exhibit no soil development. They are in the great group Torriorthents. Riverwash does not support vegetation because of the frequent flooding and churning of the soil material. It is referenced in Soil Taxonomy as "not-soil" (USDA, 1975).

Alluvial fans

Alluvial fan landforms represent active forms of aggradation of fan alluvium. Typically, during and immediately after a rain, water in well-defined mountain streams moves downslope. At the base of the mountain, the water divides and crosses dissected pediments and/or dissected fan terraces. The water, loaded with sediment with or without debris, forms a cone as it emerges from these fan terrace channels radiating downslope. The broad fan-shaped sheet spreads out on and covers the valley floor or stream terraces. As adjacent fans merge or

coalesce, they form a coalescent fan piedmont (see Glossary).

The alluvial fans that are formed by deposition from sheet flooding are floored or underlain by a relict soil which Bryan terms "adobe flats" (Bryan, 1922). The Yaqui series is an example of a soil forming on this landform (fig. 13). The Yaqui soil series is in the subgroup Fluventic Camborthids. It is characterized as a two-stage soil: about 20 to 40 inches of late Holocene alluvium over a buried paleosol (relict soil), thought to have formed in the Pleistocene or early Holocene (Gile et al., 1981).

The late Holocene alluvium is stratified with alternating light and dark layers. "Time zero" for soil development has passed on the deeper layers of the young alluvium. The first stage of the soil exhibits a structural B horizon and some redistribution of calcium carbonate. This indicates the incipient formation of a cambic horizon. The buried paleosol is deep enough so as not to influence the classification of the soil, but close enough to the surface to be considered part of the series criteria. The buried paleosol had properties similar to the Mohave series, in the great group Haplargids.

Fan terraces

Fan terrace landforms are coalescent fan piedmonts (i.e. alluvial fans) which have been incised

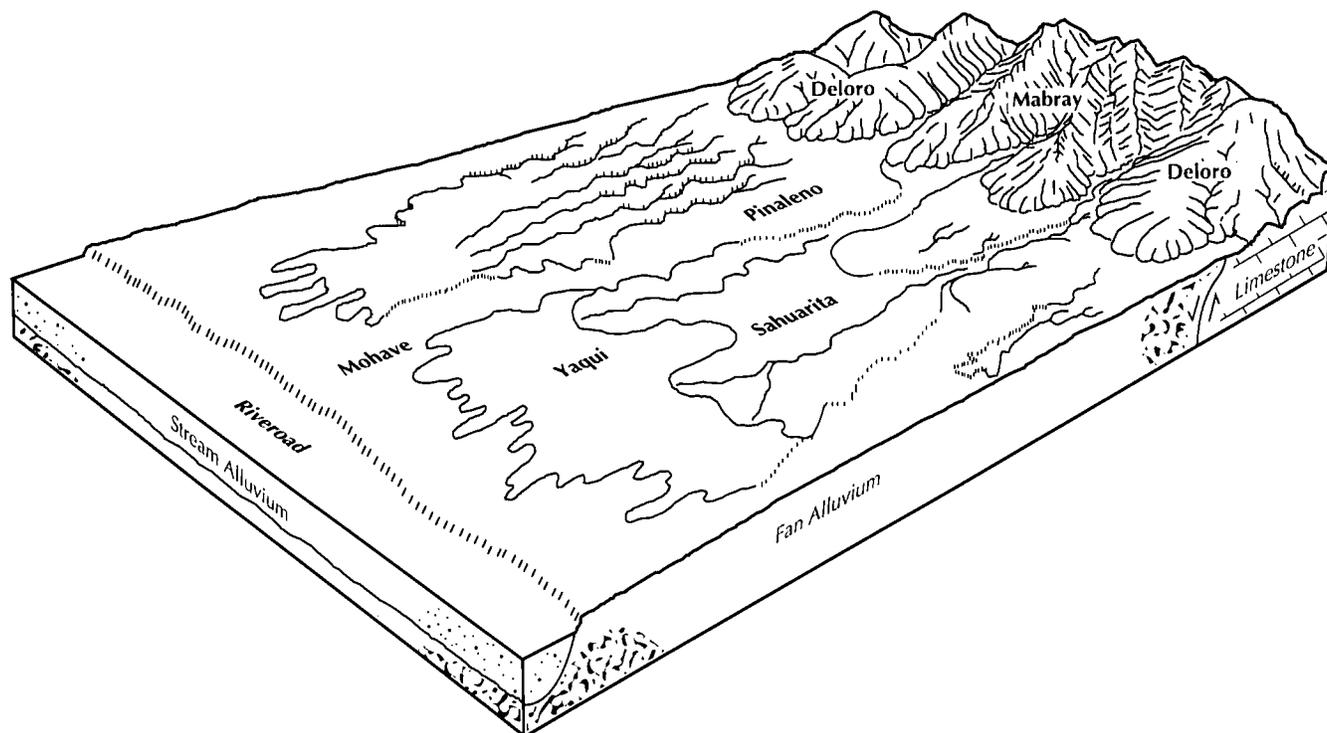


Figure 13.—Typical soil and landscape relationship on the northwest side of the Santa Rita Mountains.

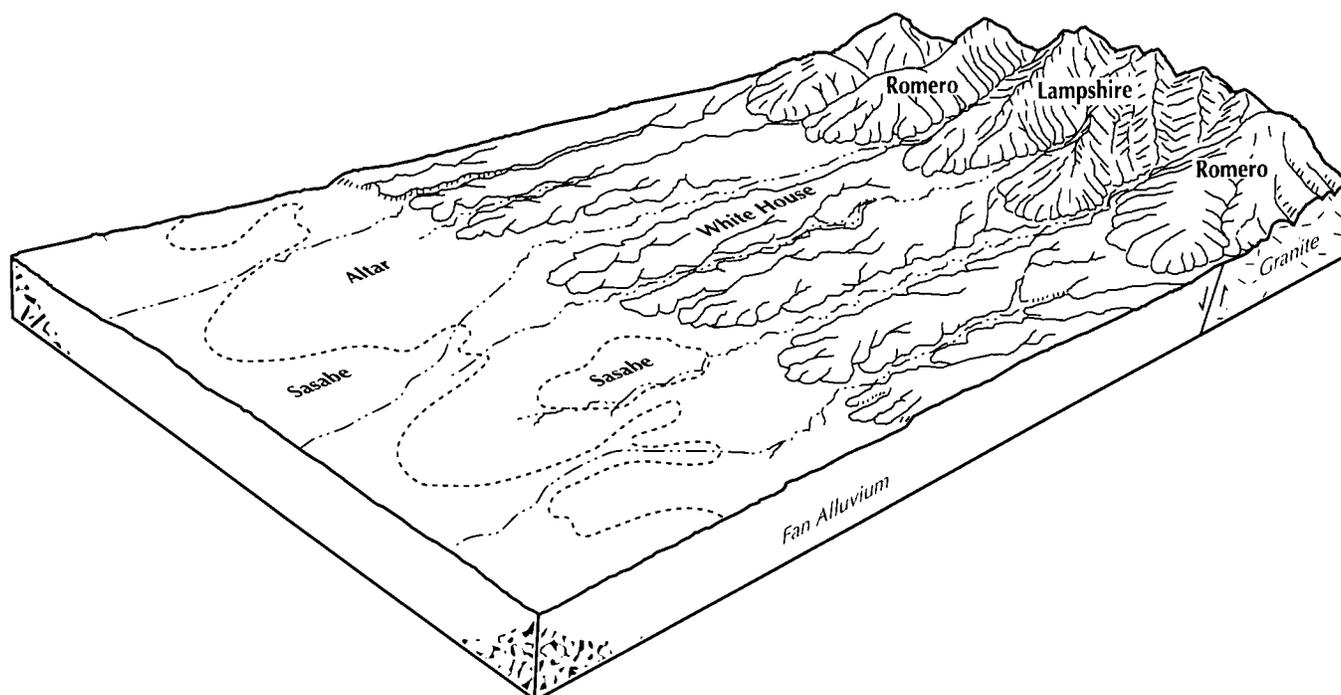


Figure 14.—Typical soil and landscape relationship on the east side of the Baboquivari Mountains.

by drainages. They account for almost one-half of the land area in the survey. Slope gradients are usually less than 15 to 20 percent.

Fan terrace landforms encompass a steplike sequence of geomorphic surfaces that range in age from the mid Pleistocene (about 1,000,000 years or more B.P.) to the late Holocene (about 1,200 years B.P.) and possibly younger. As a rule of thumb, the degree of soil development (i.e. pedotranslocation of silicate clays, silica, and/or calcium carbonate) increases with increasing age and elevation of the steps (Gile and Grossman, 1979). Exceptions to the last part of this statement occur when exhumed paleosols are juxtaposed with young soils geographically (Ruhe and Daniels, 1958). The following discussion characterizes soil formation on fan terrace landforms by time periods: 25,000 through 1,000,000 years B.P.; 4,000 to 25,000 years B.P.; and less than 4,000 years B.P.

Soils that began formation on this landform in the mid to late Pleistocene (greater than 25,000 through 1,000,000 years B.P.), are characterized by a horizon that is plugged and strongly cemented or indurated with silica and/or calcium carbonate (commonly called caliche or hardpan). These relict soils are on terraces that have been stable since the Pleistocene Epoch or longer. The oldest of these soils on this surface have indurated horizons that are capped with a laminar layer which has a troweled appearance.

These horizons formed through pedotranslocation of silica and calcium carbonate in solution by gravitational soil waters. When the depth of wetting in a soil is reached in arid climates, the water is drawn back towards the surface through evaporative processes, thus precipitating silica and/or calcium carbonate out of solution. Accumulations of these precipitates eventually reach the point of inhibiting further downward movement of soil water. The layer then seals over and a laminar cap forms as water is forced to move horizontally over the plugged horizon while depositing its precipitates (Gile et al., 1981).

These soils commonly exhibit a reddish brown or red horizon of silicate clay accumulations above the strongly-cemented horizons, as is the case in the Nahda soil. Absence of these reddish "argillic" horizons, as in the Delnorte soil, can often be attributed to truncation by an erosional episode. In other cases, such as with the Cave soil, the former clay rich horizon above the hardpan is thought to have been engulfed by additional accumulations of calcium carbonate (Gile et al., 1981). This is evidenced by the thin reddish Btk or Bk horizon that is still present above the hardpan in some of the Cave soils.

The primary cementing agent for the hardpan (caliche) in the Cave soil is calcium carbonate. The main source of this carbonate is the alluvium in which the soil developed. The alluvial source can be

easily traced back to the limestone hills located along the upper Pantano Wash watershed.

Soils that began formation on this landform in the late Pleistocene to mid Holocene (about 25,000-4,000 years B.P.) are characterized by the presence of a calcic horizon and/or argillic horizon (Gile et al., 1981). The soils formed in much the same manner as older soils. The primary difference is that the accumulated silica and/or calcium carbonate horizons have not as yet plugged and cemented over. These soils are located on stable surfaces or on metastable surfaces where the rate of soil development has exceeded the rate of soil loss through erosion.

Some of the soils that are on these intermediate fan terrace landforms include Bucklebar, Caralampi, Tombstone, Mohave, Stagecoach, Pinaleno, and White House. These soils and the other soils on these geomorphic surfaces are in the great group Haplargids or Calciorthids.

Soils that began formation on this landform in the mid to late Holocene (less than 4,000 years B.P.) are

characterized by minimal evidence of pedogenic soil development. Some redistribution of calcium carbonate and the aggregation of soil particles into structural peds indicate the presence of a cambic horizon in some of these soils. The Altar soil has such a cambic horizon and is in the subgroup Ustochreptic Camborthids (fig. 14). Some of the soils on this surface exhibit little or no soil development. The Comoro soil is an example of such a soil. Gile, Hawley, Grossman, and others indicate that the incipient formation of an argillic horizon can occur in soils that began to develop 1,100 years B.P. They noted that high-gravel soil could exhibit argillic horizon properties in as little as 2,200 years (Gile et al., 1981; Reckendorf and Parsons, 1966). It is believed that, within the survey area, soils this young that exhibit these properties are rare.

Soils that are on these low fan terrace landforms include the Altar, Denure, Hayhook, Momoli, and Sahuarita soils. These, and the other soils on these geomorphic surfaces, are in the great group Camborthids or Torriorthents.

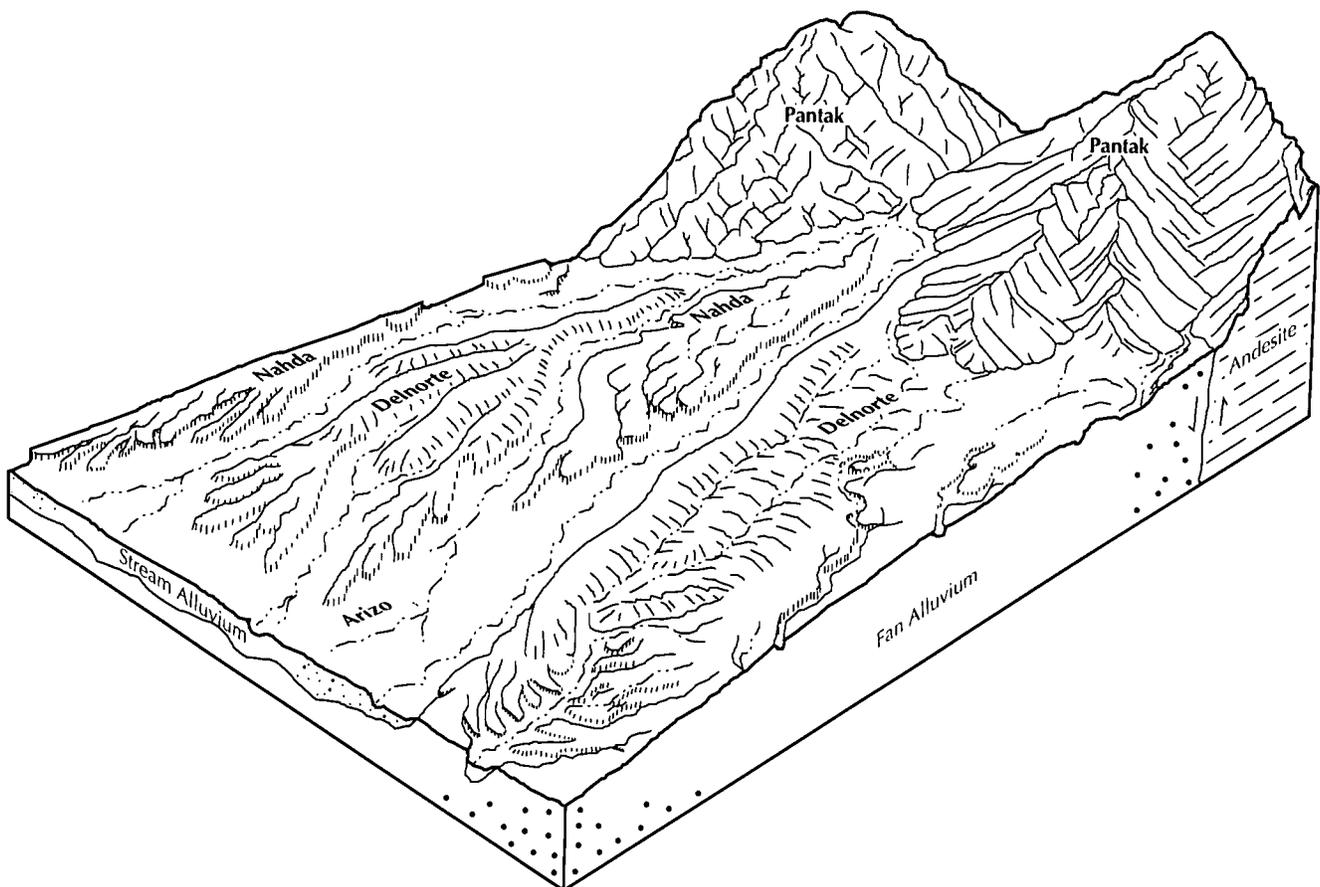


Figure 15.—Typical soil and landscape relationship in the San Pedro River Valley.



Figure 16.—Redington very gravelly fine sand on actively eroding backslopes of a truncated “ballena.” Arizo-Riverwash complex, 0 to 3 percent slopes, is in the foreground.

Hills and mountains

Hill and mountain landforms have steep slope gradients. Many of the slopes are metastable and have been so since the Pleistocene Epoch. They may, however, become active slopes if the environmental balance is disturbed. This disturbance includes climatic changes, forest and range fires, road construction, and overgrazing by cattle.

As one can readily imagine, the age of the soil and the degree of soil development is highly dependent on relief, living organisms (including humans), and climate. Soils on these landforms can change rapidly if any of the above factors are altered significantly.

Metastable slopes have slope gradients that can range to 45 percent. Soils on these slopes can range in age from the mid Pleistocene (about 1,000,000 years B.P.) to present. The alluvium in which these soils form is slope alluvium, and the soils are commonly shallow or moderately deep to bedrock or other restricting layer such as a duripan or petrocalcic horizon.

The soils that are on metastable hill and mountain

landforms can be viewed from an age and soil development standpoint much the same way as are soils on fan terrace landforms. The oldest soils on these landforms began to form on hills which stabilized more than 75,000 years ago. They formed on fan remnants in Plio-Pleistocene alluvium which, in turn, is underlain by a core of Tertiary fanglomerate (Keith and Wilt, 1978). These fan remnants had been modified by erosion throughout the early and mid Pleistocene. The erosion formed distinctive round-topped ridgeline fan remnant called “ballenas.” These “ballenas” (Spanish for whale) are characterized by the fact that they commonly have the same soil, or very similar soil, on their crest, over their shoulders, down across their backslopes and footslopes, and sometimes even through a concave flume and up onto an adjacent ballena (Peterson, 1981). In this survey area, these soils are shallow to either an indurated duripan or petrocalcic horizon and are in the great group Durorthids or Paleorthids. Typical soils mapped on this surface include the Delnorte soil and Kimrose family soil (fig. 15). Closer to the valley-border, the ballenas are apt to be truncated or modified by

Holocene erosion. The truncated relict soil, Delnorte soil, may persist along the crest and younger soils with minimal diagnostic characteristics are on the active sideslopes (Peterson, 1981). The Redington soil, which is in the great group Torriorthents, is an example of such a soil (fig. 16).

Soils that began development on hills and mountains and which stabilized by the late Pleistocene to early Holocene (about 75,000-8,000 years B.P.) are characterized by the presence of an argillic or calcic horizon (Gile et al., 1981). Examples of the soils on these surfaces are the Andrada, Anklam, Pantak, Lemmon, and Pantano soils. These soils, and the other soils of this age on hills and mountains, are Haplargids, Haplustalfs, and Calciorthids.

Soils that began development on mountains and hills which stabilized by the mid to late Holocene (about 8,000 to 1,100 years B.P.) are characterized by the presence of a cambic horizon (Gile et al., 1981). Examples of soils on these surfaces are

Spudrock soils, which are in the great group Ustochrepts. Other soils observed on these surfaces, but not considered extensive enough to map, include soils in the great group Camborthids and Haplustolls.

Soils on mountains and hills which stabilized less than 1,100 years ago or soils that are on active slopes (gradient usually over 45 percent) have undergone only minimal pedogenesis. Soils with a good grass cover may have developed a darkened surface layer called a mollic epipedon. Other soils may have just kept pace with erosion and do not exhibit any soil development. Borianana, Cellar, Cortaro, and Lampshire soils are examples of soils on these surfaces. They are in the great group Haplustolls, Torriorthents, and Ustorthents.

The five factors of soil formation—time, climate, living organisms, parent materials, and relief—are closely interrelated. Few generalizations can be made regarding the effect of any one factor on soil formation unless conditions are specified for the other four factors.

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Glossary

Active slope. A hill or mountain slope that is responding to valley incision, with erosion (either geologic or accelerated) exceeding regolith weathering, and that has detritus accumulated behind obstructions indicating contemporary transport of slope alluvium. Slope gradients usually exceed 45 percent. (cf. metastable slope)

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvial cone. The material washed down the sides of mountains and hills by ephemeral streams and deposited at the mouth of gorges in the form of a moderately steep, conical mass descending equally in all directions from the point of issue.

Alluvial fan. The fanlike deposit of stream where it issues from a gorge upon a plain or of a tributary stream near or at its junction with its main stream.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Animal-unit-month (AUM). The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without calf, for 1 month.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Arroyo. The flat-floored channel of an ephemeral stream, commonly with very steep to vertical banks cut in alluvium.

Association, soil. A group of soils geographically

associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Back slope. The geomorphic component that forms the steepest inclined surface and principal element of many hillsides. Back slopes in profile are commonly steep, are linear, and may or may not include cliff segments.

Badland. Steep or very steep, commonly nonstony, barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.

Bajada. A broad alluvial slope extending from the base of a mountain range out into a basin and formed by coalescence of separate alluvial fans.

Basal area. The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

Base level. The theoretical limit or lowest level toward which erosion of the earth's surface constantly progresses but seldom, if ever, reaches; especially the level below which a stream cannot erode its bed. The ultimate base level for the land surface is sea level, but temporary base levels may exist locally.

- Base saturation.** The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.
- Basin (intermontane).** A broad structural lowland, commonly elongated and many miles across, between mountain ranges.
- Basin floor.** A general term for the nearly level to gently sloping, bottom surface of an intermontane basin.
- Bedding planes.** Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.
- Bedrock.** The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.
- Bench terrace.** A raised, level or nearly level strip of earth constructed on or nearly on the contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.
- Bisequum.** Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.
- Bottom land.** The normal flood plain of a stream, subject to flooding.
- Boulders.** Rock fragments larger than 2 feet (60 centimeters) in diameter.
- Breaks.** The steep to very steep broken land at the border of an upland summit that is dissected by ravines.
- Breast height.** An average height of 4 1/2 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.
- Brush management.** Use of mechanical, chemical, or biological methods to reduce or eliminate competition of woody vegetation to allow understory grasses and forbs to recover, or to make conditions favorable for reseeding. It increases production of forage, which reduces erosion. Brush management may improve the habitat for some species of wildlife.
- Buried.** Pertaining to paleosols, landforms, and geomorphic surfaces covered by a mantle of geologic material (e.g., sedimentary or volcanic).
- Butte.** An isolated small mountain or hill with steep or precipitous sides and a top variously flat, rounded, or pointed that may be a residual mass isolated by erosion or an exposed volcanic neck.
- Calcareous soil.** A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.
- Caliche.** A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.
- Canopy.** The leafy crown of trees or shrubs. (See Crown.)
- Canyon.** A long, deep, narrow, very steep sided valley with high, precipitous walls in an area of high local relief.
- Capillary water.** Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.
- Cation.** An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.
- Cation-exchange capacity.** The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.
- Cattle, cows and calves.** Breeding age (2-10 years old) females with offspring.
- Cattle, stocker-type.** Young (1-2 years old) steers or heifers.
- Channery soil.** A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.
- Chemical treatment.** Control of unwanted vegetation by use of chemicals.
- Chiseling.** Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.
- Clay.** As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.
- Clay film.** A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.
- Climax vegetation.** The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.
- Coalescent fan piedmont.** A broad, gently-inclined, piedmont slope formed by lateral coalescence of a series of alluvial fans, and having a broadly

undulating transverse profile (parallel to the mountain front) due to the convexities of component fans.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conglomerate. A coarse grained, clastic rock composed of rounded to subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer material. Conglomerate is the consolidated equivalent of gravel.

Conservation cropping system. Growing crops in combination with needed cultural and management practices. If soil improving crops and practices used in the system more than offset the soil depleting crops and deteriorating practices, then it is a good conservation cropping system. Cropping systems are needed on all tilled soils. Soil improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

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 gently pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coppice dune. A small dune of fine-grained soil material stabilized around shrubs or small trees.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Crop residue management. Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cropping system. Growing crops using a planned system of rotation and management practices.

Cross-slope farming. Deliberately conducting farming operations on sloping farmland in such a way that tillage is across the general slope.

Crown. The upper part of a tree or shrub, including the living branches and their foliage.

Cuesta. An asymmetric, homoclinal ridge capped by resistant rock layers of slight to moderate dip.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Delta. A body of alluvium whose surface is nearly flat and fan shaped, deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Desert pavement. A layer of gravel or coarser fragments on a desert soil surface that was emplaced by upward movement of fragments from underlying sediment or remains after finer particles have been removed by running water or wind.

Dip slope. A slope of the land surface, roughly determined by and approximately conforming with the dip of underlying bedded rock.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants

throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Draw. A small stream valley, generally more open and with broader bottom land than a ravine or gulch.

Duff. A term used to identify a generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

- Eluviation.** The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.
- Eolian soil material.** Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.
- Ephemeral stream.** A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.
- Erosion.** The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
- Erosion pavement.** A layer of gravel or stones that remains on the surface after fine particles are removed by sheet or rill erosion.
- Escarpment.** A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and produced by erosion or faulting.
- Excess alkali (in tables).** Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.
- Excess fines (in tables).** Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.
- Excess lime (in tables).** Excess carbonates in the soil that restrict the growth of some plants.
- Excess salts (in tables).** Excess water-soluble salts in the soil that restrict the growth of most plants.
- Exhumed.** Formerly buried landforms, geomorphic surfaces or paleosols that have been reexposed at the ground surface by erosion of the covering mantle. (cf. relict)
- Extrusive rock.** Igneous rock derived from deep-seated molten matter (magma) emplaced on the earth's surface.
- Fallow.** Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.
- Fan terrace.** A relict alluvial fan, no longer a site of active deposition, incised by younger and lower alluvial surfaces.
- Fast intake (in tables).** The rapid movement of water into the soil.
- Fertility, soil.** The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.
- Field moisture capacity.** The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called normal field capacity, normal moisture capacity, or capillary capacity.
- Fill slope.** A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.
- Fine textured soil.** Sandy clay, silty clay, and clay.
- Firebreak.** Area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of people and equipment in fire fighting. Designated roads also serve as firebreaks.
- Flaggy soil material.** Material that is, by volume, 15 to 35 percent flagstones. Very flaggy soil material is 35 to 60 percent flagstones, and extremely flaggy soil material is more than 60 percent flagstones.
- Flagstone.** A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.
- Flood plain.** A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.
- Fluvial.** Of or pertaining to rivers; produced by river action, as a fluvial plain.
- Foothill.** A steeply sloping upland that has relief of as much as 1,000 feet (or 300 meters) and fringes a mountain range or high-plateau escarpment.
- Foot slope.** The inclined surface at the base of a hill.
- Forb.** Any herbaceous plant not a grass or a sedge.
- Forest cover.** All trees and other woody plants (underbrush) covering the ground in a forest.
- Forest type.** A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.
- Fragile (in tables).** A soil that is easily damaged by use or disturbance.
- Genesis, soil.** The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.
- Geomorphology.** The science that treats the general configuration of the earth's surface; specifically

the study of the classification, description, nature, origin, and development of landforms and their relationships to underlying structures, and of the history of geologic changes as recorded by these surface features.

Geomorphic surface. A geomorphic surface represents an episode of landscape development and consists of one or more landforms (Balster and Parsons). A mappable part of the land surface that is defined in terms of morphology (relief, slope, aspect, etc.), origin (erosional, constructional, etc.), age (absolute, relative), and stability of component landforms. (cf. buried, exhumed, relict)

Gilgai. Commonly a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of Vertisols—clayey soils having a high coefficient of expansion and contraction with changes in moisture content.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard rock. Rock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Head out. To form a flower head.

High-residue crops. Crops such as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established.

These crops return large amounts of organic matter to the soil.

Hill. A natural elevation of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well-defined outline; hillsides generally have slopes of more than 15 percent. The distinction between a hill and a mountain is arbitrary and is dependent on local usage.

Hillslope. The steeper part of a hill between its summit and the drainage line, valley flat or depression floor at the base of the hill.

Holocene. The second epoch of the Quaternary Period of geologic time, extending from the end of the Pleistocene Epoch (about 10 thousand years ago) to the present; also the corresponding (time-stratigraphic) "series" of earth materials. (Synonym: post-glacial, Recent)

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Igneous rock. Rock formed by solidification from a molten or partially molten state. Major varieties include plutonic and volcanic rock. Examples are andesite, basalt, and granite.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasesers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasesers commonly are the shorter plants and the less palatable to livestock.

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.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Intermittent stream. A stream, or reach of a stream, that flows for prolonged periods only when it receives ground water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—*Border*.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Knoll. A small, low, rounded hill rising above adjacent landforms.

Landform. Any physical, recognizable form or feature of the earth's surface, having a characteristic shape, and produced by natural causes.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement,

as well as the amount of soil and rock material, vary greatly.

- Large stones (in tables).** Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.
- Leaching.** The removal of soluble material from soil or other material by percolating water.
- Liquid limit.** The moisture content at which the soil passes from a plastic to a liquid state.
- Loam.** Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.
- Low-residue crops.** Crops such as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.
- Low strength.** The soil is not strong enough to support loads.
- Marl.** An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal amounts.
- Mechanical treatment.** Use of mechanical equipment for seeding, brush management, and other management practices.
- Medium textured soil.** Very fine sandy loam, loam, silt loam, or silt.
- Mesa.** A broad, nearly flat topped and commonly isolated upland mass characterized by summit widths that are more than the heights of bounding erosional scarps.
- Metamorphic rock.** Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.
- Metastable slope.** A slope that is relatively stable at the present time, but may become active if the environmental balance is disturbed, for instance, by road construction or destruction of vegetation. A metastable slope is often related to base levels of former geomorphic episodes. The regolith is generally moderately deep, may contain stone lines, or relict evidence of slope alluvium. Slope gradients usually range from 15 to 45 percent. (cf. active slope)
- Mineral soil.** Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.
- Minimum tillage.** Only the tillage essential to crop production and prevention of soil damage.
- Miscellaneous area.** An area that has little or no natural soil and supports little or no vegetation.

Examples are rock outcrop, riverwash, and urban land.

- Moderately coarse textured soil.** Coarse sandy loam, sandy loam, and fine sandy loam.
- Moderately fine textured soil.** Clay loam, sandy clay loam, and silty clay loam.
- Morphology, soil.** The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.
- Mountain.** A natural elevation of the land surface, rising more than 1,000 feet above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides and considerable bare-rock surface. A mountain can occur as a single, isolated mass or in a group forming a chain or range.
- Mudstone.** Sedimentary rock formed by induration of silt and clay in approximately equal amounts.
- Munsell notation.** A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.
- Neutral soil.** A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)
- Nutrient, plant.** Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.
- Observed rooting depth.** Depth to which roots have been observed to penetrate.
- Open space.** A relatively undeveloped green or wooded area provided mainly within an urban area to minimize feelings of congested living.
- Organic matter.** Plant and animal residue in the soil in various stages of decomposition.
- Paleosol.** A soil with distinctive morphological features (color, structure, etc. that may be consistently described) that formed on a landscape of the past resulting from a soil-forming environment that no longer exists at the site.
- Pan.** A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, hardpan, fragipan, claypan, plowpan, and traffic pan.
- Parent material.** The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pediment. A gently sloping erosional surface developed at the foot of a receding hill or mountain slope.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piedmont slope. The dominant gentle slope at the foot of a mountain. (cf. bolson)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plateau. An extensive upland mass with relatively flat summit area that is considerably elevated (more than 100 meters) above adjacent lowlands and separated from them on one or more sides by escarpments.

Playa. The generally dry and nearly level lake plain that occupies the lowest parts of closed depressional area, such as those on

intermontane basin floors. Temporary flooding occurs primarily in response to precipitation and runoff.

Pleistocene. The first epoch of the Quaternary Period of geologic time, (approx. from 2 million to 10 thousand years ago); following the Tertiary Pliocene Epoch and preceding the Holocene; also the corresponding (time-stratigraphic) "series" of earth materials.

Pliocene. The last epoch of the Tertiary Period of geologic time, (approx. 7 to 2 million years ago) following the Miocene Epoch and preceding the (Quaternary) Pleistocene Epoch; also the corresponding (time-stratigraphic) "series" of earth materials.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Potential plant community. The plant community on a given site that will be established if present environmental conditions continue to prevail and the site is properly managed.

Potential rooting depth (effective rooting depth). Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Prescribed burning. The application of fire to land under such conditions of weather, soil moisture, and time of day as presumably will result in the intensity of heat and spread required to accomplish specific forest management, wildlife, grazing, or fire hazard reduction purposes.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use. Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. This increases the vigor and reproduction of the key plants and promotes the accumulation of litter and mulch necessary to conserve soil and water.

Quaternary. The second period of the Cenozoic Era

of geologic time, extending from the end of Tertiary Period (about 2 million years ago) to the present and comprising two epochs, the Pleistocene (Ice Age) and the Holocene (Recent); also the corresponding (time-stratigraphic) "system" of earth materials.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, deserts, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are—

Ultra acid	0.0 to 3.4
Extremely acid	3.5 to 4.4
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Red beds. Sedimentary strata mainly red in color and composed largely of sandstone and shale.

Relief. The elevations or inequalities of a land surface, considered collectively.

Relict. Pertaining to surface landscape features (e.g., landforms, geomorphic surfaces, paleosols) that have never been buried and are products of past

environments no longer operative in a given area. (cf. exhumed)

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Road cut. A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, gravel, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saddle. A low point on a ridge or crestline, generally a divide between the heads of streams flowing in opposite directions.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Saprolite (soil science). Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Scarification. The act of abrading, scratching; loosening, crushing, or modifying the surface to increase water absorption or to provide a more tillable soil.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate,

formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Sheetflood (sheetwash). A broad expanse of moving, storm-borne water that spreads as a thin, continuous, relatively uniform film over a large area in an arid region and that is not concentrated into well defined channels, its duration is brief and distance of flow is short.

Shoulder (hillslope). The geomorphic component that forms the uppermost inclined surface at the top of a hillslope. It comprises the transition zone from backslope to summit of an upland. The surface is dominantly convex in profile and erosional in origin.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and

codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey the following slope classes are recognized:

Nearly level	0 to 3 percent
Gently sloping or undulating	3 to 7 percent
Strongly sloping or rolling	7 to 15 percent
Moderately steep or hilly	15 to 25 percent
Steep	25 to 55 percent
Very steep	55 percent and higher

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slope alluvium. Sediment gradually transported on mountain or hill slopes primarily by alluvial processes and characterized by particle sorting. In a profile sequence, sediments may be distinguished by differences in size and/or specific gravity of coarse fragments and may be separated by stone lines. Sorting of rounded or subrounded pebbles or cobbles, and burned peds contrast with unsorted colluvial deposits.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Sodic (alkali) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na to Ca + Mg. The degrees of sodicity and their respective ratios are—

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Soft. Rock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stratified. Arranged in strata, or layers. The term refers to geologic material.

Stream terrace. One of a series of platforms in a stream valley, flanking and more or less parallel

to the stream channel, originally formed near the level of the stream, and representing the dissected remnants of an abandoned flood plain, stream bed, or valley floor produced during a former stage of erosion or deposition.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are— platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Tail water. The water just downstream of a structure.

Talus. Rock fragments of any size or shape, commonly coarse and angular, derived from and lying at the base of a cliff or very steep, rock slope. The accumulated mass of such loose, broken rock formed chiefly by falling, rolling, or sliding.

Tank. A natural depression in an impervious stratum in which water collects.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace (geomorphic). A step-like surface, bordering a valley floor or shoreline, that represents the former position of an alluvial plain, fan, or lake or sea shore.

Tertiary. The first period of the Cenozoic Era of geologic time, following the Mesozoic Era preceding the Quaternary (approx. from 65 to 2 million years ago); also the corresponding time-stratigraphic subdivision (system) of earth materials. Epoch/series subdivisions comprise, in order of increasing age, Pliocene, Miocene, Oligocene, Eocene, and Paleocene.

- 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."
- Thin layer (in tables).** Otherwise suitable soil material too thin for the specified use.
- Tilth, soil.** The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.
- Toe slope.** The outermost inclined surface at the base of a hill; part of a foot slope.
- Too arid (in tables).** The soil is dry most of the time, and vegetation is difficult to establish.
- Topsoil.** The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.
- Toxicity (in tables).** Excessive amount of toxic substances, such as sodium or sulfur, that severely hinder establishment of vegetation or severely restrict plant growth.
- Tuff.** A compacted deposit that is 50 percent or more volcanic ash and dust.
- Unstable fill (in tables).** Risk of caving or sloughing on banks of fill material.
- Upland (geology).** Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.
- Valley fill.** The unconsolidated sediment deposited by any agent (water, wind, ice, mass wasting) so as to fill or partly fill a valley.
- Valley floor.** A general term for the nearly level to gently sloping, bottom surface of a valley. Component landforms include axial stream channels, the flood plain, and in some areas, low terrace surfaces that may be subject to flooding from tributary streams.
- Valley side (valley wall).** The sloping to very steep surfaces between the valley floor and summits of adjacent uplands.
- Valley side alluvium.** A concave "slopewash" deposit at the base of a hillslope, mountain slope, terrace escarpment, etc. that may not include the alluvial toeslope of a pediment.
- Variation.** Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.
- Volcanic.** Pertaining to (1) the deep-seated (igneous) processes by which magma and associated gases rise through the crust and are extended onto the earth's surface and into the atmosphere, and (2) the structures, rocks, and landforms produced. (cf. extrusive)
- Water bars.** Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of the water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.
- Weathering.** All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.
- Well graded.** Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.
- Wilting point (or permanent wilting point).** The moisture content of soil, on an oven-dry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.
- Windthrow.** The action of uprooting and tipping over trees by the wind.
- Water bars.** Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.