SOIL SURVEY

Eastern Maricopa and Northern Pinal Counties Area, Arizona

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
ARIZONA AGRICULTURAL EXPERIMENT STATION
Issued November 1974

Major fieldwork for this soil survey was done in the period 1957–68. Soil names and descriptions were approved in 1969. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1957–68. This survey was made cooperatively by the Soil Conservation Service and the Arizona Agricultural Experiment Station. It is part of the technical assistance furnished to the East Maricopa and the Florence-Coolidge Natural Resources Conservation Districts.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or can be purchased, on individual order, from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of the Eastern Maricopa and Northern Pinal Counties Area contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, recreation areas, buildings, or other structures; and in judging the suitability of tracts of land for farming, industry, or recreation.

Locating Soils

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

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

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all of the soils of the survey area in alphabetic order by map symbol. It also shows the page where each kind of soil is described and also the page for the capability unit in which the soil has been placed.

Individual colored maps showing the relative suitability or limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the section "Management for Crops and Pasture."

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

Games managers, sportsmen, and others can find information about soils and wildlife in the section "Use of the Soils for Wildlife."

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

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

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EASTERN MARICOPA AND NORTHERN PINAL COUNTIES AREA, ARIZONA

BY E. D. ADAMS, SOIL CONSERVATION SERVICE

FIELDWORK BY E. D. ADAMS AND EARL CHAMBERLIN, SOIL CONSERVATION SERVICE[1]

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE ARIZONA AGRICULTURAL EXPERIMENT STATION

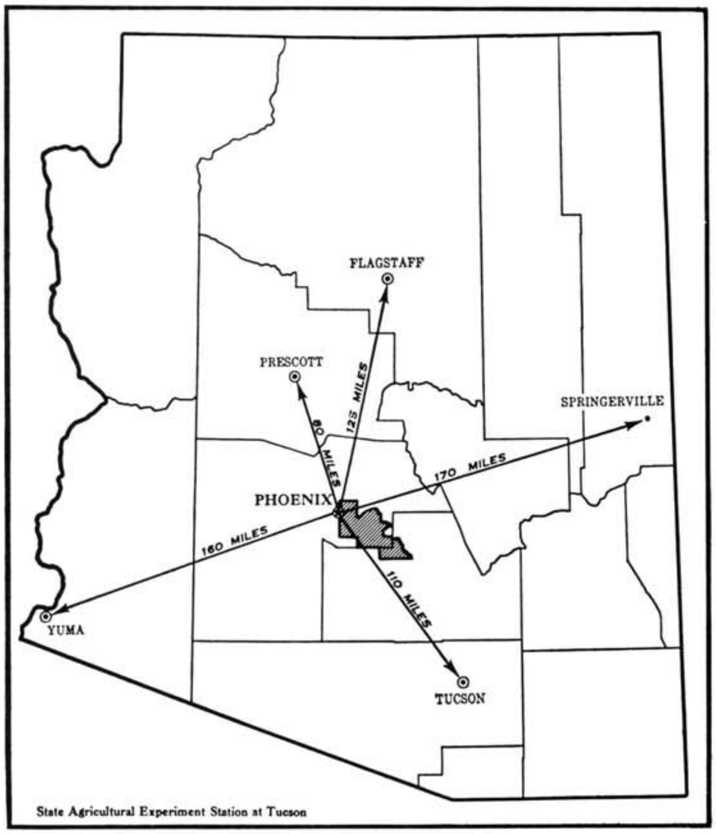

Figure 1.—Location of the Eastern Maricopa and Northern Pinal Counties Area in Arizona.

THE EASTERN MARICOPA AND NORTHERN PINAL COUNTIES AREA is located in the southeastern part of Maricopa County and in the north-central part of Pinal County (fig. 1). It has a land area of 347,925 acres of which 283,925 acres is in Maricopa County and 64,000 acres is in Pinal County. Within the survey area are soils on flood plains, soils on alluvial fans and terraces along the Salt River and the Queen Creek Wash, and soils on mountains and on alluvial fans that extend outward from these mountains.

The Salt River flows through the northern part of the survey area and through the city of Tempe. The Queen Creek Wash originally traversed the southern part of the survey area, but was later diverted to the south, onto the Gila River Indian Reservation just west of the San Tan Mountains.

The western boundary of the survey area is 16th Street, in the city of Phoenix. According to the Gila and Salt River meridian and base line, this boundary is the centerline of R. 3 E. It extends from the south side of T. 1 S. to a point 1 mile north of the south side of T. 3 N. From its western boundary, the survey area extends southeastward through the cities of Tempe, Mesa, and Chandler; through the town of Gilbert; and through the communities of Higley, Chandler Heights, and Queen Creek. The southeastern corner of the survey area is in Pinal County. It is on the south side and 1 mile east of the centerline of T. 3 S., R. 9 E. Most places in the survey area have an elevation of between 1,075 and 1,800 feet, but the elevation on some of the mountains is as much as 3,500 feet.

About 60 percent of the survey area is irrigated and is used to grow row crops, hay crops, citrus, and grapes. Cotton is the most extensively grown cash crop. The rest of the survey area is occupied by cities and towns, mountains, and miscellaneous land types that are not suitable for crops and that have little value as range. Most of the cultivated areas are on flood plains, alluvial fans, and terraces of the Salt River and the Queen Creek Wash.

The economy of the survey area is based mainly on farming and on diverse kinds of manufacturing.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Eastern Maricopa and Northern Pinal Counties Area, where they are located, and how they can be used. They went into the survey area knowing they likely would find many soils they had already seen and perhaps some they had not. They observed steepness,

[1] MARVIN BARNEY, LUDENE CAMPBELL, KARL DONALDSON, EARL JENSEN, JOHN SAUNDERS, SHERMON STOCK, and PAT TRIPP, Soil Conservation Service, assisted with mapping of the survey area.

length, and shape of slopes; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in other survey areas of Arizona and adjoining States. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

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

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Laveen loam, 0 to 1 percent slopes, and Laveen loam, 1 to 3 percent slopes, are two phases within the Laveen series.

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

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

In most areas surveyed, there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Rock land is a land type in the Eastern Maricopa and Northern Pinal Counties Area.

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

Soil scientists observe how soils behave when used as a growing medium for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to slow permeability or a high water table. They see that streets, road pavements, and foundations for houses crack on a given kind of soil, and they relate this failure to a high shrink-swell potential. Thus, they use observation and knowledge of soil properties, together with available research data, to predict the limitations or suitability of a soil for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their study and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

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

A map showing soil associations is useful to people who want a general idea of the soils in the Area, who want to compare different parts of the Area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure. because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in the Eastern Maricopa and Northern Pinal Counties Area are described in the following pages. The general location of the associations is shown in figure 2. The terms for texture used in the descriptive title for several of the associations apply to the surface layer. For example, in the descriptive title for association 2, the words "sandy loams and gravelly sandy loams" refer to texture of the surface layer.

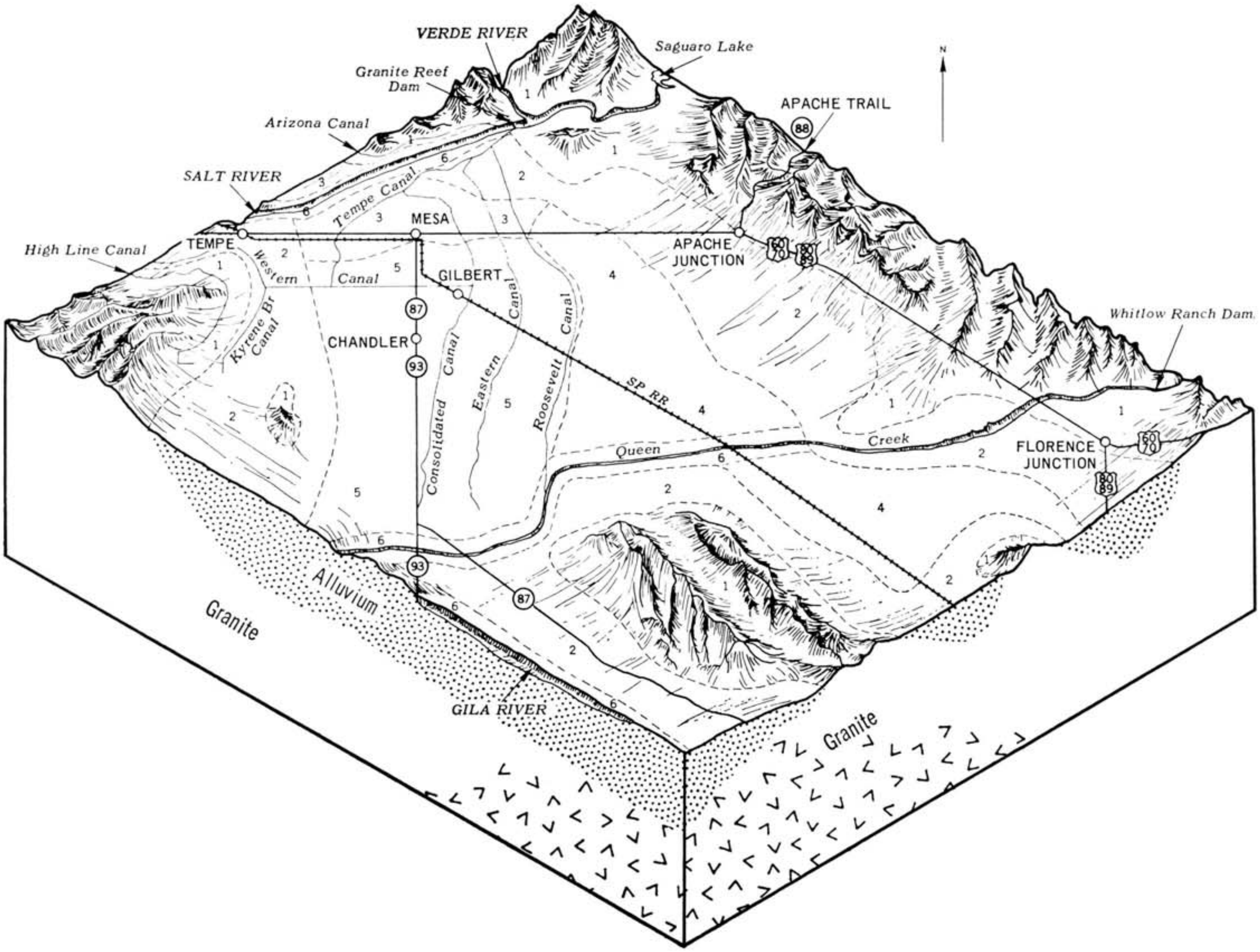

***Figure 2.*—Pattern of soil associations in the survey area.**

1. Rock Land Association

Rock outcrop and very shallow to shallow, strongly sloping to very steep gravelly sandy loams to very gravelly clay loams on mountains and buttes

This association consists mainly of strongly sloping to very steep areas of rock outcrop and of gravelly soils that are shallow or very shallow over rock. It is mainly on the sides of mountains, on the foot slopes of mountains, and on buttes and ledges. The mountains and buttes are made up mainly of granite, schist, andesite, and conglomerate. The areas are dissected by deep drainageways in which runoff is rapid and active geologic erosion is taking place. Vegetation is creosotebush, palo verde, cactus, forbs, and annual grasses. Elevations range from 1,100 to 3,500 feet. Average annual rainfall is 7 to 10 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 200 to 300 days.

This association occupies about 10 percent of the survey area. About 70 percent of it is Rock land, 15 percent is Rough broken land, 10 percent is Cavelt soils, and 5 percent is Pinamt soils.

From 50 to 70 percent of the Rock land part of this association is rock outcrops. Between the rock outcrops are areas of soils that are very shallow or shallow (3 to 20 inches thick) over bedrock, and areas of gravelly and of very gravelly soils that have a texture of sandy loam, loam, and clay loam. In some places these shallow soils have a thin subsoil horizon. In others this horizon is absent.

Areas of this association in the San Tan Mountains provide grazing for short periods after rains in summer and in winter. They have little value for use as range, however, because of the small amount of rainfall and the shortage of storage water for animals. Because runoff is rapid, little of the water from rainfall is added to the water supply of the area, but flooding is a moderate hazard in lower lying areas.

Some areas of this association, mainly near Phoenix Mountains, are used as sites for homes. Others are used for city parks, bridle trails, and a golf course. One area is also used as a proving ground for large earthmoving equipment.

2. Antho-Valencia Association

Well-drained, nearly level to gently sloping sandy loams and gravelly sandy loams on alluvial fans

This association consists of deep, nearly level and gently sloping soils on alluvial fans. These soils have slopes of 0 to 3 percent. They formed in mixed alluvium derived from a mixture of acidic and basic rocks. In areas not cultivated, the vegetation is creosotebush, mesquite, palo verde, bur-sage, cactus, annual grasses, and weeds. Elevations range from 1,100 to 1,700 feet. Average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free season is 240 to 300 days.

This association occupies about 11 percent of the survey area. About 55 percent of it is Antho soils, 20 percent is Valencia soils, and 25 percent is minor soils. The minor soils are mainly those of the Tremant, Pinamt, Cavelt, and Rillito series and areas of Gravelly alluvial land, Rock land, and Rough broken land.

Antho soils are light-brown or brown sandy loam or gravelly sandy loam to a depth of 40 inches or more. In more than half of their acreage, the soil material below a depth of about 40 inches is light reddish-brown heavy loam. Valencia soils have a surface layer of brown light sandy loam or sandy loam. Their underlying material is brown light sandy loam or sandy loam in the upper part, light reddish-brown sandy clay loam in the middle part, and light-brown sandy loam in the lower part.

In about half of this association, the soils are irrigated and are used for the commonly grown cultivated crops. Antho soils in the San Tan Mountains are used for range for short periods after rains in summer and in winter. Areas of Antho soils northeast of Mesa and at Chandler Heights are used as sites for homes. The community of Guadalupe is located on Valencia soils. Some soils of this association are also a source of material for subgrade and road fill.

3. Laveen Association

Well-drained, nearly level to gently sloping, calcareous loams and gravelly sandy loams on alluvial fans and terraces

This association consists of well-drained, deep soils on old alluvial fans and terraces. These soils have slopes of 0 to 3 percent. They formed in mixed alluvium derived from many different acidic and basic rocks. The vegetation is creosotebush, mesquite, palo verde, cactus, sagebrush, and annual grasses. Elevations range from 1,100 to 1,700 feet. Average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days.

This association occupies about 15 percent of the survey area. About 85 percent of it is Laveen soils, and about 15 percent is Rillito, Pinal, Pinal moderately deep variant, Contine, Mohall, and Avondale soils.

Laveen soils have a surface layer of brown loam or clay loam. Below the surface layer and extending to a depth of 60 inches or more is light-brown loam that is more than 15 percent lime.

Areas of Laveen soils that have slopes of less than 1 percent are generally used to grow the irrigated crops produced in this association. The Laveen soils have little value for use as range. Where they occur on fans near the San Tan Mountains, however, they are used as range for short periods after rains in summer and in winter.

Golf courses, baseball fields, and the major part of the city of Mesa are within this association.

4. Mohall-Contine Association

Well-drained, nearly level loams, clay loams, and sandy clay loams on old alluvial fans

This association consists of well-drained, deep soils on old alluvial fans. These soils have slopes of 0 to 1 percent. They formed in mixed alluvium derived from a mixture of acidic and basic rocks. In areas not cultivated, the vegetation consists of creosotebush, mesquite, saltbush, cactus, annual grasses, and weeds. Elevations range from 1,100 to 1,700 feet. Average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days.

This association occupies about 29 percent of the survey area. About 55 percent of it is Mohall soils, 35 percent is Contine soils, and about 10 percent is Vecont, Antho, Laveen, and Estrella soils.

Mohall soils have a surface layer of light-brown loam or sandy loam, a subsoil of reddish-brown to brown light clay loam or sandy clay loam, and underlying material of brown loam that extends to a depth of 60 inches or more. Contine soils have a surface layer of brown clay loam, a subsoil of reddish-brown heavy clay loam or clay, and underlying material of light reddish-brown heavy loam or clay loam that also extends to a depth of 60 inches or more. In both the Mohall and Contine soils, calcium carbonate has accumulated in the underlying material in most places.

Soils of this association are used for most of the irrigated crops commonly grown in the survey area. After rains in summer and in winter, some areas of these soils in the desert provide grazing for short periods.

Homes are located on some areas of these soils. The town of Gilbert and parts of the city of Chandler are located on Contine soils. The rest of the city of Chandler is on Mohall soils.

5. Gilman-Estrella-Avondale Association

Well-drained, nearly level loams and clay loams on alluvial fans and flood plains

This association consists of deep, nearly level soils on alluvial fans and flood plains of the Queen Creek Wash and the Salt River. These soils have slopes of 0 to 1 percent. They formed in mixed alluvium derived from many different kinds of acidic and basic rocks. In areas not cultivated, the vegetation is creosotebush, mesquite, saltbush, cactus, annual grasses, and weeds. Elevations range from 1,075 to 1,600 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days.

This soil association occupies about 33 percent of the survey area. About 65 percent of it is Gilman soils, 15 percent is Estrella soils, and 10 percent is Avondale soils. The remaining 10 percent is Vint, Trix, Antho, Pimer, Carrizo, Glenbar, Agualt, Cashion, and Pinamt soils.

Gilman soils have a surface layer of pale-brown loam. The underlying material is mostly light yellowish-brown loam, but it contains thin layers of other material. Estrella soils have a surface layer of light-brown loam over underlying material of light reddish-brown or reddish-brown clay loam. Avondale soils have a surface layer of brown clay loam over brown or light-brown loam and very fine sandy loam. The underlying material of all of these soils extends to a depth of 60 inches or more.

Soils of this association are used for most of the irrigated crops commonly grown in the survey area. In addition, the Gilman soils are used for grazing for short periods after rains in summer and in winter.

Within the city of Phoenix, a city park is located on Avondale soils. Near the cities of Mesa, Tempe, and Phoenix, all of these soils are used as sites for homes.

6. Alluvial Land Association

Excessively drained very gravelly sand alluvium in stream channels and on adjacent lowlands

This association is mainly Alluvial land, a deep very gravelly sand consisting of mixed alluvium derived from many different kinds of rocks. Slope is less than 1 percent, and the surface is slightly hummocky. Some areas of this association in the basin of the Salt River are more than a mile wide. Others, along the side drainageways that lead to the Salt River, are long and narrow. Occasionally, a shifting stream channel or the action of wind changes the location and position of some of the alluvial material. The main water channels are generally bare, but the vegetation in other areas is mainly creosotebush, mesquite, annual grasses, and weeds. Elevations range from 1,075 to 1,600 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days.

This association occupies about 2 percent of the survey area. About 90 percent of it is Alluvial land, and the rest is Carrizo, Agualt, Gilman, and Vint soils.

Alluvial land is not suitable for farming, but it is used as a source of sand and gravel. Near Phoenix and Tempe, it is used as sites for industries and homes. In those places some protection from flooding is provided by dikes, levees, and reservoirs.

Descriptions of the Soils

This section describes the soil series and mapping units in the Eastern Maricopa and Northern Pinal Counties Area. Each soil series is described in considerable detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils. All color and consistency terms are for dry soils unless otherwise stated. Statements about depth of root penetration refer to the effective depth to which roots can penetrate to obtain moisture and plant nutrients.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Rock land and Rough broken land, for example, do not belong to a soil series, but nevertheless, they are listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit in which the mapping unit has been placed. The page for the description of each capability unit can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*8*).[2]

A given soil series in this area may be identified by a different name in a recently published soil survey of a nearby area. Such differences in name result from changes in the concepts of soil classification that have occurred since publication. The characteristics of the soil series described in this area are considered to be within the range defined for that series. In these instances where a soil series has one or more features outside the defined range, the differences are explained.

Agualt Series

The Agualt series consists of well-drained soils on flood plains and alluvial fans. These soils have slopes of 0 to 1 percent. They formed in mixed alluvial material deposited by floodwaters of large streams. The vegetation is creosotebush, mesquite, saltbush, annual weeds, and grasses. Elevations range from 1,075 to 1,600 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Agualt soils are associated with Carrizo, Gilman, and Vint soils.

In a representative profile, the surface layer is pale-brown loam about 17 inches thick. The underlying material is pale-brown very fine sandy loam to a depth of about 26 inches. Below that depth and extending to a depth of 65 inches or more, it is pale-brown sand. These soils are moderately alkaline and are calcareous throughout.

[2] Italic numbers in parentheses refer to Literature Cited, p. 59.

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

Mapping unit	Acres	Percent	Mapping unit	Acres	Percent
Agualt fine sandy loam	523	0. 1	Mohall sandy loam	8, 612	2. 5
Agualt loam	578	. 2	Mohall loam	47, 949	13. 7
Alluvial land	8, 347	2. 4	Pimer clay loam	1, 423	. 4
Antho sandy loam, 0 to 1 percent slopes	14, 832	4. 3	Pinal gravelly loam, 0 to 1 percent slopes	1, 344	. 4
Antho sandy loam, 1 to 3 percent slopes	3, 226	. 9	Pinal gravelly loam, 1 to 3 percent slopes	264	. 1
Antho gravelly sandy loam, 1 to 3 percent slopes	8, 368	2. 4	Pinal loam, moderately deep variant	1, 040	. 3
Avondale clay loam	9, 925	2. 8	Pinamt very gravelly loam, 0 to 1 percent slopes	484	. 1
Carrizo gravelly loamy sand	310	. 1	Pinamt very gravelly loam, 3 to 5 percent slopes	4, 022	1. 2
Carrizo fine sandy loam	957	. 3	Rillito gravelly loam, 0 to 1 percent slopes	1, 646	. 5
Cashion clay	384	. 1	Rillito gravelly loam, 1 to 3 percent slopes	1, 929	. 6
Cavelt gravelly loam, 1 to 5 percent slopes	5, 151	1. 4	Rock land	25, 056	7. 2
Contine clay loam	36, 711	10. 5	Rough broken land	4, 686	1. 4
Estrella loam	15, 212	4. 4	Tremant gravelly loam, 1 to 3 percent slopes	2, 939	. 8
Gilman fine sandy loam	7, 267	2. 1	Trix clay loam	3, 579	1. 0
Gilman loam	64, 741	18. 6	Valencia sandy loam	7, 858	2. 3
Glenbar clay loam	1, 145	. 3	Vecont clay	5, 351	1. 5
Gravelly alluvial land	894	. 3	Vint loamy fine sand	5, 438	1. 6
Laveen loam, 0 to 1 percent slopes	37, 203	10. 7			
Laveen loam, 1 to 3 percent slopes	684	. 2			
Laveen clay loam, 0 to 1 percent slopes	7, 947	2. 3	Total	347, 925	100. 0

Both permeability and available water capacity are moderate. Roots can penetrate to a depth of more than 60 inches.

These soils are used for most of the irrigated crops commonly grown in the survey area. They are also a source of material for engineering structures and are used as sites for homes.

Representative profile of Agualt loam in a cultivated area, 950 feet south and 75 feet west of the northeast corner of sec. 23, T. 2 S., R. 7 E., in Maricopa County:

Ap—0 to 17 inches, pale-brown (10YR 6/3) loam, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine and very fine roots; common mica flakes; slightly effervescent; moderately alkaline; abrupt, smooth boundary. 12 to 18 inches thick.

C1—17 to 26 inches, pale-brown (10YR 6/3) very fine sandy loam, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; many fine and very fine roots; common, very fine, tubular and interstitial pores; common fine mica flakes; slightly effervescent; moderately alkaline; abrupt, wavy boundary. 8 to 22 inches thick.

IIC2—26 to 65 inches, pale-brown (10YR 6/3) sand, dark brown (10YR 4/3) when moist; single grain; loose both when dry and when moist, nonsticky and nonplastic when wet; few very fine roots; many, very fine, interstitial pores; common very fine mica flakes; slightly effervescent; moderately alkaline.

The A horizon is typically loam, but it is very fine sandy loam in small areas. In most places in the A, C, and IIC horizons, hue is 10YR, but it ranges to 7.5YR. Value in those horizons ranges from 5 to 7 when the soils are dry and from 3 to 5 when they are moist. Chroma ranges from 2 to 4, both when the soils are dry and when they are moist. In small areas the C1 horizon is fine sandy loam, but it is very fine sandy loam or loam in most places. The C1 horizon contains thin layers (1 to 3 inches thick) of sand to clay loam in some areas, and in places it contains fine threads of lime. The IIC horizon is sand in most places, but ranges to gravelly loamy sand and contains thin layers of sandy loam or fine sandy loam. Coarse-textured material is at depths ranging from 20 to 40 inches, but it is mostly at some depth between 24 and 30 inches. Soil material throughout the profile is slightly effervescent to strongly effervescent.

Agualt fine sandy loam (Af).—This nearly level soil is mostly in long, narrow areas on flood plains and alluvial fans of the Queen Creek Wash. Its profile is similar to the one described as representative for the Agualt series, but the surface layer is fine sandy loam.

Included with this soil in mapping were small areas of Carrizo fine sandy loam, Gilman fine sandy loam, and Agualt loam. Also included were narrow areas of Vint loamy sand.

Runoff is slow. Soil blowing is a slight hazard.

This Agualt soil is used to grow irrigated cotton, alfalfa, sorghum, sugar beets, small grains, and citrus. Near Phoenix, it is also used as sites for homes. In addition, it is a source of material for subgrade and fill used in constructing roads. Capability unit IIs–7 irrigated; subclass VIIs dryland.

Agualt loam (Ag).—This nearly level soil is in long, narrow areas on flood plains and alluvial fans of the Queen Creek Wash and the Salt River. It has slopes of less than 1 percent. In irrigated areas the surface is smooth. The profile is the one described as representative for the Agualt series.

Included with this soil in mapping were small areas of Agualt fine sandy loam, Gilman loam, and Gilman fine sandy loam. Also included were areas of Vint loamy fine sand that are long and narrow.

Runoff is slow. The hazard of erosion is slight.

This Agualt soil is used to grow irrigated cotton, alfalfa, sorghum, sugar beets, small grains, and citrus. Near Phoenix, it is also used as sites for homes. In addition, it is a source of material for subgrade and fill used in constructing roads. Capability unit IIs–7 irrigated; subclass VIIs dryland.

Alluvial Land

Alluvial land (Am) is a nearly level land type that generally has a hummocky appearance. It consists of stratified, recently deposited stream sediment in the channels of the Salt River and the Queen Creek Wash. This alluvial material was derived from a mixture of acidic and basic rocks. Where it occurs in the channel of the Queen Creek Wash, the areas are long and narrow. Areas that are in the channel of the Salt River and that include adjacent areas of alluvial material deposited by the river are as much as a mile wide. Texture of the surface layer ranges from gravelly sand or very gravelly sand to fine sandy loam. The material beneath the surface layer is very gravelly sand to very fine sandy loam and loam.

Blowing wind and the shifting of the stream channel change the location of tracts of this land type. Therefore, mapping individual areas as soil units is not feasible. Areas in the present water channel are generally bare. In other areas the vegetation is mainly creosotebush, mesquite, annual grasses, and weeds. Elevations range from 1,075 to 1,600 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days.

Included with this land type in mapping were small areas of Agualt, Carrizo, Gilman, and Vint soils.

Permeability ranges from very rapid to moderate, and the available water capacity ranges from low to high. Roots can penetrate to a depth of 60 inches or more. Runoff is slow. Soil blowing is generally a hazard.

This land type is not suited to use for farming, but it can be used, to a limited extent, for grazing or as wildlife habitat. It is a major source of the sand and gravel used in the survey area. Also, industrial establishments and homes have been built on it in some places. Capability unit not assigned; subclass VIIs dryland.

Antho Series

The Antho series consists of well-drained soils on flood plains and alluvial fans. These soils have slopes of 0 to 3 percent. They formed in mixed alluvial material. The vegetation is creosotebush, mesquite, palo verde, annual grasses, weeds, saguaro cactus, and cholla cactus. Elevations range from 1,100 to 1,700 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Antho soils are associated mainly with Gilman, Valencia, Vint, Mohall, and Tremant soils.

In a representative profile, the surface layer is light-brown sandy loam about 17 inches thick. The next layer, also light brown, is light sandy loam about 29 inches thick. Below this and extending to a depth of 60 inches or more is light-brown heavy loam. These soils are moderately alkaline and are generally calcareous throughout.

Permeability is moderately rapid, and available water capacity is moderate. Runoff is slow. Roots can penetrate to a depth of 60 inches or more.

These soils are used for most of the irrigated crops commonly grown in the survey area. They are also used for desert range, as homesites, and as a source of material for engineering structures.

Representative profile of Antho sandy loam, 0 to 1 percent slopes, in a cultivated area, 1,170 feet west and 1,250 feet north of the south quarter corner of sec. 34, T. 2 S., R. 6 E., in Maricopa County:

Ap—0 to 17 inches, light-brown (7.5YR 6/4) sandy loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, very friable when moist, nonsticky and slightly plastic when wet; few very fine roots; common, fine, interstitial pores; slightly effervescent; moderately alkaline; abrupt, smooth boundary. 8 to 18 inches thick.

C—17 to 46 inches, light-brown (7.5YR 6/4) light sandy loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; few very fine roots; few, fine, tubular and common, fine, interstitial pores; slightly effervescent; moderately alkaline; clear, smooth boundary. 32 to 52 inches thick.

IIB2tcab—46 to 60 inches, light-brown (7.5YR 6/4) heavy loam, reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; many, very fine and micro, tubular pores; common moderately thick clay films on ped surfaces and in tubular pores; many, fine and medium, distinct, pinkish-white (7.5YR 8/2) mottles and lime filaments; strongly effervescent; moderately alkaline.

The A horizon is typically sandy loam, but it is fine sandy loam in small areas. In places the A horizon is gravelly sandy loam. In the A and the C horizons, hue ranges from 7.5YR to 10YR. Throughout the profile value ranges from 5 to 7 when the soils are dry and from 3 to 5 when they are moist. Chroma ranges from 2 to 4, both when the soils are dry and when they are moist. The C horizon is typically sandy loam, but its texture ranges from coarse sandy loam to fine sandy loam. In some places the C horizon is gravelly, and in places it contains thin layers of loam, loamy sand, or gravelly loamy sand. In that horizon effervescence ranges from slight to strong. Hue of the IIB horizon ranges from 5YR to 7.5YR. In places the IIB horizon is absent. Where present, it is below a depth of 40 inches and is finer textured than the C horizon. Effervescence in the IIB horizon ranges from slight to strong.

Antho sandy loam, 0 to 1 percent slopes (AnA).—This nearly level soil is on flood plains and alluvial fans that extend outward from nearby mountains. It has the profile described as representative for the Antho series.

Included with this soil in mapping were small areas of Antho gravelly sandy loam, Gilman fine sandy loam, and Valencia sandy loam. Also included were small areas of Antho sandy loam, 1 to 3 percent slopes.

Soil blowing is a slight hazard. Runoff is very slow.

This Antho soil is used for irrigated cotton, sorghum (fig. 3), citrus, small grains, and flowers. Some areas are used as desert range. Capability unit IIs-4 irrigated; subclass VIIs dryland.

Antho sandy loam, 1 to 3 percent slopes (AnB).—This gently sloping soil is on alluvial fans that are adjacent to the Salt River and the San Tan and Phoenix Mountains. It has a profile similar to the one described as representative of the series. Where this soil is irrigated and used for cultivated crops, the surface is smooth and the dominant slopes are mainly 1¼ to 1½ percent. In noncultivated areas the surface is irregular and the dominant slopes are generally between 1½ and 2 percent.

Included with this soil in mapping were small areas of an Antho sandy loam that has slopes of less than 1 percent, and some areas in which the slopes are greater than 3 percent. Also included were small areas of Antho

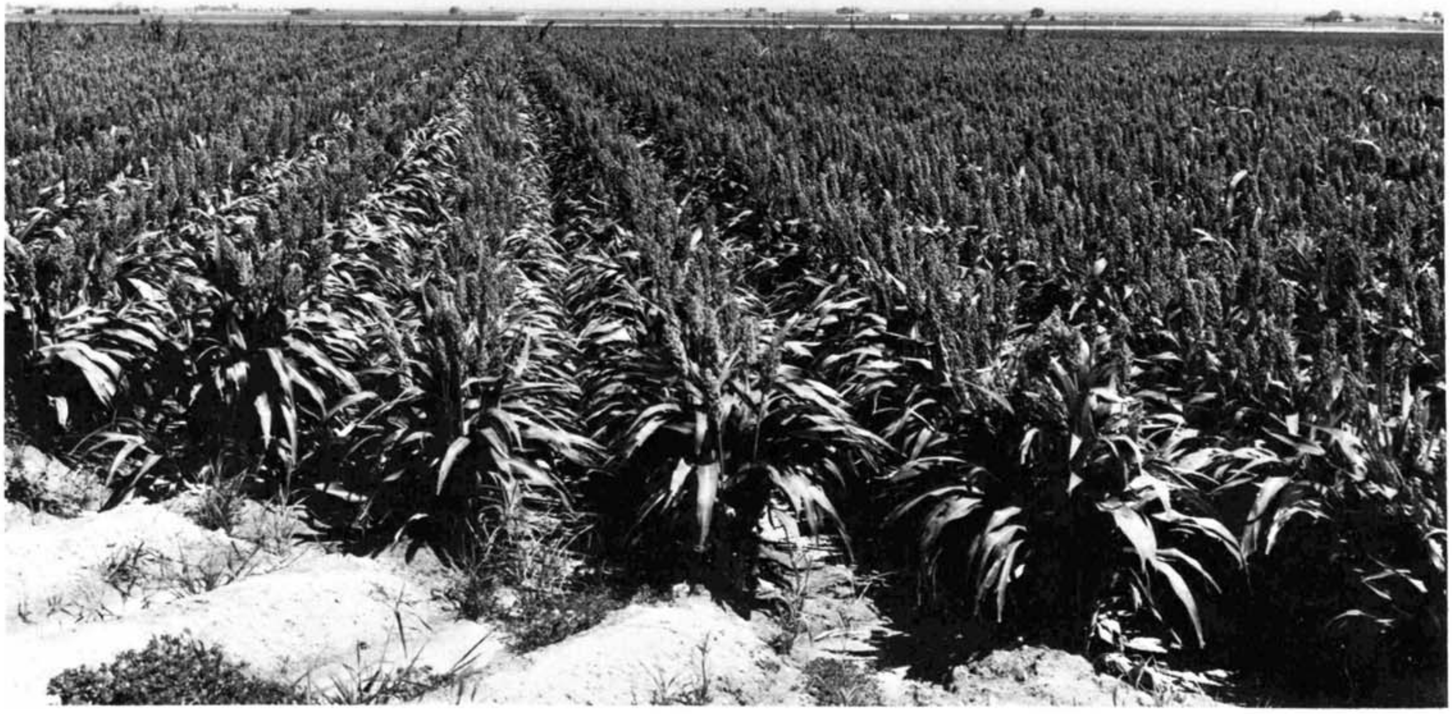

Figure 3.—**Grain sorghum on Antho sandy loam, 0 to 1 percent slopes.**

gravelly sandy loam and of Valencia sandy loam. Other inclusions consist of long, narrow areas of Mohall sandy loam and of Tremant gravelly loam.

Runoff is slow to medium. Water erosion and soil blowing are slight to moderate hazards.

This Antho soil is suited to the same crops as are grown on Antho sandy loam, 0 to 1 percent slopes. It has better air drainage, however, because of its gentle slopes and its location on the higher parts of alluvial fans. As a result, this soil is especially well suited to citrus, flowers, and other crops that are particularly sensitive to frost. Capability unit IIe-4 irrigated; subclass VIIs dryland.

Antho gravelly sandy loam, 1 to 3 percent slopes (AoB).—This gently sloping soil is on the upper parts of alluvial fans that border the adjacent mountains. The profile is similar to the one described as representative for the Antho series, but 15 to 35 percent of it, by volume, is gravel. Where this soil is irrigated and has been cultivated, its surface has been smoothed and the slopes are mainly between 1½ and 1¾ percent. In noncultivated areas the surface is irregular and slopes are generally between 1½ and 2½ percent.

Included with this soil in mapping were small areas of an Antho sandy loam that has slopes of less than 1 percent, and other small areas where slopes are more than 1 percent. Also included were areas of Valencia sandy loam, Tremant gravelly loam, and Mohall sandy loam. The included areas of Tremant and Mohall soils are generally long and narrow.

Runoff is slow to medium. Water erosion and soil blowing are slight to moderate hazards.

Only a small part of the acreage is cultivated, but the good air drainage makes this Antho soil well suited to the more frost-susceptible crops that are commonly grown in the survey area. Cotton, sorghum, alfalfa, small grains, citrus, and flowers are the principal crops. Capability unit IIe-4 irrigated; subclass VIIs dryland.

Avondale Series

The Avondale series consists of well-drained soils on flood plains and alluvial fans of the Salt River. These soils have slopes of 0 to 1 percent. They formed in mixed alluvium derived from several different kinds of acidic and basic rocks. The vegetation is mesquite, saltbush, creosotebush, annual grasses, and weeds. Elevations range from 1,075 to 1,600 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Avondale soils are associated mainly with Cashion, Laveen, Gilman, and Pimer soils.

In a representative profile, the surface layer is brown clay loam about 13 inches thick. The underlying layers generally consist of brown loam over light-brown very fine sandy loam that extends to a depth of 60 inches or more. These soils are moderately alkaline and are generally calcareous throughout.

Permeability is moderate, and available water capacity is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for most of the irrigated crops commonly grown in the survey area. They are also used as sites for homes and as recreational areas.

Representative profile of Avondale clay loam in a cultivated area, 650 feet west and 100 feet north of the east quarter corner of sec. 3, T. 1 N., R. 5 E., in Maricopa County:

Ap—0 to 13 inches, brown (7.5YR 5/2) clay loam, dark brown (7.5YR 3/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist, sticky and plastic when wet; common fine roots; common very fine pores; strongly effervescent; moderately alkaline; abrupt, smooth boundary. 7 to 18 inches thick.

C1—13 to 35 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; common fine and few medium roots; many fine and very fine pores; strongly effervescent; moderately alkaline; clear, smooth boundary. 20 to 53 inches thick.

C2—35 to 60 inches, light-brown (7.5YR 6/4) very fine sandy loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; few fine roots; common very fine pores; strongly effervescent; moderately alkaline.

The A horizon is clay loam in most places, but it is heavy loam in some small areas. In the A and C horizons, hue is 7.5YR or 10YR. Value in the A horizon is 4 or 5 when the soils are dry and is 2 or 3 when the soils are moist. In the C horizon value is 3 or 4 when the soils are moist, and chroma is 2 through 4, both when the soils are dry and when they are moist. The C horizon ranges from light clay loam or loam to silt loam or very fine sandy loam. In places the soil profile contains thin layers (about 1 inch thick) of a finer textured or of a coarser textured material. The C horizon contains fine veins or threads of lime in some places. In most areas the entire profile is strongly effervescent, but in places effervescence is only slight.

Avondale clay loam (Av).—This soil has slopes of less than 1 percent. Where it is used for irrigated crops, the surface is smooth. Size of the areas ranges from 10 to 1,600 acres.

Included with this soil in mapping were small areas of Cashion clay, Gilman loam, and Pimer clay loam. Also included were a few small spots of Laveen clay loam.

Runoff is very slow. Water erosion and soil blowing are not hazards.

In irrigated areas the main crops are cotton, alfalfa, sorghum, small grains, vegetables, citrus, and sugar beets. Within the city limits of Mesa, Tempe, and Phoenix, this soil is also used as sites for homes. In addition, it is used as a site for a multiple-use city park that is within the city limits of Phoenix. Capability unit I–1 irrigated; subclass VIIc dryland.

Carrizo Series

In the Carrizo series are excessively drained soils on flood plains and alluvial fans of the Queen Creek Wash and the Salt River. These soils have slopes of 0 to 1 percent. They formed in mixed alluvial material derived chiefly from granite, gneiss, sandstone, and limestone. The vegetation is creosotebush, mesquite, annual grasses, and weeds. Elevations range from 1,075 to 1,600 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Carrizo soils are associated with Agualt, Gilman, and Vint soils.

In a representative profile, the surface layer is brown fine sandy loam about 15 inches thick. The underlying material is light brownish-gray very gravelly sand that extends to a depth of 70 inches or more. These soils are moderately alkaline and are generally calcareous throughout.

Permeability is very rapid, and available water capacity is low. Roots can penetrate to a depth of 60 inches or more.

These soils are used for some of the irrigated crops commonly grown in the survey area, namely cotton, alfalfa, sorghum, small grains, and potatoes. They are also used as sites for homes and as a source of material for engineering structures.

Representative profile of Carrizo fine sandy loam in a cultivated area, 1,900 feet south and 1,650 feet west of the northeast corner of sec. 20, T. 2 S., R. 8 E., in Pinal County:

Ap—0 to 15 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; few fine and very fine roots; common, very fine, interstitial pores; few pebbles; slightly to strongly effervescent; moderately alkaline; clear, smooth boundary. 7 to 17 inches thick.

C—15 to 70 inches, light brownish-gray (10YR 6/2) very gravelly sand, dark brown (10YR 4/3) when moist; single grain; loose both when dry and when moist, nonsticky and nonplastic when wet; few very fine roots in upper part of horizon; many, fine and medium, interstitial pores; 40 percent of horizon, by volume, is gravel; slightly effervescent; moderately alkaline.

The A horizon is sandy loam or loamy fine sand in some small areas. In places as much as 5 percent of the A horizon is gravel. In the A and C horizons, hue ranges from 7.5YR to 10YR, but it is 10YR in most places; value is 4 or 6 and chroma ranges from 2 through 4, both when the soils are dry and when they are moist. The C horizon is typically very gravelly sand, but the texture ranges to very gravelly loamy sand, with thin layers of material of other textures. From 35 to 60 percent of the C horizon, by volume, is gravel. In some areas the entire profile is strongly effervescent. In others effervescence is only slight or is practically nonexistent.

Carrizo gravelly loamy sand (Ca).—This soil occurs in long, narrow areas that range from 5 to 40 acres in size. It has a profile similar to the one described as representative for the Carrizo series, but the surface layer is gravelly loamy sand. The content of gravel in the profile ranges from 35 to 65 percent.

Included with this soil in mapping were small areas of Carrizo fine sandy loam and Vint loamy fine sand.

This Carrizo soil is not well suited to the irrigated crops commonly grown in the survey area. It is used for growing some of those crops, however, because it is within areas of more productive soils. Allowing it to remain idle when the adjoining soils are farmed would be difficult. This soil is also used as sites for homes and as a source of material for engineering structures. Capability unit IVs–7 irrigated; subclass VIIs dryland.

Carrizo fine sandy loam (Cb).—This soil is in long, narrow areas that range from 5 to 70 acres in size. In most places it has slopes of less than 1 percent. The profile is the one described as representative for the Carrizo series.

Included with this soil in mapping were small areas of Agualt fine sandy loam, Carrizo gravelly loamy sand, and Vint loamy fine sand.

Soil blowing is a slight hazard. Runoff is slow.

This Carrizo soil is used to grow cotton, alfalfa, sorghum, small grains, and potatoes. In places, near the cities of Mesa, Phoenix, and Tempe, it is used as sites for homes. It is also a source of material for subgrade and road fill to be used in the construction of roads. Capability unit IVs–7 irrigated; subclass VIIs dryland.

Cashion Series

The Cashion series consists of well-drained soils on flood plains of the Salt River. These soils have slopes of 0 to 1 percent. The vegetation is mainly mesquite, but it includes some creosotebush, annual grasses, and weeds. Elevations range from 1,075 to 1,600 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Cashion soils are associated with Pimer, Gilman, and Avondale soils.

In a representative profile, the surface layer is brown clay and light clay about 28 inches thick. It is underlain by brown fine sandy loam that extends to a depth of 60 inches or more. These soils are moderately alkaline and are generally calcareous throughout.

Permeability is slow, and available water capacity is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for growing irrigated crops and as sites for homes.

Representative profile of Cashion clay in a cultivated area, 100 feet north and 800 feet west of the southeast corner of sec. 18, T. 1 N., R. 5 E., in Maricopa County:

Ap—0 to 12 inches, brown (7.5YR 5/2) clay, dark brown (7.5YR 3/2) when moist; weak, fine, granular structure; hard when dry, friable when moist, sticky and plastic when wet; common very fine and fine roots; few, fine and very fine, interstitial pores; strongly effervescent; moderately alkaline; abrupt, smooth boundary. 8 to 15 inches thick.

A1—12 to 28 inches, brown (7.5YR 5/2) light clay, dark brown (7.5YR 3/2) when moist; weak, medium and fine, subangular blocky structure; hard when dry, friable when moist, sticky and very plastic when wet; few very fine roots; few, fine and very fine, interstitial and tubular pores; few, fine, pinkish-white (7.5YR 8/2) lime veins; strongly effervescent; moderately alkaline; clear, wavy boundary. 7 to 29 inches thick.

IIC—28 to 60 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine roots; common, very fine, interstitial pores; few, fine, white (10YR 8/2) mycelialike lime veins; strongly effervescent; moderately alkaline.

In the A horizons, hue ranges from 7.5YR to 10YR, but it is generally 7.5YR. Value in those horizons is 4 or 5 when the soils are dry and is 2 or 3 when the soils are moist. Chroma is 2 or 3, both when the soils are dry and when they are moist. The A horizons are clay or light clay, and they range from 20 to 30 inches in combined thickness. The IIC horizon is fine sandy loam to loam or silt loam, and it is stratified in places. In most places hue in the IIC horizon is 7.5YR, but it ranges to 10YR. Value in that horizon is 5 or 6 when the soils are dry and is 3 or 4 when the soils are moist; chroma ranges from 2 to 4, both when the soils are dry and when they are moist. In some areas veins or threads of lime are lacking in the IIC horizon. The soil profile is strongly effervescent throughout in most places, but effervescence ranges to slight in some areas.

Cashion clay (Cc).—This soil has a smooth surface and has slopes of less than one-half percent. It occurs in areas 40 to 100 acres in size. Practically no areas of other soils were included in mapping.

Water erosion and soil blowing are not hazards. Runoff is slow.

Crops grown on this soil are mainly cotton, alfalfa, sorghum, and small grains, but sugar beets and citrus are grown to some extent. A large area that will be subdivided and used for houses is idle. This soil has already been used as a site for a few low cost homes. Because of the high shrink-swell potential, however, large cracks have developed in the walls of these homes. Capability unit IIIs–3 irrigated; subclass VIIs dryland.

Cavelt Series

The Cavelt series consists of well-drained soils that have an indurated lime-cemented hardpan at a depth of 5 to 20 inches. These soils have slopes of 1 to 5 percent. They are on alluvial fans that extend outward from the base of the mountains. The material in which they formed was mixed gravelly alluvium derived from many different kinds of acidic and basic igneous rocks. The vegetation is creosotebush, mesquite, palo verde, annual grasses, and weeds. Elevations range from 1,100 to 1,800 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Cavelt soils are associated mainly with Rillito, Tremant, and Pinamt soils.

In a representative profile, the surface layer is light yellowish-brown gravelly loam about 2 inches thick. The upper part of the underlying material is light-brown gravelly loam that extends to a depth of about 10 inches; the middle part is a white, indurated lime hardpan that extends to a depth of about 46 inches; and the lower part is a layer of very pale brown gravelly loam that extends to a depth of 60 inches or more These soils are moderately alkaline and are strongly calcareous throughout.

Permeability is moderate in the upper part of the profile and is very slow in the hardpan. The available water capacity is low. Roots can penetrate to a depth of 5 to 20 inches.

These soils are not used for crops. Small areas near the San Tan Mountains are used as range for short periods following rains in summer and in winter. These soils are also used as sites for a few homes and for some recreational facilities.

Representative profile of Cavelt gravelly loam, 1 to 5 percent slopes, in a noncultivated area of the desert, 850 feet east and 200 feet north of the south quarter corner of sec. 31, T. 3 S., R. 8 E., in Pinal County:

A1—0 to 2 inches, light yellowish-brown (10YR 6/4) gravelly loam, dark brown (10YR 4/3) when moist; massive;

slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine and medium roots; common, fine, vesicular pores; 25 percent of horizon is gravel; strongly effervescent; moderately alkaline; abrupt, smooth boundary. 1 to 4 inches thick.

C1—2 to 8 inches, light-brown (7.5YR 6/4) gravelly loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine and medium roots; few, fine, tubular and interstitial pores; 25 to 30 percent of horizon is gravel; strongly effervescent; moderately alkaline; abrupt, irregular boundary. 2 to 10 inches thick.

C2ca—8 to 10 inches, light-brown (7.5YR 6/4) gravelly loam, dark brown (7.5YR 4/4) when moist; many, medium, distinct, pinkish-white (7.5YR 8/2) segregations of calcium carbonate, pink (7.5YR 7/4) when moist; massive; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; very few fine roots; few, fine, tubular and interstitial pores; 25 to 30 percent of horizon is gravel; violently effervescent; moderately alkaline; abrupt, wavy boundary. 2 to 8 inches thick.

C3cam—10 to 46 inches, white (10YR 8/2), indurated to very strongly cemented hardpan consisting of pebbles that are cemented together with calcium carbonate; upper surface of the hardpan has a thin (about 1/16 to 1/8 inch thick), indurated laminar layer, very pale brown (10YR 7/2) when moist; violently effervescent; moderately alkaline; gradual, wavy boundary. 20 to 45 inches thick.

C4ca—46 to 60 inches, very pale brown (10YR 8/3) gravelly loam, very pale brown (10YR 7/3) when moist; massive; extremely hard when dry, extremely firm when moist; mostly weakly to strongly cemented by calcium carbonate but indurated in small areas; violently effervescent; moderately alkaline.

In the A horizon, hue is 10YR in most places, but it ranges to 7.5YR; value is 5 or 6 when the soils are dry and is 3 or 4 when they are moist; and chroma is 3 or 4, both when the soils are dry and when they are moist. Texture of the A and the C horizons is typically gravelly loam (15 to 35 percent of these horizons, by volume, is gravel), but the texture is gravelly sandy loam in small areas. Erosion has removed all of the A1 and the C1 horizons in some small spots. In the C horizon, hue is generally 7.5YR, but it ranges to 10YR; value ranges from 5 to 8 when the soils are dry and from 4 to 7 when they are moist; and chroma ranges from 2 to 4, both when the soils are dry and when they are moist. In small areas the profile contains a thin (2 to 5 inches thick), reddish-brown B horizon that lies just above the hardpan. The pan of indurated lime is typically at some depth between 8 and 16 inches, but the depth ranges from 5 to 20 inches. In small areas the pan is primarily cemented with silica. Its thickness ranges from 12 to more than 40 inches.

Cavelt gravelly loam, 1 to 5 percent slopes (CeC).—This soil is mainly on fans that extend outward from the Phoenix Mountains, Salt River, and from the base of the San Tan Mountains. The areas range from 5 to 380 acres in size.

Included with this soil in mapping were small areas of Pinamt, Rillito, and Tremant soils; small areas of a soil that has slopes of less than 1 percent; and small areas of a soil that has slopes of as much as 10 percent.

Runoff is slow to medium. Water erosion is a slight hazard.

This Cavelt soil is not used for cultivated crops, but areas in the vicinity of the San Tan Mountains are occasionally used for grazing following rainy periods. Homes have been built in a few places. One area is used for a golf course. Capability unit not assigned; subclass VIIs dryland.

Contine Series

Well-drained soils on old alluvial fans are in the Contine series. These soils have slopes of 0 to 1 percent. They formed in mixed alluvial material derived from a mixture of acidic and basic igneous rocks. The vegetation is mainly creosotebush, mesquite, saltbush, cactus, annual grasses, and weeds. Elevations range from 1,100 to 1,700 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Contine soils are associated mainly with Mohall, Vecont, and Laveen soils.

In a representative profile, the surface layer is brown clay loam about 12 inches thick. The upper part of the subsoil is reddish-brown clay over light reddish-brown light clay, and it extends to a depth of about 38 inches. The lower part of the subsoil is light reddish-brown clay loam and heavy loam that extends to a depth of 60 inches or more. These soils are moderately alkaline and are slightly to strongly calcareous throughout.

Permeability is slow, and available water capacity is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for all the irrigated crops commonly grown in the survey area. They are also occasionally used as desert range and are used as sites for homes.

Representative profile of Contine clay loam in a cultivated area, 75 feet south and 50 feet east of the northwest corner of sec. 14, T. 1 S., R. 6 E., in Maricopa County:

Ap—0 to 12 inches, brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) when moist; weak, coarse, granular and fine, subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; many very fine and fine roots; common, very fine and fine, interstitial pores; 2 to 6 percent of horizon is gravel; slightly effervescent; moderately alkaline; abrupt, smooth boundary. 8 to 18 inches thick.

B21t—12 to 25 inches, reddish-brown (5YR 5/4) clay, dark reddish brown (5YR 3/4) when moist; moderate, medium and coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky and angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; many very fine roots; many, very fine and medium, tubular pores; common thin clay films on ped surfaces and in tubular pores; 8 to 12 percent of horizon is gravel; slightly effervescent; moderately alkaline; gradual, wavy boundary. 12 to 28 inches thick.

B22tca—25 to 38 inches, light reddish-brown (5YR 6/4) light clay, dark reddish brown (5YR 3/4) when moist; moderate, medium, subangular blocky and angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; common fine and very fine roots; common, very fine and medium, tubular pores; common moderately thick clay films on ped surfaces and in tubular pores; 8 to 12 percent of horizon is gravel; many, fine and medium, soft, distinct, pink (5YR 8/3) lime segregations, pink (5YR 7/4) when moist; violently effervescent; moderately alkaline; gradual, wavy boundary. 10 to 24 inches thick.

B23tca—38 to 47 inches, light reddish-brown (5YR 6/4) clay loam, reddish brown (5YR 4/4) when moist; weak, medium and coarse, subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; few very fine roots; many, fine and medium, tubular pores; common thin clay films on ped surfaces; about 10 percent of horizon is gravel; many, fine and medium, distinct, pink (5YR 8/3) lime mottles, pink (5YR 7/4) when moist; strongly to violently effervescent; moderately alkaline; gradual, wavy boundary. 6 to 12 inches thick.

B3tca—47 to 66 inches, light reddish-brown (5YR 6/4) heavy loam, reddish brown (5 YR 4/4) when moist; weak, coarse, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine roots; many, very fine and medium, tubular pores; few thin clay films on ped surfaces; 12 to 15 percent of horizon is gravel; common, fine and medium, distinct, pink (5YR 8/3) lime mottles, pink (5YR 7/4) when moist; strongly effervescent; moderately alkaline.

In most places the A horizon has a hue of 7.5YR, but the hue ranges to 5YR. Value in the A horizon is 4 or 5 when the soils are dry and is 3 or 4 when the soils are moist. Chroma in that horizon is 3 or 4, both when the soils are dry and when they are moist. Texture of the A horizon is clay loam to sandy clay loam. In some small areas, the B horizons have a hue of 7.5YR. In places the segregated lime in the B horizons has chroma as low as 1. The B3tca horizon is clay loam or loam in some areas. In places a C horizon is at some depth below 30 inches.

Contine clay loam (Co).—This soil is mainly on old alluvial fans, between the flood plains of the Salt River and the Queen Creek Wash. Areas in which it occurs extend from north of Williams Air Force Field westward to the town of Gilbert and the city of Chandler. Average size of the areas is about 460 acres. Slopes are less than 1 percent.

Included with this soil in mapping were small areas of Vecont clay, Mohall loam, and Laveen clay loam.

Runoff is slow to medium. Water erosion and soil blowing are not hazards or are only slight hazards.

Cultivated areas of this Contine soil are used mainly to grow cotton, alfalfa, sorghum, small grains, vegetables, sugar beets, and citrus, but some areas are used to grow corn for ensilage. Other areas are used as range for short periods following rains. The town of Gilbert and part of the city of Chandler are located on this soil. Capability unit IIs–8 irrigated; subclass VIIs dryland.

Estrella Series

The Estrella series consists of well-drained soils on flood plains and alluvial fans. These soils have slopes of 0 to 1 percent. They formed in recent alluvium over old alluvial material derived from a mixture of basic and acidic igneous rocks. The vegetation is creosotebush, mesquite, cactus, annual grasses, and weeds. Elevations range from 1,075 to 1,600 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Estrella soils are associated mainly with Gilman, Mohall, Trix, and Valencia soils.

In a representative profile, the surface layer and the upper part of the underlying material are light-brown loam. The rest of the underlying material from a depth of about 26 inches to a depth of 60 inches or more is light reddish-brown or reddish-brown clay loam. These soils are moderately alkaline and are calcareous throughout.

Permeability is moderately slow, and available water capacity is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for most of the irrigated crops commonly grown in the survey area. They are also used as sites for homes.

Representative profile of Estrella loam in a cultivated area, 50 feet north and 1,260 feet east of the southwest corner of sec. 20, T. 2 S., R. 5 E., in Maricopa County:

Ap—0 to 15 inches, light-brown (7.5YR 6/4) loam, dark brown (7.5YR 4/4) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine and medium roots; common, very fine, interstitial pores; slightly effervescent; moderately alkaline; abrupt, smooth boundary. 12 to 18 inches thick.

C—15 to 26 inches, light-brown (7.5YR 6/4) loam, brown (7.5YR 5/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine, fine, and medium roots; common, very fine, interstitial and tubular pores that have a few, fine lime filaments in the lower part; strongly effervescent; moderately alkaline; clear, smooth boundary. 11 to 20 inches thick.

IIB21tcab—26 to 35 inches, light reddish-brown (5YR 6/4) clay loam, reddish brown (5YR 4/4) when moist; weak, medium and coarse, prismatic structure parting to moderate, medium, subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few fine and medium roots; common, fine and very fine, tubular pores; many thin clay films on ped surfaces and in tubular pores; common, fine, distinct, pinkish-gray (5YR 7/2) lime veins and mottles, reddish brown (5YR 5/3) when moist; strongly effervescent; moderately alkaline; clear, wavy boundary. 6 to 14 inches thick.

IIB22tcab—35 to 49 inches, reddish-brown (5YR 5/4) clay loam, yellowish red (5YR 4/6) when moist; weak, medium and coarse, prismatic structure parting to moderate, medium, subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few fine roots; very fine tubular pores; many, moderately thick, continuous clay films on ped surfaces and in tubular pores; many, fine and medium, distinct, pink (5YR 7/3) lime mottles, reddish brown (5YR 5/4) when moist; strongly effervescent; moderately alkaline; clear, wavy boundary. 10 to 16 inches thick.

IICca—49 to 60 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) when moist; massive; hard when dry, friable when moist, slightly sticky and plastic when wet; few, fine, tubular pores; common, fine and medium, distinct, pink (5YR 7/3) lime mottles, pink (5YR 7/4) when moist; strongly effervescent; moderately alkaline; diffuse, wavy boundary.

In the A and the C horizons, hue ranges from 7.5YR to 10YR; value is 5 or 6 when the soils are dry and is 3 to 5 when they are moist; and chroma is 3 or 4, both when the soils are dry and when they are moist. Typically, the A and the C horizons are loam, but their texture ranges to silt loam or very fine sandy loam in some places. The IIB horizon is typically clay loam, but its texture ranges to sandy clay loam or heavy loam in places. Depth to the IIB horizon ranges from 23 to 38 inches, but the depth is between 24 and 28 inches in most places. In some areas accumulations of calcium carbonate are lacking in the IIB and the IIC horizons. In those horizons hue ranges from 5YR to 7.5YR and value is 4 or 5 when the soils are moist. Where calcium carbonate has accumulated, as in the IIC horizon, the value can be as high as 8 and the chroma as low as 2, both when the soils are dry and when they are moist. In some areas the IIC horizon is loam.

Estrella loam (Es).—This soil is mainly on alluvial fans and flood plains of the Queen Creek Wash and the Salt River. In most places slopes are less than 0.5 percent. Average size of the areas is about 160 acres.

Included with this soil in mapping were small areas of Gilman, Valencia, and Mohall soils. The areas of Mohall soils generally occur when deep cuts have been made during leveling.

Runoff is slow. Water erosion and soil blowing are not hazards.

This Estrella soil is used to grow cotton, alfalfa, sorghum, small grains, sugar beets, citrus, and vegetables. Near Phoenix, it is used as a site for several homes. Capability unit I-1 irrigated; subclass VIIc dryland.

Gilman Series

The Gilman series consists of level or nearly level, well-drained soils on flood plains and alluvial fans of the Salt River, Queen Creek Wash, and other large streams. These soils have slopes of no more than 1 percent. They formed in mixed alluvium derived from basic and acidic igneous rocks. The vegetation is creosotebush, mesquite, saltbush, annual grasses, and weeds. Elevations range from 1,075 to 1,600 feet. Average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Gilman soils are associated mainly with Avondale, Antho, Estrella, Glenbar, Trix, and Vint soils.

In a representative profile, the surface layer is pale-brown loam about 13 inches thick. The underlying material is light yellowish-brown loam that extends to a depth of 60 inches or more. The profile commonly contains a few fine veins and seams of lime, and it is moderately alkaline and calcareous throughout.

Permeability is moderate. The available water capacity is high. Roots can penetrate to a depth of 60 inches or more.

These soils can be used for most of the irrigated crops commonly grown in the survey area. Small areas are used as range for short periods, and some areas are used as sites for homes.

Representative profile of Gilman loam in a cultivated area, 950 feet west and 40 feet north of the east quarter corner of sec. 1, T. 2 S., R. 6 E., in Maricopa County:

Ap—0 to 13 inches, pale-brown (10YR 6/3) loam, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine and coarse roots; common, very fine, interstitial pores; strongly effervescent; moderately alkaline; abrupt, smooth boundary. 8 to 17 inches thick.

C1—13 to 22 inches, light yellowish-brown (10YR 6/4) loam, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine and medium roots; common, very fine, interstitial pores; strongly effervescent; moderately alkaline; clear, wavy boundary. 5 to 22 inches thick.

C2—22 to 60 inches, light yellowish-brown (10YR 6/4) loam, dark yellowish brown (10YR 4/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; few very fine roots; common, very fine, interstitial pores; common, fine, faint, mycelialike veins of lime; strongly effervescent; moderately alkaline.

In the A and the C horizons, hue ranges from 10YR to 7.5YR; value is 5 or 6 when the soils are dry and is 4 or 5 when they are moist; and chroma is 3 or 4. The A and the C horizons are typically loam, but their texture ranges to silt loam or very fine sandy loam. Where the C horizon is silt loam or very fine sandy loam, it contains thin layers of coarser textured or of finer textured material. The profile is typically slightly to strongly effervescent throughout.

Gilman fine sandy loam (Gf).—This soil is on flood plains and alluvial fans. It has slopes of less than 1 percent. The areas are long and narrow and are about 50 acres in size. The profile is similar to the one described as representative for the series, but the surface layer is fine sandy loam.

Included with this soil in mapping were small areas of Gilman loam, Antho sandy loam, and Vint loamy fine sand.

Runoff is slow. Soil blowing is a slight hazard.

This Gilman soil is especially well suited to potatoes. It is also used for irrigated cotton, alfalfa, sorghum, sugar beets, small grains, vegetables, and some citrus. Capability unit I–2 irrigated; subclass VIIc dryland.

Gilman loam (Gm).—This soil is on flood plains and alluvial fans of large streams, in areas about 300 acres in size. It has the profile described as representative for the Gilman series. Slopes are dominantly less than 0.6 percent.

Included with this soil in mapping were small, long and narrow areas where the surface layer is clay loam or fine sandy loam; small areas of Antho, Avondale, Estrella, and Vint soils; and small areas of saline and alkali soils. On the soil map, the included saline and alkali soils are indicated by a spot symbol.

Runoff is slow. Soil blowing and water erosion are not hazards.

Some citrus (fig. 4) and cotton, alfalfa, sorghum, sugar beets, small grain, and vegetables are grown under irrigation. Also, for short periods after rains, both in summer and in winter, this soil is used as range. Some areas, mainly near Phoenix, are used as sites for homes. Capability unit I–1 irrigated; subclass VIIc dryland.

Glenbar Series

The Glenbar series consists of well-drained soils on flood plains and alluvial fans of the Salt River and other large streams. These soils have slopes of 0 to 1 percent. They formed in mixed alluvium from basic and acidic igneous rocks. The vegetation is mesquite, creosotebush, saltbush, annual grasses, and weeds. Elevations range from 1,075 to 1,600 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Glenbar soils are associated mainly with Gilman, Trix, and Mohall soils.

In a representative profile, the surface layer is light-brown clay loam about 14 inches thick. The underlying material is brown and light-brown to light yellowish-brown clay loam to a depth of about 47 inches. Below that depth and extending to a depth of 60 inches or more, it is light yellowish-brown heavy silt loam. The lower part of the profile contains a few fine threads or veins of lime. These soils are moderately alkaline and are calcareous throughout.

Permeability is moderately slow, and the available water capacity is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for most of the irrigated crops commonly grown in the survey area. They are also used as sites for homes.

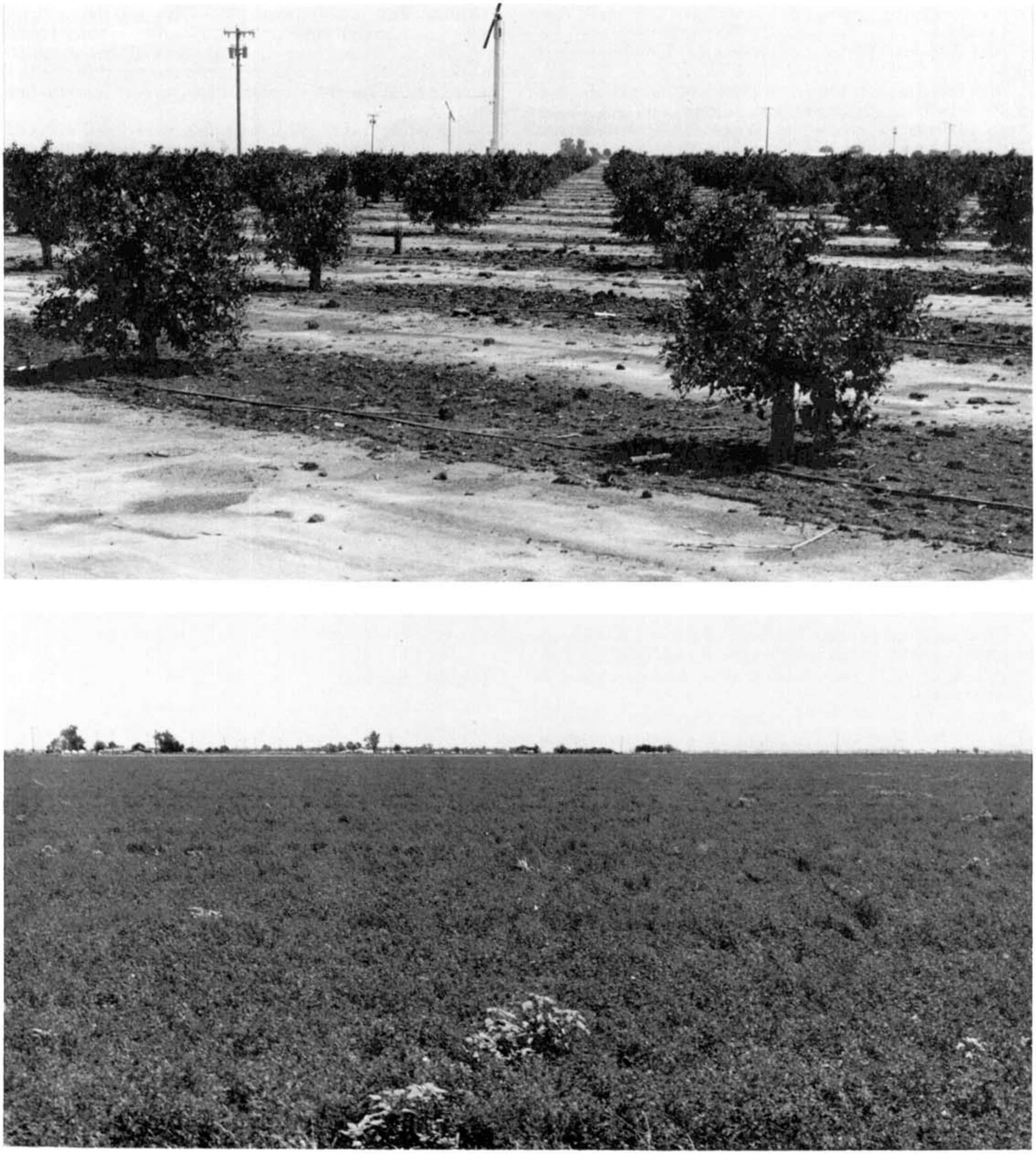

Figure 4.—**Two crops grown on Gilman loam under irrigation: citrus (upper part) and alfalfa (lower part).**

Representative profile of Glenbar clay loam in a cultivated area, 200 feet north of the south quarter corner of sec. 6, T. 3 S., R. 8 E., in Pinal County:

Ap—0 to 14 inches, light-brown (7.5YR 6/4) clay loam, dark brown (7.5YR 4/4) when moist; massive; hard when dry, firm when moist, sticky and plastic when wet; few fine and medium roots; common, fine and medium, interstitial pores; slightly effervescent; moderately alkaline; clear, smooth boundary. 8 to 17 inches thick.

C1—14 to 20 inches, brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) when moist; massive; hard when dry, firm when moist, sticky and plastic when wet; very few very fine roots; common, fine, tubular pores; slightly effervescent; moderately alkaline; clear, smooth boundary. 5 to 32 inches thick.

C2—20 to 34 inches, light yellowish-brown (10YR 6/4) clay loam, dark brown (10YR 4/3) when moist; massive; hard when dry, firm when moist, sticky and plastic when wet; few fine roots; common, fine, tubular pores; strongly effervescent; moderately alkaline; gradual, smooth boundary. 0 to 20 inches thick.

C3—34 to 47 inches, light-brown (7.5YR 6/4) clay loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; few fine roots; common, fine, tubular pores; strongly effervescent and contains fine threads of lime; moderately alkaline; abrupt, smooth boundary. 10 to 20 inches thick.

C4—47 to 60 inches, light yellowish-brown (10YR 6/4) heavy silt loam, dark brown (10YR 4/3) when moist; massive; soft when dry, very friable when moist, slightly sticky and nonplastic when wet; common, fine, tubular pores; strongly effervescent; moderately alkaline.

The A horizon is typically clay loam, but it is loam in a few small areas. The C horizons are clay loam, silty clay loam, heavy loam or heavy silt loam. Also, in some places the texture is very fine sandy loam or fine sandy loam at a depth of 40 inches or below. In some areas the soils are stratified and contain thin layers (1 inch thick) of finer textured or of coarser textured material. Fine threads or veins of lime are absent in some places. In some small areas, the profile contains a buried B horizon that is below a depth of 40 inches.

Glenbar clay loam (Gn).—This soil is on flood plains and alluvial fans of the Queen Creek Wash, the Salt River, and tributaries of those rivers. The areas are long and narrow, and most of them contain about 90 acres. Slopes are generally less than 0.5 percent.

Included with this soil in mapping were small areas of Gilman loam, Trix clay loam, and Mohall loam.

Runoff is slow. Water erosion and soil blowing are not hazards.

This Glenbar soil is used to grow cotton, alfalfa, sorghum, small grains, sugar beets, citrus, and vegetables. Near Phoenix, it is also used as a site for a few homes. Capability unit I–1 irrigated; subclass VIIc dryland.

Gravelly Alluvial Land

Gravelly alluvial land (Gr) consists of moderately coarse textured and coarse textured, unconsolidated alluvium that is very gravelly and contains thin layers of coarse fragments. The texture is generally sandy loam or loamy sand, and the content of gravel and of other coarse fragments is 50 to 70 percent. This mapping unit mainly occupies high fans on the foot slopes of mountains. Slopes are mostly between 3 and 5 percent, but they are as much as 10 percent in a few places. The vegetation is creosotebush, mesquite, palo verde, cactus, annual grasses, and weeds. Elevations range from 1,100 to 1,800 feet. The average annual rainfall is 6 to 8 inches, the average annual air temperature is 72° to 74° F., and the frost-free period is 240 to 300 days.

Runoff is slow. Permeability is very rapid, and the available water capacity is low. Roots can penetrate to a depth of 60 inches or more.

This mapping unit is not suited to crops. For short periods after rains in summer and in winter, however, it is occasionally used for grazing. Subgrade material, used for building airfields and roads, has been obtained from some areas. Capability unit not assigned; subclass VIIs dryland.

Laveen Series

In the Laveen series are well-drained soils on old alluvial fans and old stream terraces. These soils have slopes of 0 to 3 percent. They formed in mixed alluvium from many different kinds of rocks. The vegetation is creosotebush, mesquite, palo verde, bur-sage, cactus, annual grasses, and weeds. Elevations range from 1,100 to 1,700 feet. The average annual rainfall ranges from 6 to 8 inches, the average annual soil temperature ranges from 72° to 74° F., and the frost-free period ranges from 240 to 300 days. Laveen soils are associated mainly with Rillito, Pinal, Avondale, and Mohall soils.

In a representative profile, the surface layer is brown loam about 14 inches thick. The underlying material is light-brown loam that is high in content of lime and extends to a depth of 60 inches or more. These soils are moderately alkaline and are generally strongly calcareous throughout.

Permeability is moderate, and the available water capacity is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for most of the irrigated crops commonly grown in the survey area, and they are used as range for short periods. Some areas are also used as sites for homes and for recreation.

Representative profile of Laveen loam, 0 to 1 percent slopes, in a cultivated area, 500 feet west of the center of sec. 32, T. 1 N., R. 5 E., in Maricopa County:

Ap—0 to 14 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) when moist; massive, parting to weak, medium, granular structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few, medium, fine and very fine roots; many, very fine, interstitial pores; strongly effervescent; moderately alkaline; abrupt, smooth boundary. 8 to 15 inches thick.

C1ca—14 to 34 inches, light-brown (7.5YR 6/4) loam, brown (7.5YR 5/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine and very fine roots; common, fine, interstitial pores; common, fine, pink (7.5YR 7/4) lime segregations, filaments, and concretions; violently effervescent; moderately alkaline; gradual, wavy boundary. 10 to 28 inches thick.

C2ca—34 to 44 inches, light-brown (7.5YR 6/4) loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; few fine and very fine roots; common, very fine, interstitial and tubular pores; many, fine and medium, pink (7.5YR 7/4) lime mottles and lime nodules; violently effervescent; moderately alkaline; clear, wavy boundary. 18 to 40 inches thick.

C3ca—44 to 60 inches, light-brown (7.5YR 6/4) loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; few very fine roots; common, very fine, interstitial and tubular pores; many, fine, medium and distinct, pink (7.5YR 8/4) mottles of lime, pink (7.5YR 7/4) when moist; violently effervescent; moderately alkaline.

In the A horizon, hue ranges from 7.5YR to 10YR; value is 5 or 6 when the soils are dry and is 4 or 5 when the soils are moist; and chroma is 3 or 4 when the soils are dry and is 2 to 4 when they are moist. In the C horizons, hue is generally 7.5YR, but it ranges to 10YR; value is 5 or 6 when the soils are dry; and chroma is 4 to 6 when the soils are dry and is 3 or 4 when they are moist. In some areas a C1 horizon, without an accumulation of calcium carbonate, lies just below the A horizon. Value in the segregated lime in the profile is as high as 8, and chroma is as low as 2. Depth to the accumulation of calcium carbonate ranges from 14 to 30 inches. The content of lime nodules or concretions in the C horizons is less than 15 percent, by volume. The content of calcium carbonate in those horizons ranges from 10 to 45 percent. In places the C horizons are weakly cemented.

Laveen loam, 0 to 1 percent slopes (LaA).—This soil has the profile described as representative for the Laveen series. Size of individual areas is about 350 acres.

Included with this soil in mapping were small areas of Rillito, Cavelt, Avondale, and Mohall soils. Also included were small areas of soils in which more than 15 percent of the surface layer, by volume, is gravel and slopes are greater than 1 percent. Other inclusions consist of small areas of soils that have a surface layer of fine sandy loam or of loamy fine sand, and underlying material that is generally very fine sandy loam and sandy loam.

Runoff is slow. The hazard of erosion is slight.

This Laveen soil is used to grow cotton, alfalfa, sorghum, small grains, sugar beets, citrus, and vegetables. Following rains in summer and in winter, it is also occasionally used for grazing. Most of the city of Mesa is located on this soil. Some areas are used for baseball fields and golf courses. Capability unit I–1 irrigated; subclass VIIc dryland.

Laveen loam, 1 to 3 percent slopes (LaB).—This soil is on old alluvial fans adjacent to the foot slopes of mountains. It has a profile similar to the one described as representative of the series. Included in mapping were small areas of Laveen loam, 0 to 1 percent slopes; Mohall loam; and Rillito gravelly loam.

Runoff is slow to medium. Water erosion is a slight hazard.

This soil is used for the same crops as are grown on Laveen loam, 0 to 1 percent slopes, but only a small acreage is cultivated. A large part of the acreage is used as sites for homes and for golf courses and other recreational areas. Capability unit IIe–1 irrigated; subclass VIIc dryland.

Laveen clay loam, 0 to 1 percent slopes (LeA).—This soil is mainly on low terraces of the Salt River. In most places slopes are less than 0.5 percent. Size of most individual areas is about 285 acres. The profile is similar to the one described as representative for the Laveen series. The surface layer is clay loam, however, and it has a slightly darker color and contains slightly more organic matter than the one in the profile described as representative.

Included with this soil in mapping were small areas of Avondale clay loam and Contine clay loam. Also included were small areas in which the surface layer is loam.

Runoff is slow. The hazard of erosion is slight.

This Laveen soil is used to grow cotton (fig. 5), alfalfa, sorghum, small grains, sugar beets, citrus, and vegetables. Near the cities of Mesa and Tempe, it is also used as sites for many homes. A golf course, a baseball diamond, and other recreational facilities occupy some areas. Capability unit I–1 irrigated; subclass VIIc dryland.

Mohall Series

The Mohall series consists of well-drained soils on old alluvial fans and on the sides of valleys. These soils have slopes of 0 to 1 percent. They formed in old alluvial material derived from a mixture of rocks, including granite, schist, some basic igneous rocks, and limestone. Vegetation is mainly creosotebush, mesquite, saltbush, a few cactuses, annual grasses (fig. 6), and weeds. Elevations range from 1,100 to 1,700 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Mohall soils are associated mainly with Antho, Contine, and Vecont soils.

In a representative profile, the surface layer is about 18 inches thick. It is light-brown loam in the upper part and is light-brown light sandy clay loam in the lower part. The upper part of the subsoil extends to a depth of about 40 inches and is reddish-brown light clay loam over brown sandy clay loam. The lower part of the subsoil extends to a depth of 60 inches or more and is brown and light-brown loam. These soils are generally moderately alkaline and are calcareous throughout.

Permeability is moderately slow, and the available water capacity is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for most of the irrigated crops commonly grown in the survey area. Areas that still have a cover of desert vegetation are sometimes grazed for short periods. Some areas are used as sites for homes.

Representative profile of Mohall loam in a cultivated area, 60 feet east and 60 feet south of the northwest corner of sec. 24, T. 1 S., R. 5 E., in Maricopa County:

Ap1—0 to 15 inches, light-brown (7.5YR 6/4) loam, dark brown (7.5YR 4/4) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine, fine, and medium roots; few, very fine, interstitial pores; strongly effervescent; moderately alkaline; abrupt, smooth boundary. 12 to 18 inches thick.

Ap2—15 to 18 inches, light-brown (7.5YR 6/4) light sandy clay loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine and fine roots; few, very fine, interstitial pores; strongly effervescent; moderately alkaline; clear, smooth boundary. 4 to 7 inches thick.

B21tca—18 to 26 inches, reddish-brown (5YR 5/4) light clay loam, reddish brown (5YR 4/4) when moist; weak, fine and medium, subangular and angular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; few very fine and fine roots; many, very fine, tubular pores; common thin clay films on ped surfaces and in pores; common to many, fine and medium, pinkish-white (5YR 8/2) masses and veins of lime, pinkish gray (5YR 7/2) when moist; strongly to violently effer-

Figure 5.—**Irrigated cotton on Laveen clay loam, 0 to 1 percent slopes.**

vescent; moderately alkaline; clear, wavy boundary. 4 to 14 inches thick.

B22tca—26 to 40 inches, brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) when moist; moderate, fine and medium, subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; few very fine and fine roots; many, very fine, tubular pores; common thin clay films on ped surfaces and in tubular pores; many, fine to coarse, distinct, pinkish-white (7.5YR 8/2) masses of lime and fragments of soft lime, pinkish gray (7.5YR 7/2) when moist; violently effervescent; moderately alkaline; gradual, wavy boundary. 10 to 24 inches thick.

B31ca—40 to 52 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine roots; many, very fine, tubular pores; common, fine, distinct, pinkish-white (7.5YR 8/8) mycelialike veins and masses of lime; strongly effervescent; moderately alkaline; gradual, wavy boundary. 6 to 16 inches thick.

B32ca—52 to 60 inches, light-brown (7.5YR 6/4) loam, brown (7.5YR 5/4) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common, very fine, tubular pores; common thin manganese stains and coatings in root channels); common, fine, distinct, pinkish-white (7.5YR 8/2) mycelialike veins and masses of lime; strongly to violently effervescent; moderately alkaline.

In the A horizon, hue is generally 7.5YR, but ranges to 10YR; value is 5 to 6 when the soils are dry and 3 or 4 when they are moist; and chroma is 2 to 6, both when the soils are dry and when they are moist. In most places the A horizon is loam, but it is light sandy clay loam in small areas. In places where this soil has been plowed to depths of 15 to 18 inches, the A horizon contains some material from the B horizons. Hue of the B horizon ranges from 5YR to 7.5YR; value is 5 or 6 when the soils are dry and 4 or 5 when they are moist; and chroma of those horizons ranges from 3 to 6, both when the soils are dry and when they are moist. The B horizon is clay loam, sandy clay loam, or loam. In places a C horizon is below a depth of 24 inches. Where present, the C horizon is sandy loam to clay loam. Depth to horizons of lime accumulation ranges from 16 to 36 inches. The entire soil profile is slightly to violently effervescent.

Mohall sandy loam (Mo).—This soil has a profile similar to the one described as representative for the Mohall series, but the surface layer is sandy loam. The surface layer is about 12 to 16 inches thick.

Included with this soil in mapping were small areas of Antho, Laveen, and Valencia soils, and small areas of Mohall loam. Also included were small areas of soils that have slopes greater than 1 percent, and other small areas of soils in which the content of gravel is more than 15 percent.

Runoff is slow. Soil blowing is a slight hazard.

This Mohall soil is used to grow cotton, alfalfa, small grains, sorghum, sugar beets, citrus, and vegetables. In the city of Chandler, it is also used as a site for several homes. Capability unit I–2 irrigated; subclass VIIc dryland.

Figure 6.—**Bermudagrass pasture on Mohall sandy loam.**

Mohall loam (Mv).—This soil has the profile described as representative for the Mohall series. Size of most individual areas is about 180 acres, but some areas are as large as 2,000 acres.

Included with this soil in mapping were small areas of Mohall sandy loam, Antho sandy loam, Contine clay loam, and Vecont clay. Also included were small areas of soils that are saline and alkali. On the soil map, these included saline and alkali soils are indicated by a spot symbol.

Runoff is slow. Soil blowing and water erosion are not hazards.

This Mohall soil is used to grow cotton, alfalfa (fig. 7), small grains, sorghum, sugar beets, citrus, and vegetables. It is also used for grazing for short periods after rains in summer and in winter, and as sites for many homes in the city of Chandler. Capability unit I–1 irrigated; subclass VIIc dryland.

Pimer Series

The Pimer series consists of well-drained soils on flood plains and alluvial fans. These soils have slopes of 0 to 1 percent. They formed in mixed alluvium from acidic and basic igneous rocks. The vegetation is mesquite, creosotebush, saltbush, annual grasses, and weeds. Elevations range from 1,075 to 1,600 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Pimer soils are associated with Avondale, Gilman, Vint, and Cashion soils.

In a representative profile, the surface layer is brown light clay loam and clay loam about 27 inches thick. The underlying material is brown clay loam and loam to a depth of 60 inches or more. These soils are moderately alkaline and are generally calcareous throughout.

Permeability is moderately slow, and available water capacity is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for most of the irrigated crops commonly grown in the survey area. They are also used as sites for homes.

Representative profile of Pimer clay loam in a cultivated area, 850 feet west and 950 feet south of the northeast corner of sec. 17, T. 1 N., R. 5 E., in Maricopa County:

Ap—0 to 15 inches, brown (7.5YR 5/2) light clay loam, dark brown (7.5YR 3/2) when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; many very fine roots; common, very fine, interstitial and tubular pores; strongly effervescent; moderately alkaline; abrupt, smooth boundary. 8 to 16 inches thick.

A1—15 to 27 inches, brown (7.5YR 5/2) clay loam, dark brown (7.5YR 3/2) when moist; weak, fine and medium, subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; common very fine roots; common, very fine, interstitial pores; strongly effervescent; moderately alkaline; gradual, wavy boundary. 11 to 36 inches thick.

Figure 7.—Two irrigated areas of Mohall loam. The upper area is used to grow alfalfa. The lower one is used to grow grain sorghum.

C1—27 to 45 inches, brown (7.5YR 5/2) loam, dark brown (7.5YR 3/2) when moist; weak, fine and medium, subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; common very fine roots; common, very fine, interstitial pores; strongly effervescent; moderately alkaline; clear, wavy boundary. 0 to 24 inches thick.

C2—45 to 60 inches, brown (7.5YR 5/2) clay loam, dark brown (7.5YR 3/2) when moist; weak, medium, subangular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; few very fine roots; few, very fine, interstitial pores; strongly effervescent; moderately alkaline.

Throughout the entire soil profile, hue is generally 7.5YR, but it ranges to 10YR in some areas. In most places value throughout the profile is 5 when the soils are dry and is 3 when they are moist. In some areas below a depth of 36 inches, value is 6 when the soils are dry and is 4 when the soils are moist. Chroma is generally 2 or 3, both when the soils are dry and when they are moist, but it ranges to 4 below a depth of 36 inches in some places. The soil profile is mainly clay loam, loam, or heavy loam throughout, but it contains thin layers of fine sandy loam, very fine sandy loam, silt loam, and silty clay loam in places. These soils are slightly to strongly effervescent throughout.

Pimer clay loam (Pm).—This nearly level soil is in long, narrow areas on alluvial fans and flood plains of the Salt River. Size of the areas is mostly about 50 acres. Slopes are generally about 0.3 percent.

Included with this soil in mapping were areas of soils that have a surface layer of heavy loam, and small areas of Avondale, Cashion, and Gilman soils.

Runoff is slow. Water erosion and soil blowing are not hazards.

This Pimer soil is used to grow cotton, alfalfa, sorghum, small grains, sugar beets, citrus, and vegetables. In the cities of Mesa, Tempe, and Phoenix, it is also used as sites for homes. Capability unit I–1 irrigated; subclass VIIc dryland.

Pinal Series

The Pinal series consists of well-drained soils that have an indurated, lime-silica-cemented pan at a depth of 4 to 20 inches. These soils have slopes of 0 to 3 percent. They are on terraces, where they formed in gravelly alluvium derived from many different kinds of acidic and basic igneous rocks. The vegetation is creosotebush, mesquite, annual grasses, and weeds. Elevations range from 1,100 to 1,700 feet. Average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Pinal soils are associated mainly with Rillito and Laveen soils.

In a representative profile, the soil material is light-brown gravelly loam to a depth of about 18 inches. A very pale brown, indurated, lime-silica-cemented pan is just beneath the gravelly loam and extends to a depth of about 28 inches.

Permeability is moderate above the pan and is very slow in the pan. Available water capacity is low. Roots can penetrate to a depth of 4 to 20 inches.

These soils are not well suited to irrigated crops. Where they occur in small fingerlike areas that extend into areas of more productive Laveen and Rillito soils, however, they are irrigated and are used for the same crops as the Laveen and Rillito soils. North and northeast of the city of Mesa, these soils are used as sites for several homes.

Representative profile of Pinal gravelly loam, 0 to 1 percent slopes, in a noncultivated area of the desert, 940 feet west and 940 feet north of the southeast corner of sec. 6, T. 1 N., R. 6 E., in Maricopa County:

A1—0 to 5 inches, light-brown (7.5YR 6/4) gravelly loam, dark brown (7.5YR 4/4) when moist; weak, medium, platy structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine roots; few, very fine, interstitial pores and few, micro, interstitial pores; about 20 percent of horizon is gravel; strongly effervescent; moderately alkaline; clear, wavy boundary. 1 to 5 inches thick.

C1ca—5 to 18 inches, light-brown (7.5YR 6/4) gravelly loam, dark brown (7.5YR 4/4) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine roots; many, very fine, tubular pores; approximately 20 percent of horizon is gravel; few, fine, distinct, white (10YR 8/2) lime segregations; violently effervescent; moderately alkaline; abrupt, wavy boundary. 3 to 15 inches thick.

C2sicam—18 to 28 inches, very pale brown (10YR 8/3), indurated, lime-silica-cemented duripan that has a thin laminar layer on the upper surface, very pale brown (10YR 7/3) when moist; massive; violently effervescent.

In the A horizon, hue ranges from 7.5YR to 10YR; value is 5 to 7 when the soils are dry and is 4 or 5 when they are moist; and chroma is 3 or 4. The A horizon is loam to gravelly sandy loam. In the C horizon, chroma ranges from 2 to 4. Texture of the C horizon ranges to gravelly very fine sandy loam. More than 15 percent of the indurated lime-silica-cemented pan is gravel and cobblestones.

Pinal gravelly loam, 0 to 1 percent slopes (PnA).—This nearly level soil is on terraces along the Salt River. The areas are mainly long and narrow, and they range from 5 to 70 acres in size. The profile of this soil is the one described as representative for the Pinal series.

Included with this soil in mapping were small areas of Pinal gravelly loam, 1 to 3 percent slopes; Rillito gravelly loam; Pinal loam, moderately deep variant; and Laveen loam.

Runoff is slow. Water erosion and soil blowing are not hazards.

This Pinal soil is used for cotton, alfalfa, and citrus, mainly because some small areas extend into areas of more productive soils and are farmed with those soils. Where citrus trees are to be planted, dynamite is sometimes used to blast holes. A few homes are located on this soil. Capability unit not assigned; subclass VIIs dryland.

Pinal gravelly loam, 1 to 3 percent slopes (PnC).—This gently sloping soil is on terraces. Its profile is similar to the one described as representative of the series. Most areas are long and narrow and range from 3 to 45 acres in size.

Included with this soil in mapping were small areas where slopes are less than 1 percent, and other small areas where slopes are as much as 5 percent. Also included were small areas of Rillito soils.

Runoff is slow to medium. Water erosion is a slight hazard.

This Pinal soil is not used for irrigated crops. Some homes are located on it. Capability unit not assigned; subclass VIIs dryland.

Pinal Series, Moderately Deep Variant

Soils of the Pinal series, moderately deep variant, are well drained. They have an indurated lime-silica-cemented pan at a depth of 30 to 40 inches. These soils are on terraces, where they formed in mixed alluvial material from acidic and basic igneous rocks. Slopes are 0 to 1 percent. The vegetation is creosotebush, mesquite, saltbush, annual grasses, and weeds. Elevations range from 1,100 to 1,700 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Soils of the Pinal series, moderately deep variant, are associated with normal Pinal soils and with Rillito, Laveen, and Mohall soils.

In a representative profile, the surface layer is brown and light-brown loam about 13 inches thick. The upper part of the underlying material is brown loam about 11 inches thick over a layer of pink gravelly loam about 14 inches thick. A white, indurated, lime-silica-cemented pan is at a depth of about 38 inches and extends to a depth of 60 inches or more. These soils are moderately alkaline and are strongly calcareous throughout.

Permeability is moderate above the hardpan and is very slow in the pan. The available water capacity is moderate. Roots can penetrate to a depth of 30 to 40 inches.

These soils are used for most of the irrigated crops commonly grown in the survey area. They are also used as sites for a few homes.

Representative profile of Pinal loam, moderately deep variant, in a cultivated area, 450 feet east and 50 feet north of the southwest corner of the NE¼SW¼ sec. 1, T. 1 N., R. 5 E., in Maricopa County:

Ap1—0 to 9 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; massive or weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; about 6 percent of horizon is gravel; few very fine roots; violently effervescent; moderately alkaline; abrupt, smooth boundary. 7 to 9 inches thick.

Ap2—9 to 13 inches, light-brown (7.5YR 6/4) loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; about 6 percent of horizon is gravel; few very fine roots; many, very fine, interstitial pores and few, fine, tubular pores; violently effervescent; moderately alkaline; clear, smooth boundary. 0 to 4 inches thick.

C1ca—13 to 24 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) when moist; massive; hard when dry, friable when moist, slightly sticky and plastic when wet; about 6 percent of horizon is gravel; few very fine roots; many, very fine and micro, tubular pores; common to many, fine and medium, distinct pinkish-white (7.5YR 8/2) segregations of soft lime; violently effervescent; moderately alkaline; clear, wavy boundary. 9 to 11 inches thick.

C2ca—24 to 38 inches, pink (7.5YR 7/4) gravelly loam, light brown (7.5YR 6/4) when moist; massive; very hard when dry, friable when moist, nonsticky and slightly plastic when wet; few very fine roots; many very fine and micro pores; many, medium and coarse, distinct, white (10YR 8/2) segregations of lime and very hard nodules of lime; violently effervescent; about 20 percent of horizon is gravel that occurs as lime concretions; moderately alkaline; clear, wavy boundary. 6 to 15 inches thick.

C3cam—38 to 60 inches, white (10YR 8/2), indurated lime-silica hardpan that has a thin laminar layer on its upper surface.

In the A horizon, hue is 7.5YR to 10YR; value is 5 or 6 when the soils are dry and 3 or 4 when they are moist. Chroma is 3 or 4, both when the soils are dry and when they are moist. In most places the A horizon is loam, but texture ranges to fine sandy loam. The C1 horizon is loam in most areas, but texture ranges to very fine sandy loam. Hue in the C1 and C2 horizons ranges from 7.5YR to 10YR; value ranges from 5 to 7 when the soils are dry and from 4 to 6 when they are moist. Chroma ranges from 2 to 4 when the soils are dry and moist. In some places the C1 horizon has a content of gravel of as much as 14 percent. The C2 horizon is loam to very fine sandy loam or fine sandy loam. Gravel in the C2 horizon is in the form of hard, lime-silica concretions. The content of gravel in the C2 horizon ranges from 15 to 30 percent. Depth to the indurated, lime-silica hardpan ranges from 22 to 40 inches. The soil profile is strongly effervescent or violently effervescent throughout.

Pinal loam, moderately deep variant (Po).—This soil occurs in long, narrow areas. Size of most of the areas is about 30 acres.

Included with this soil in mapping were small areas of Pinal gravelly loam, 0 to 1 percent slopes; Rillito gravelly loam, 0 to 1 percent slopes; and Laveen loam, 0 to 1 percent slopes.

Runoff is slow. Water erosion and soil blowing are not hazards.

This Pinal soil is used to grow irrigated cotton, alfalfa, sugar beets, sorghum, small grains, and citrus. In a few places northeast of the city of Mesa, it is also used as sites for homes. Capability unit IIs-5 irrigated; subclass VIIs dryland.

Pinamt Series

The Pinamt series consists of well-drained soils on terraces and alluvial fans. These soils have slopes of 0 to 5 percent. They formed in alluvium derived from acidic and basic igneous rocks. The vegetation is mainly creosotebush, mesquite, cactus, annual grasses, and weeds. Elevations range from 1,100 to 1,800 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Pinamt soils are associated mainly with Antho, Cavelt, and Tremant soils.

In a representative profile, the surface layer is light-brown very gravelly loam about 3 inches thick. The subsoil, about 37 inches thick, is reddish-brown and yellowish-red very gravelly sandy clay loam in the upper part and is reddish-yellow very gravelly loam in the lower part. The substratum is light-brown, weakly cemented very gravelly loam that extends to a depth of 60 inches or more. These soils are moderately alkaline and are generally calcareous throughout.

Permeability is moderately slow, and the available water capacity is low. Roots can penetrate to a depth of 40 to 48 inches.

Some areas of these soils that have slopes of less than 1 percent are used for the commonly grown irrigated crops. Mainly, these soils are used as sites for homes and for recreation areas.

Representative profile of Pinamt very gravelly loam, 3 to 5 percent slopes, in a noncultivated area of the desert, 450 feet south and 800 feet east of the west quarter corner of sec. 34, T. 3 N., R. 3 E., in Maricopa County:

A1—0 to 3 inches, light-brown (7.5YR 6/4) very gravelly loam, reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; many, very fine and fine, vesicular and tubular pores; more than 70 percent of horizon is gravel; slightly effervescent; moderately alkaline; abrupt, wavy boundary. 2 to 6 inches thick.

B1t—3 to 6 inches, reddish-brown (5YR 5/4) very gravelly sandy clay loam, reddish brown (5YR 4/4) when moist; weak, fine, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; few very fine and fine roots; common, fine, tubular pores and many, fine, interstitial pores; approximately 70 percent of horizon is gravel; few thin clay films in pores; strongly effervescent; moderately alkaline; clear, wavy boundary. 2 to 6 inches thick.

B2t—6 to 17 inches, yellowish-red (5YR 4/6) very gravelly sandy clay loam, reddish brown (5YR 4/4) when moist; moderate, fine and medium, subangular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; few fine and medium roots; few, fine, tubular and interstitial pores; approximately 60 percent of horizon is gravel; common thin clay films on ped surfaces and in pores; strongly effervescent; moderately alkaline; abrupt, wavy boundary. 9 to 18 inches thick.

B3ca—17 to 40 inches, reddish-yellow (5YR 6/6) very gravelly loam, yellowish red (5YR 5/6) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; many, fine, interstitial pores and few, fine, tubular pores; approximately 60 percent of horizon is gravel; few thin clay films in pores; many, large, distinct, pink (5YR 8/4) lime segregations and coatings on the underside of pebbles; violently effervescent; moderately alkaline; abrupt, wavy boundary. 12 to 28 inches thick.

Cca—40 to 60 inches, light-brown (7.5YR 6/4), weakly cemented very gravelly loam, reddish brown (5YR 4/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; many, fine and medium, distinct lime segregations; approximately 50 percent of horizon is gravel; strongly effervescent; moderately alkaline.

In the A horizon, hue is 7.5YR to 10YR; value is 5 or 6 when the soils are dry and is 4 or 5 when they are moist; and chroma is 3 or 4, both when the soils are dry and when they are moist. Typically, the A horizon is very gravelly loam, but it is very gravelly clay loam in small areas. In most places the A horizon is slightly to strongly effervescent. Hue in the B and C horizons ranges from 5YR to 7.5YR; value is 4 to 6 when the soils are dry and 4 to 5 when they are moist. Chroma is 4 to 6 when the soils are dry and moist. The B horizons are generally very gravelly sandy clay loam or very gravelly loam, but their texture ranges to very gravelly clay loam. The C horizon is typically very gravelly loam, but its texture ranges to very gravelly sandy loam.

Pinamt very gravelly loam, 0 to 1 percent slopes (PvA).—In most places this nearly level soil occurs on alluvial fans and terraces in association with Avondale and Gilman soils. Its profile is similar to the one described as representative of the series. The areas are long and narrow, and they mostly are about 13 acres in size.

Included with this soil in mapping were small areas of Rillito and Pinal soils.

Runoff is slow. Erosion is not a hazard.

This Pinamt soil is used for cotton, alfalfa, small grains, sorghum, pasture, and citrus, but it is not well suited to these crops. It is used for them mainly because it is within areas of more productive soils and is farmed with those soils. Capability unit IVs-6 irrigated; subclass VIIs dryland.

Pinamt very gravelly loam, 3 to 5 percent slopes (PvC).—This gently sloping soil is on old alluvial fans, near the foot slopes of mountains. It has the profile described as representative for the Pinamt series. Slopes are mainly 3 to 4 percent. Size of most areas is about 155 acres.

Included with this soil in mapping were small areas of Antho, Cavelt, Rillito, and Tremant soils.

Runoff is medium. Water erosion is a slight hazard.

This Pinamt soil is not used for cultivated crops, but it is used as range for short periods after rains in summer and in winter. Some homes are located on it, and other areas are used for picnicking. Capability unit not assigned; subclass VIIe dryland.

Rillito Series

The Rillito series consists of well-drained soils on old alluvial fans and terraces. These soils have slopes of 0 to 3 percent. They formed in mixed alluvium derived from acidic and basic igneous rocks. The vegetation is creosotebush, mesquite, cactus, desert sage, annual grasses, and weeds. Elevations range from 1,100 to 1,700 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Rillito soils are associated mainly with Pinal, Laveen, and Tremant soils.

In a representative profile, the surface layer is light-brown gravelly loam about 13 inches thick. The underlying material is light-brown and pinkish-gray gravelly loam that extends to a depth of 60 inches or more. The soil profile contains lime concretions and masses of soft lime. These soils are moderately alkaline and are strongly calcareous throughout.

Permeability and the available water capacity are both moderate. Roots can penetrate to a depth of 60 inches or more.

These soils are used for most of the irrigated crops commonly grown in the survey area. Some areas are used as range for short periods following rains. Other small tracts are used as sites for homes or for recreation areas.

Representative profile of Rillito gravelly loam, 0 to 1 percent slopes, in a cultivated area, 800 feet east and 1,200 feet north of the center of sec. 11, T. 1 N., R. 5 E., in Maricopa County:

Ap—0 to 13 inches, light-brown (7.5YR 6/4) gravelly loam, brown (7.5YR 5/4) when moist; weak, fine and very fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastice when wet; common fine and few medium roots; few, fine, tubular and interstitial pores; 25 to 30 percent of horizon is gravel; strongly effervescent; moderately alkaline; abrupt, smooth boundary. 8 to 16 inches thick.

C1—13 to 18 inches, light-brown (7.5YR 6/4) gravelly loam, brown (7.5YR 5/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine and few medium roots; few, fine, tubular and interstitial pores; 30 percent of horizon is gravel that is partly lime concretions; strongly effervescent; moderately alkaline; clear, wavy boundary. 3 to 16 inches thick.

C2ca—18 to 43 inches, pinkish-gray (7.5YR 7/2) gravelly loam, brown (7.5YR 5/4) when moist; massive; hard when dry, friable when moist, slightly sticky and plastic when wet; common fine roots; few, fine, tubular and interstitial pores; 35 percent of horizon is gravel that is largely lime concretions; common, medium, distinct lime mottles that are pinkish white (7.5YR 8/2) and pinkish gray (7.5YR 7/2) when moist; violently effervescent; moderately alkaline; clear, wavy boundary. 20 to 36 inches thick.

C3ca—43 to 60 inches, light-brown (7.5YR 6/4), weakly cemented gravelly loam, dark brown (7.5YR 4/4) when moist; massive; hard when dry, firm when moist, slightly sticky and plastic when wet; few, very fine, interstitial and tubular pores; 25 percent of horizon is gravel, mostly lime concretions; many, medium, distinct, pinkish-white (7.5YR 8/2) lime mottles that are pinkish gray (7.5YR 7/2) when moist; violently effervescent; moderately alkaline.

The A horizon ranges from gravelly loam to gravelly sandy loam. Throughout the profile hue ranges from 7.5YR to 10YR; value ranges from 5 to 7 when the soils are dry and from 4 to 6 when they are moist. In most places the C horizons are gravelly loam, but the texture ranges to gravelly sandy loam.

Rillito gravelly loam, 0 to 1 percent slopes (RlA).—This soil has the profile described as representative for the Rillito series. It occurs in long, narrow areas that mostly are about 40 acres in size.

Included with this soil in mapping were small areas of Laveen, Cavelt, Pinamt, and Tremant soils.

Runoff is slow. Erosion is not a hazard.

This Rillito soil is used to grow irrigated cotton, alfalfa, sorghum, small grains, sugar beets, and citrus. For short periods after rains in summer and in winter, some areas are used as range. Some homes and a golf course are located on this soil. Capability unit IIs–6 irrigated; subclass VIIs dryland.

Rillito gravelly loam, 1 to 3 percent slopes (RlB).—This soil occurs in areas that are mostly about 45 acres in size. Its profile is similar to the one described as representative of the series. Included with this soil in mapping were small areas of a soil that has a surface layer of gravelly sandy loam, and small areas of Cavelt, Antho, and Tremant soils.

Runoff is slow to medium. Water erosion is a slight hazard.

This Rillito soil is used to grow irrigated cotton, alfalfa, sorghum, small grain, and citrus. Only a small acreage is cultivated. This soil is also used as a site for a few homes. Capability unit IIe–6 irrigated; subclass VIIs dryland.

Rock Land

Rock land (Ro) consists of areas that are 50 to 70 percent exposed rock, local rubble, and very shallow or shallow gravelly loam, sandy loam, and clay loam. It is dominantly strongly sloping to very steep, but it is gently sloping or moderately sloping in small areas. Most of the acreage is in the Phoenix, Salt River, and San Tan Mountains. Rocks are mainly granite, schist, andesite, and conglomerate.

Rock land supports a sparse cover of vegetation consisting of cactus, creosotebush, palo verde, grasses, and forbs. Moss and lichen grow on the north-facing slopes of exposed rock. Elevations range from 1,100 to 3,500 feet. The average annual rainfall is 7 to 10 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 200 to 300 days.

Runoff is very rapid, and geologic erosion is active. Permeability is variable, but in general it ranges from moderately slow to rapid. The available water capacity is low. The root zone is shallow or very shallow.

Rock land is used for limited grazing and as sites for homes. It is also used for parks and recreation areas. Capability unit not assigned; subclass VIIs dryland.

Rough Broken Land

Rough broken land (Ru) is a moderately sloping to very steep land type on the breaks of high terraces and on toe slopes of the Phoenix, Salt River, and San Tan Mountains. The areas are dissected by many intermittent V-shaped drainage channels that mostly are about 30 feet deep and are 70 to 100 feet wide at the top. Between the channels are irregular, narrow ridges occupied by different soils. On the ridgetops are mainly gravelly soils and small areas of gently sloping Antho, Cavelt, Pinamt, Rillito, and Tremant soils. Slopes range from 5 to 60 percent.

The vegetation on Rough broken land is mainly creosotebush, mesquite, palo verde, cactus, forbs, and annual grasses. Elevations range from 1,200 to 2,000 feet. The average annual rainfall is 6 to 9 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 225 to 300 days.

Runoff is rapid, and geologic erosion is active. Permeability is rapid to moderate, and the available water capacity is low to moderate. The root zone is shallow to deep.

Rough broken land is used for limited grazing, for city parks, and for bridle trails and other recreation areas. It is also used as a site for a few homes. Capability unit not assigned; subclass VIIe dryland.

Tremant Series

The Tremant series consists of well-drained soils on old alluvial fans that extend outward from the nearby mountains. These soils have slopes of 1 to 3 percent. They formed in alluvium derived from a mixture of different rocks from the local mountains. The vegetation is creosotebush, mesquite, desert sage, cactus, annual grasses, and weeds. Elevations range from 1,100 to 1,800 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Tremant soils are associated with Antho, Cavelt, and Pinamt soils.

In a representative profile, the surface layer is light-brown gravelly loam about 1 inch thick. The subsoil is reddish-brown gravelly sandy clay loam about 15 inches thick. It is underlain by a substratum that extends to a depth of 60 inches or more and is pink gravelly loam in the upper part and is light-brown gravelly sandy loam in the lower part. These soils are moderately alkaline and are generally calcareous throughout.

Permeability is moderately slow, and the available water capacity is moderate. Roots can penetrate to a depth of 60 inches or more.

These soils are used for most of the crops commonly grown in the survey area. Following rains in summer and in winter, they are used as range for short periods. A few areas are also used as sites for homes.

Representative profile of Tremant gravelly loam, 1 to 3 percent slopes, in a noncultivated area of the desert, 1,600 feet east and 1,100 feet north of the east quarter corner of sec. 13, T. 3 S., R. 7 E., in Pinal County:

A1—0 to 1 inch, light-brown (7.5YR 6/4) gravelly loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; very few very fine roots; common, fine, vesicular pores; 45 percent of horizon is gravel; slightly effervescent; moderately alkaline; abrupt, smooth boundary. 1 to 4 inches thick.

B21t—1 to 5 inches, reddish-brown (5YR 5/4) gravelly sandy clay loam, reddish brown (5YR 4/4) when moist; moderate, medium, subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; very few very fine roots; common, fine, tubular pores; 20 percent of horizon is gravel; common thin clay films on ped surfaces and in pores; slightly effervescent; moderately alkaline; clear, wavy boundary. 4 to 8 inches thick.

B22t—5 to 16 inches, reddish-brown (5YR 5/4) gravelly sandy clay loam, reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; very few fine roots; few, fine, tubular pores; 15 to 20 percent of horizon is gravel; few thin clay films on ped surfaces; strongly effervescent; moderately alkaline; gradual, wavy boundary. 8 to 18 inches thick.

C1ca—16 to 41 inches, pink (7.5YR 7/4) gravelly loam, light brown (7.5YR 6/4) when moist; massive; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few, fine, tubular pores; 25 percent of horizon is gravel; violently effervescent; moderately alkaline; abrupt, wavy boundary. 20 to 36 inches thick.

C2—41 to 60 inches, light-brown (7.5YR 6/4) gravelly sandy loam, brown (7.5YR 5/4) when moist; massive; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; 25 percent of horizon is gravel; strongly effervescent; moderately alkaline.

In the A horizon, hue ranges from 7.5YR to 10YR and value is 5 or 6 when the soils are dry and is 4 or 5 when they are moist. The A horizon ranges from gravelly loam to gravelly sandy clay loam or gravelly clay loam. In places the B horizon is gravelly clay loam or gravelly heavy loam. In the B horizon, hue ranges from 5YR to 7.5YR; value is 5 or 6 when the soils are dry and is 4 or 5 when they are moist; and chroma is 4 or 5, both when the soils are dry and when they are moist. The A horizon ranges from gravelly loam to 5YR, value ranges from 4 to 6 when the soils are moist, and and chroma is 4 or 5, both when the soils are dry and when are moist. In some areas the C horizon is gravelly heavy loam or gravelly light sandy loam. The content of gravel in the soil profile ranges from 15 to 35 percent, by volume.

Tremant gravelly loam, 1 to 3 percent slopes (TrB).—This soil is in areas that are rather long and narrow. Size of most areas is about 60 acres.

Included in mapping were areas of Pinamt, Antho, Cavelt, and Rillito soils, and areas in which the slope is less than 1 percent. Also included were areas of a soil that has short slopes of as much as 5 percent.

Runoff is slow to medium. Water erosion is a slight hazard in places.

Though only a small acreage is cultivated, this Tremant soil is used for such crops as cotton, alfalfa, sorghum, small grains, and citrus, peaches, and other fruits (fig. 8). Some areas are used as range for short periods following rains in summer and in winter, and a few areas are used as homesites. Capability unit IIe–6 irrigated; subclass VIIs dryland.

Trix Series

The Trix series consists of well-drained soils, mainly on flood plains and fans of the Queen Creek Wash. These soils have slopes of 0 to 1 percent. They formed in mixed parent material derived from many different kinds of rocks. The vegetation is mesquite, creosotebush, bur-sage, annual grasses, and weeds. Elevations range from 1,075 to 1,600 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Trix soils are associated with Gilman, Glenbar, and Estrella soils.

In a representative profile, the surface layer is light-brown light clay loam about 14 inches thick. It is underlain by a layer of light-brown clay loam that extends to a depth of about 24 inches. The next layer is light reddish-brown clay loam that extends to a depth of about 37 inches. Beneath it and extending to a depth of 60 inches or more is light-brown clay loam. These soils are moderately alkaline and are calcareous throughout the profile.

Permeability is moderately slow, and available water capacity is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for most of the crops commonly grown in the survey area.

Representative profile of Trix clay loam in a cultivated area, 60 feet east and 40 feet south of the north quarter corner of sec. 4, T. 2 S., R. 6 E., in Maricopa County:

Ap—0 to 14 inches, light-brown (7.5YR 6/4) light clay loam, dark brown (7.5YR 4/4) when moist; massive; hard when dry, friable when moist, slightly sticky and plastic when wet; many very fine and fine roots and a few medium roots; common, very fine, tubular pores; strongly effervescent; moderately alkaline; abrupt, smooth boundary. 10 to 16 inches thick.

C—14 to 24 inches, light-brown (7.5YR 6/4) clay loam, dark brown (7.5YR 4/4) when moist; massive; hard when dry, friable when moist, slightly sticky and plastic when wet; common very fine and fine roots; many, very fine, tubular pores and a few tubular pores that are fine and medium; strongly effervescent; moderately alkaline; clear, smooth boundary. 10 to 22 inches thick.

IIB21tcab—24 to 37 inches, light reddish-brown (5YR 6/4) clay loam, reddish brown (5YR 4/4) when moist; weak, fine and medium, subangular blocky structure; very hard when dry, friable when moist, slightly sticky and plastic when wet; few very fine roots; common, very fine, tubular pores; few thin clay films on ped surfaces and lining tubular pores; few to common, fine, distinct, pink (5YR 8/3) filaments and mottles of lime; violently effervescent; moderately alkaline; clear, wavy boundary. 12 to 16 inches thick.

IIB22tcab—37 to 60 inches, light-brown (7.5YR 6/4) clay loam, dark brown (7.5YR 4/4) when moist; moderate, fine and medium, subangular blocky structure; very hard when dry, friable when moist, slightly sticky and plastic when wet; few very fine roots; many, very fine and micro, tubular pores; common thin clay films on ped surfaces and lining tubular pores; common, fine, distinct, pink (5YR 8/3) veins and mottles of lime; violently effervescent; moderately alkaline.

The A horizon is heavy loam in a few small areas, but the A and C horizons are mainly light clay loam to heavy clay loam. Hue of the A and the C horizons ranges from 7.5YR to 10YR. Value in those horizons is 5 or 6 when the soils are

Figure 8.—Areas of Tremant gravelly loam, 1 to 3 percent slopes, used for fruit trees. Upper part shows an orchard of peaches and apricots. Lower part shows an orchard of plums and nectarines.

dry and 4 or 5 when they are moist. In the IIB horizons, hue ranges from 5YR to 7.5YR and value is 5 or 6 when the soils are dry and 4 or 5 when they are moist. The segregated lime in the IIB horizons has a value of 7 or 8 and chroma as low as 2. In the lower IIB horizon, texture ranges from heavy clay loam to loam. Depth to the IIB horizons ranges from 20 to 38 inches, but it is generally between 24 and 30 inches. In places the uppermost part of the profile is only slightly effervescent, but effervescence ranges to violent in the lower part.

Trix clay loam (Tx).—This soil mostly has slopes of about 0.3 percent. Size of the areas in which it occurs is generally about 170 acres. Small areas of Gilman and Glenbar soils were included in mapping.

Runoff is slow. Erosion is not a hazard.

This Trix soil is used to grow cotton, alfalfa, sorghum, small grains, sugar beets, citrus, and vegetables. Capability unit I–1 irrigated; subclass VIIc dryland.

Valencia Series

In the Valencia series are well-drained soils on valley plains and alluvial fans. These soils have slopes of 0 to 1 percent. They formed in mixed alluvium from many different kinds of acidic and basic igneous rocks. The vegetation is mainly creosotebush, mesquite, palo verde, bur-sage, cactus, annual grasses, and weeds. Elevations range from 1,100 to 1,700 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Valencia soils are associated with Antho, Mohall, and Estrella soils.

In a representative profile, the surface layer is brown light sandy loam about 13 inches thick. The next layer, also brown light sandy loam about 13 inches thick, is underlain by a buried subsoil of light reddish-brown light sandy clay loam about 19 inches thick. Beneath the buried subsoil and extending to a depth of 60 inches or more is a substratum of light-brown sandy loam. In most places these soils are moderately alkaline and are calcareous throughout.

Permeability is moderately rapid in the upper horizons and is moderately slow in the rest of the profile. The available water capacity is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for most of the irrigated crops commonly grown in the survey area. For short periods after rains, they are also used as range. Some areas are used as sites for homes. Others are used as a source of material to be used in engineering structures.

Representative profile of Valencia sandy loam in a cultivated area, 1,620 feet west and 100 feet south of the east quarter corner of sec. 19, T. 2 S., R. 5 E., in Maricopa County:

Ap—0 to 13 inches, brown (7.5YR 5/4) light sandy loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; few fine roots; many, fine, interstitial pores; slightly effervescent; moderately alkaline; gradual, smooth boundary. 8 to 15 inches thick.

C—13 to 26 inches, brown (7.5YR 5/4) light sandy loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; few fine roots; few, fine, tubular pores; strongly effervescent; moderately alkaline; clear, wavy boundary. 7 to 20 inches thick.

IIBtcab—26 to 45 inches, light reddish-brown (5YR 6/4) light sandy clay loam, reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; few, fine and medium, tubular pores; few thin clay films on ped surfaces; few, fine, distinct, pinkish-gray (7.5YR 7/2) lime segregations; strongly effervescent; moderately alkaline; clear, wavy boundary. 14 to 24 inches thick.

IICca—45 to 60 inches, light-brown (7.5YR 6/4) sandy loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; common, fine, distinct, pinkish-gray (7.5YR 7/2) lime segregations; strongly effervescent; few, fine, tubular pores; moderately alkaline.

In the A and the C horizons, hue is 7.5YR to 10YR; value is 5 or 6 when the soils are dry and is 4 or 5 when they are moist. Texture of the A and the C horizons is light sandy loam or sandy loam to fine sandy loam. In a few small areas, the content of gravel in the A and the C horizons is as much as 15 percent. In the IIB horizon, hue is 5YR to 7.5YR; value is 5 or 6 when the soils are dry and is 4 or 5 when the soils are moist; and chroma is 4 or 5, both when the soils are dry and when they are moist. The IIB horizon is sandy clay loam to loam or clay loam. In the segregated lime in the IIB and the IIC horizons, value is as high as 8 and chroma is 2 or 3 in some areas. Effervescence in the IIB and the IIC horizons is violent in some areas. The IIC horizon is sandy loam to loam or sandy clay loam.

Valencia sandy loam (Va).—This soil is in areas that mostly are about 240 acres in size. Included with it in mapping were small areas of soils that have slopes of as much as 1.5 percent, and small areas of Antho, Mohall, and Estrella soils.

Runoff is slow. Soil blowing is a slight hazard.

This soil is used to grow cotton, alfalfa, sorghum, small grains, sugar beets, and citrus. In the community of Guadalupe, it is also used as sites for homes. In some areas it has been used for road fill. Capability unit I–2 irrigated; subclass VIIc dryland.

Vecont Series

The Vecont series consists of well-drained soils in slight depressions on old alluvial fans. These soils have slopes of 0 to 1 percent. They formed in mixed alluvium derived from acidic and basic igneous rocks. The vegetation is mesquite, creosotebush, annual grasses, and weeds. Elevations range from 1,075 to 1,600 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Vecont soils are associated with Contine and Mohall soils.

In a representative profile, the surface layer is reddish-brown clay about 14 inches thick. The subsoil, also reddish-brown clay, is about 27 inches thick. It is underlain by a substratum of reddish-brown clay loam that extends to a depth of 60 inches or more. The soil profile is moderately alkaline and is slightly to strongly calcareous throughout.

Permeability is slow, and available water capacity is high. Roots can penetrate to a depth of 60 inches or more.

These soils are used for most of the crops commonly grown in the survey area. For short periods after rains, nonirrigated areas are occasionally used as range.

Representative profile of Vecont clay in a cultivated area, 1,200 feet south and 100 feet east of the west quarter corner of sec. 14, T. 1 S., R. 6 E., in Maricopa County:

Ap—0 to 14 inches, reddish-brown (5YR 5/4) clay, reddish brown (5YR 4/4) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; common medium and fine roots; common, fine, tubular pores and many, medium, tubular pores; slightly effervescent; moderately alkaline; clear, smooth boundary. 8 to 16 inches thick.

B21t—14 to 27 inches, reddish-brown (5YR 5/4) clay, reddish brown (5YR 44) when moist; weak, coarse, prismatic structure parting to weak, medium and coarse, angular blocky structure; very hard when dry, firm when moist, sticky and very plastic when wet; few very fine and fine roots; common, fine and very fine, tubular pores; common thin clay films on ped surfaces and lining tubular pores; few, fine, distinct, pink (5YR 7/4) lime filaments; slightly effervescent; moderately alkaline; gradual, smooth boundary. 8 to 20 inches thick.

B22tca—27 to 41 inches, reddish-brown (5YR 5/3) clay, reddish brown (5YR 4/4) when moist; weak, medium and coarse, subangular blocky and angular blocky structure; very hard when dry, very firm when moist, sticky and very plastic when wet; common very fine roots; common, fine and very fine, tubular pores; common thin clay films on ped surfaces and lining tubular pores; common, fine, distinct, light-brown (7.5YR 6/4) lime filaments and segregations; strongly effervescent; moderately alkaline; clear, wavy boundary. 8 to 24 inches thick.

Cca—41 to 64 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; few very fine roots; common, fine and very fine, tubular pores; few, thin clay films that occur as bridges and that line tubular pores; few, fine, distinct, light-brown (7.5YR 6/4) lime filaments and segregations; strongly effervescent; moderately alkaline.

The Ap horizon ranges from clay or light clay to clay loam in texture. Throughout the profile, hue ranges from 5YR to 7.5YR; value ranges from 4 to 6 when the soils are dry and from 3 to 5 when they are moist; and chroma ranges from 2 to 4, both when the soils are dry and when they are moist. The B horizon is light clay in places. In some areas the segregated lime in the B and the C horizons has a color value as high as 8 and chroma as low as 1. The C horizon is absent in some areas. Where present, it is at a depth of 24 to 60 inches and is light clay loam to clay.

Vecont clay (Ve).—This soil is on the lower parts of old alluvial fans that extend from Williams Air Force Base to the town of Gilbert. It is also on fans in the southeastern corner of the survey area. Slopes are generally less than 0.3 percent. Size of individual areas is about 360 acres.

Included with this soil in mapping were small areas of Contine and Mohall soils.

Runoff is slow. Water erosion and soil blowing are not hazards.

This Vecont soil is used to grow cotton, alfalfa, sorghum, small grains, citrus, and sugar beets. After rains in summer and in winter, some areas in the southeastern corner of the survey area are used for grazing. Capability unit IIIs-3 irrigated; subclass VIIs dryland.

Vint Series

The Vint series consists of nearly level, well-drained soils on flood plains and alluvial fans of the Queen Creek Wash and the Salt River. These soils have slopes of 0 to 1 percent. They formed in mixed, coarse-textured alluvial material derived from many different kinds of rocks. The vegetation is mainly creosotebush, mesquite, annual grasses, and weeds. Elevations range from 1,075 to 1,600 feet. The average annual rainfall is 6 to 8 inches, the average annual soil temperature is 72° to 74° F., and the frost-free period is 240 to 300 days. Vint soils are associated mainly with Carrizo, Gilman, and Agualt soils.

In a representative profile, the surface layer is pale-brown loamy fine sand about 12 inches thick. The underlying layers, to a depth of 60 inches or more, are mainly brown or pale-brown loamy fine sand, but they contain thin layers of silt loam or very fine sandy loam. These soils are generally mildly alkaline in the upper part of the profile and are moderately alkaline in the lower part. The entire profile is calcareous.

Permeability is moderately rapid, and available water capacity is moderately low. Roots can penetrate to a depth of 60 inches or more.

These soils are used for most of the irrigated crops commonly grown in the survey area. For short periods after rains, some areas are used for grazing. Some areas are also used as sites for homes, and others are a source of material to be used in engineering structures.

Representative profile of Vint loamy fine sand in a cultivated area, 930 feet east and 50 feet south of the northwest corner of sec. 19, T. 2 S., R. 7 E., in Maricopa County:

Ap—0 to 12 inches, pale-brown (10YR 6/3) loamy fine sand, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; few fine and medium roots; few fine interstitial pores; slightly effervescent; mildly alkaline; clear, smooth boundary. 6 to 16 inches thick.

C1—12 to 25 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) when moist; single grain; loose both when dry and when moist, nonsticky and nonplastic when wet; few fine and medium roots; few, fine, interstitial pores; slightly effervescent; mildly alkaline; abrupt, wavy boundary. 10 to 20 inches thick.

IIC2—25 to 27 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine and medium roots; common, fine and medium, interstitial pores; strongly effervescent; moderately alkaline; abrupt, wavy boundary. 0 to 3 inches thick.

IIIC3—27 to 33 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) when moist; single grain; loose when dry and when moist, nonsticky and nonplastic when wet; few fine and medium roots; few, fine, interstitial pores; slightly effervescent; moderately alkaline; abrupt, wavy boundary. 5 to 10 inches thick.

IVC4—33 to 36 inches, pale-brown (10YR 6/3) very fine sandy loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine and medium roots; common, fine, interstitial pores; strongly effervescent; moderately alkaline; abrupt, wavy boundary. 0 to 5 inches thick.

VC5—36 to 42 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) when moist; massive; soft when dry, very friable when moist, nonsticky and nonplastic when wet; few fine roots; few, fine, interstitial pores; slightly effervescent; moderately alkaline; clear, wavy boundary. 4 to 8 inches thick.

VIC6—42 to 45 inches, pale-brown (10YR 6/3) fine sandy loam, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; few, fine, interstitial pores; slightly effervescent; moderately alkaline; clear, wavy boundary. 1 to 3 inches thick.

VIIC7—45 to 60 inches, brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) when moist; single grain; loose when dry and moist, nonsticky and nonplastic when wet; very few fine roots; few, fine, interstitial pores; slightly effervescent; moderately alkaline.

The A horizon ranges from loamy fine sand to sandy loam, fine sandy loam, loamy very fine sand, or loamy sand. Throughout the profile hue ranges from 10YR to 7.5YR and chroma is 3 or 4, both when the soils are dry and when they are moist. The C horizons range from loamy fine sand or loamy sand to loamy very fine sand. In a few places, a layer of loam, silt loam, or very fine sandy loam is at some depth below 40 inches. The profile contains thin layers (1 to 3 inches thick) of finer textured material in most places.

Vint loamy fine sand (Vf).—This nearly level soil is on alluvial fans of the Queen Creek Wash. It has slopes of less than 0.4 percent. The areas are rather long and narrow, and they mostly are about 42 acres in size.

Included with this soil in mapping were small areas of Carrizo fine sandy loam, Gilman fine sandy loam, and Agualt fine sandy loam.

Soil blowing is a slight hazard. Runoff is very slow.

This Vint soil is used to grow cotton, alfalfa, sugar beets, sorghum, small grains, citrus, potatoes, and grapes (fig. 9). Some homes are also built on it, and material to be used as subgrade and as fill for use in constructing roads and airfields has been taken from some areas. Capability unit IIIs-7 irrigated; subclass VIIs dryland.

Use and Management of the Soils

This section describes use and management of the soils for crops and pasture. It also gives facts about suitability of the soils as recreational areas, briefly discusses their use for wildlife habitat, and explains engineering uses of the soils.

Management for Crops and Pasture

Among the principal crops commonly grown in the survey area under irrigation are cotton, sorghum, barley, alfalfa, sugar beets, and citrus. In the following pages, practices suitable for these main crops are described. First, management of irrigated soils is briefly discussed, the system of capability classification used by the Soil Conservation Service is defined, and management suitable for the soils of each capability unit is explained. Then,

Figure 9.—Area of Vint loamy fine sand used to grow grapes.

predicted average acre yields of these principal crops are given and specific management practices are described for each of the crops for which predicted average yields per acre are listed. Finally, management of nonirrigated and nonarable soils is briefly discussed.

Management of irrigated soils[3]

The productivity of a soil and its response to management depend upon the characteristics of the soil and on the kind of management received. Soil characteristics are difficult to change, but management can be controlled. Proper soil management consists of applying a combination of several practices that conserve the soils and water. Among the practices needed on nearly all the soils of the survey area are returning crop residue to the soils, keeping tillage to a minimum, and applying the proper kinds and amounts of fertilizer. Also important for keeping the soils in good tilth is a good cropping system that includes legumes.

Crop residue, returned to the soils, is an important source of organic matter. Regularly supplying additions of organic matter increases the supply of plant nutrients, makes the soils more porous so that air and moisture can penetrate more readily, and maintains or improves soil structure.

Practicing minimum tillage helps to maintain satisfactory soil structure and reduces compaction, thus allowing air and water to move freely within the soils. It is also important to till the soils at a time when the content of moisture is such that compaction is kept to a minimum. Another practice that helps to reduce compaction consists of constructing well-designed access roads that serve to minimize travel across these soils. Chemical weed control, where practical to apply, reduces the amount of tillage required.

On irrigated soils of the survey area, the best results from fertilizer are obtained if soil tests are used to determine the requirements for fertilizer. Generally, nonlegumes grown in the survey area respond well to applications of a fertilizer high both in content of nitrogen and in content of phosphorus. Legumes respond to applications of a fertilizer high in content of phosphorus.

If management is good, a large part of the cropping system can generally consist of row crops. Practicing minimum tillage is necessary, however, and it is necessary to return all crop residue to the soils.

Most of the crops commonly grown in Maricopa and Pinal Counties are grown on soils of the survey area. The small amount of moisture received from rainfall, the long growing season, and the hot, dry summers cause moisture requirements to be high. For satisfactory results where crops are grown, a properly designed irrigation system is required that will supply the need for moisture. Efficient management of irrigation water can be achieved by shaping fields to a level or nearly level grade, lining the irrigation ditches with concrete, and adjusting the length of irrigation runs according to texture and permeability of the soils. In the survey area, it is assumed that a good quality of irrigation water is available. Irrigation water is generally applied by the border, furrow, or corrugation method. A few sprinkler systems are in use.

[3] LEON KIMBERLIN, agronomy specialist, Soil Conservation Service, assisted in preparing this section.

All of the irrigated soils in the survey area are at an elevation of 1,075 to 1,800 feet. The average annual rainfall is 6 to 8 inches, and the average annual soil temperature is 72° to 74° F. (*7*). The frost-free season is 240 to 300 days.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, and for engineering.

In the capability system, the kinds of soil are grouped at three levels, the capability class, the subclass, and the unit. These levels are described 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, 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, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife. (None in the survey area.)

Class VI soils have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture or range, woodland, or wildlife. (None in the survey area.)

Class VII soils have very severe limitations that make unsuitable for cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial production of crops and restrict their use to recreation, wildlife, or water supply, or to use for esthetic purposes. (None in the survey area.)

Capability Subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture or range, woodland, wildlife habitat, or recreation.

Capability Units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIs-7. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages, the capability units in classes I through IV in the Eastern Maricopa and Northern Pinal Counties Area are described and suggestions for the use and management of the soils are given. Capability numbers are generally assigned locally but are part of a statewide system. All the units in the system are not represented by the soils of the survey area; therefore, the numbers are not consecutive. To find the names of all the soils in any given capability unit, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I-1 IRRIGATED

This capability unit consists of nearly level, deep, well-drained soils on flood plains, alluvial fans, and terraces. These soils have slopes of 0 to 1 percent. They are loam or clay loam throughout. Permeability is moderate or moderately slow, and available water capacity is 7½ to 13 inches in the 60-inch depth to which roots normally penetrate. Runoff is slow, and the hazard of erosion is slight.

These soils are used mainly to grow cotton, alfalfa, sorghum, small grains, citrus, vegetables, and sugar beets, but safflower and grapes are also grown to some extent. If tillage is kept to a minimum and if crop residue is returned to the soils, a large part of the cropping system can consist of row crops.

Where the border or furrow method is used for applying irrigation water, leveling is needed to eliminate nearly all of the slope. These soils are deep enough that deep cuts and fills can be made during leveling without making the soils less suitable for crops. For the most efficient use of water, length of irrigation runs should normally not exceed 1,320 feet.

CAPABILITY UNIT I-2 IRRIGATED

In this unit are level or nearly level, deep, well-drained soils on alluvial fans and flood plains. These soils have slopes of 0 to 1 percent. Their surface layer is sandy loam or fine sandy loam, and their subsoil is loam to clay loam. Soil blowing is not a hazard or is only a slight hazard. Runoff is slow. Permeability is moderate or moderately slow. Available water capacity is 7½ to 10 inches in the 60-inch depth to which roots normally penetrate.

These soils are used for cotton, alfalfa, sorghum, small grain, sugar beets, vegetables, potatoes, citrus, and grapes. A large part of the cropping system can consist of row crops if tillage is kept to a minimum and if crop residue is returned to the soils. A rotation frequently used is 3 years of alfalfa, 1 year of cotton, and 1 year of a small grain or grain sorghum.

If the furrow or border method of applying irrigation water is used, the soils should be leveled so that all or nearly all of the slope is eliminated. These soils are deep enough that deep cuts and fills can be made and the suitability of the soils for crops will be affected only slightly if at all. For the most efficient use of irrigation water, the length of irrigation runs should not exceed 880 feet. From the time the crop is seeded until the time the seedlings emerge and become established, the surface layer should be kept moist enough for seeds to germinate and for the needs of the young plants to be met.

CAPABILITY UNIT IIe-1 IRRIGATED

Only Laveen loam, 1 to 3 percent slopes, is in this capability unit. This soil is gently sloping, deep, and well drained, and it is on old alluvial fans that extend outward from the local mountains. The texture is loam throughout the profile. Permeability is moderate. Available water capacity is 9 to 11 inches in the 60-inch depth to which roots normally penetrate. Runoff is slow to medium. The hazard of erosion is slight.

If this soil is adequately protected from erosion, it is suited to all the crops commonly grown in the survey area. Crops generally grown are cotton, alfalfa, barley, sorghum, citrus, and sugar beets. If tillage is kept to a minimum and if crop residue is returned to the soil, a large part of the cropping system can consist of row crops. A frequently used crop rotation is 2 years of cotton, 1 year of a small grain or grain sorghum, and 3 years of alfalfa.

Where the border or furrow method of irrigation is used for applying irrigation water, bench leveling is needed to eliminate all or nearly all the slope. Avoiding deep cuts into material that is high in content of lime is important. For the most efficient use of irrigation water, length of the irrigation runs should not exceed 1,320 feet. Where the more sloping areas are irrigated, the flow of water ought to be small enough that it will not be erosive and the length of runs must be shorter than in less sloping areas. Irrigating across the slope is also desirable.

CAPABILITY UNIT IIe-4 IRRIGATED

Deep, gently sloping soils comprise this capability unit. These soils are on alluvial fans that are adjacent to the local mountains. They are sandy loam throughout. Slopes range from 1 to 3 percent. Permeability is moderately rapid, and the available water capacity is 5 to 7 inches in the 60-inch depth to which roots normally penetrate. Water erosion and soil blowing are slight to moderate hazards.

Where these soils are adequately protected from erosion, they are used for all the crops commonly grown in the survey area. The principal crops are cotton, alfalfa, sorghum, barley, sugar beets, citrus, potatoes, grapes, vegetables, and flowers. A large part of the cropping system can consist of row crops if all crop residue is returned to the soils. A crop rotation frequently used is 2 years of cotton, 1 year of grain sorghum, and 1 year of vegetables.

Where the border or furrow method of irrigation is used for applying water, bench leveling is needed to eliminate all or nearly all the slope. Length of irrigation runs should not exceed 800 feet. If the more sloping areas are irrigated, the flow of water should be small enough that it will not be erosive and a shorter length of irrigation run should be used. For these sloping areas, applying water across the slope or using a sprinkler system is desirable. From the time the crop is seeded until the time the seedlings emerge and become established, the surface layer should be kept moist enough for seeds to germinate and for the needs of the young plants to be met.

CAPABILITY UNIT IIe-6 IRRIGATED

This capability unit consists of gently sloping, deep, well-drained soils on alluvial fans, flood plains, and terraces. These soils have slopes of 1 to 3 percent. They are gravelly loam or gravelly sandy loam throughout. Permeability is moderate, and available water capacity is 5 to 7 inches in the 60-inch depth to which roots normally penetrate. Runoff is slow to medium, and the hazard of erosion is slight.

Where these soils are adequately protected from erosion, they are suited to most of the crops commonly grown in the survey area. The principal crops are cotton, alfalfa, sorghum, barley, citrus, grapes, and flowers. If tillage is kept to a minimum and if crop residue is returned to the soils, a fairly large part of the cropping system can consist of row crops.

If irrigation is to be by the border or furrow method, bench leveling is necessary to eliminate all or nearly all the slope. It is important to avoid making deep cuts during leveling, for deep cuts can expose the limy material in the substratum. If the more sloping areas are irrigated, runs that do not exceed 800 feet in length are needed and the flow of water must be small enough that it will not cause erosion. Direction of furrow irrigation should be across the slope.

CAPABILITY UNIT IIs-4 IRRIGATED

Only Antho sandy loam, 0 to 1 percent slopes, is in this capability unit. This soil is deep, well drained, and nearly level. It is on flood plains and alluvial fans. Permeability is moderately rapid, and the available water capacity is 5 to 7 inches in the 60-inch depth to which roots normally penetrate. Soil blowing is a slight hazard. Runoff is very slow.

Cotton, alfalfa, sorghum, barley, sugar beets, citrus, potatoes, and grapes are the main crops grown on this soil.

The border or furrow method is generally used for applying irrigation water. To prepare the soil for irrigation, leveling is needed to eliminate all or nearly all of the slope. The length of irrigation runs should not exceed 800 feet. Where irrigated crops are grown, minimum tillage and proper management of crop residue are necessary conservation practices.

CAPABILITY UNIT IIs-5 IRRIGATED

The only soil in this unit is Pinal loam, moderately deep variant, on old stream terraces. This soil is nearly level and is well drained. It has slopes of 0 to 1 percent. The entire profile is loam, except that an indurated lime-silica-cemented pan is at a depth of 30 to 40 inches. Permeability is moderate above the pan and is very slow in the pan. Available water capacity is 5 to 7 inches. Runoff is slow, and erosion is not a hazard.

This soil is used to grow cotton, alfalfa, barley, sorghum, citrus, and sugar beets. It is better suited to shallow-rooted crops than to deep-rooted ones.

If irrigation water is to be applied efficiently by either the border or the furrow method, leveling is needed to eliminate all or nearly all of the slope. Because of the lime-silica-cemented hardpan, it is important to avoid deep cuts. The length of irrigation runs should not exceed 1,320 feet. Returning all available crop residue to the soil and keeping tillage to a minimum are desirable conservation practices.

CAPABILITY UNIT IIs-6 IRRIGATED

Only Rillito gravelly loam, 0 to 1 percent slopes, is in this capability unit. It is a deep, well-drained, nearly level soil on alluvial fans and terraces. Texture is gravelly loam throughout the profile. Permeability is moderate, and the available water capacity is 6 to 7 inches in the 60-inch depth to which roots normally penetrate. Runoff is slow, and erosion is not a hazard.

This soil is used to grow cotton alfalfa, barley, sorghum, citrus, and sugar beets. If tillage is kept to a minimum and if crop residue is returned to the soil, a fairly large part of the cropping system can consist of row crops.

Where irrigation is to be by the border or furrow method, leveling is needed to eliminate all or nearly all of the slope. Avoiding deep cuts is important, for deep cuts can expose the limy material in the substratum. The length of irrigation runs should not exceed 800 feet.

CAPABILITY UNIT IIs-7 IRRIGATED

In this capability unit are well-drained, nearly level soils on flood plains and alluvial fans. These soils have slopes of 0 to 1 percent. They have a texture of loam to very fine sandy loam in the upper part of the profile and are sand or gravelly sand below a depth of 20 to 40 inches. Permeability is moderate, and the available water capacity is 5 to 7 inches in the 60-inch depth to which roots normally penetrate. Runoff is slow, and the hazard of erosion is slight.

These soils are used for cotton, alfalfa, sorghum, barley, sugar beets, citrus, and most other crops commonly grown in the survey area. A suitable cropping system is one that allows for rotation of crops and for the efficient management of irrigation water. All crop residue should be returned to the soils. A fertilizer that is high in content of nitrogen and fertilizer is needed.

Where the border or furrow method of applying irrigation water is used, leveling is necessary to eliminate most of the slope. Because of the sandy substratum, it is important to avoid making deep cuts during leveling. Length of the irrigation runs should not exceed 1,320 feet. Lining the irrigation ditches with concrete is desirable to eliminate seepage. A sprinkler system can be used to apply irrigation water, instead of the border or furrow method. No matter what method is used, light and frequent applications of water are necessary.

CAPABILITY UNIT IIs-8 IRRIGATED

Contine clay loam is the only soil in this capability unit. It is a deep, well-drained, nearly level soil on old alluvial fans. The surface layer is clay loam, and the subsoil is heavy clay loam or clay. Slopes are 0 to 1 percent. Permeability is slow, and the available water capacity is 9 to 11 inches in the 60-inch depth to which roots normally penetrate. Runoff is slow to medium, and the hazard of erosion is slight.

This soil is used mainly for growing cotton, alfalfa, sorghum, small grains, sugar beets, citrus, and vegetables. Occasionally, it is used to grow corn for ensilage.

If irrigation water is to be applied efficiently, leveling is needed to eliminate all or nearly all of the slope. To minimize the risk of exposing the clay subsoil, it is important to avoid making deep cuts. Irrigation runs should not exceed 1,320 feet in length. Returning all crop residue to the soil and keeping tillage to a minimum are suggested practices that conserve water and that help to control erosion.

CAPABILITY UNIT IIIs-3 IRRIGATED

This capability unit consists of nearly level clays on flood plains and alluvial fans. Some of these soils have a substratum of sandy loam at a depth of 20 to 30 inches. Slopes are 0 to 1 percent. Permeability is slow, and available water capacity is 8 to 10 inches in the 60-inch depth to which roots normally penetrate. Runoff is slow. Erosion is not a hazard.

If these soils are properly managed to keep them in good tilth and to avoid soil compaction, they are suited to most of the crops commonly grown in the survey area. Among the crops that are generally grown are cotton, alfalfa, barley, sorghum, sugar beets, and citrus. Where these crops are grown, keeping tillage to a minimum and returning all crop residue to the soils are important practices that help to maintain or improve soil structure.

Where the border or furrow method is to be used for applying irrigation water, leveling is needed to eliminate the slope. These soils are deep enough that deep cuts and fills can be made during leveling without making the soils less suitable for crops. For the most efficient use of water, irrigation runs should not exceed 1,320 feet in length. Because of the slow intake rate and the slow permeability, attaining an adequate depth of water penetration is likely to be difficult.

CAPABILITY UNIT IIIs-7 IRRIGATED

The only soil in this capability unit is Vint loamy fine sand. This is a deep, well-drained soil on flood plains and alluvial fans. It has slopes of 0 to 1 percent. The profile is mainly loamy fine sand or loamy sand throughout, but it contains thin layers (1 to 3 inches thick) of silt loam, loam, or fine sandy loam. Permeability is moderately rapid, and available water capacity is 4 to 5 inches in the 60-inch depth to which roots normally penetrate. Soil blowing is a slight hazard. Runoff is very slow.

Cotton, alfalfa, sorghum, and small grains are the main crops grown on this soil. Sugar beets, citrus, potatoes, and grapes are grown to some extent.

This soil is deep enough that leveling has little or no effect on its suitability for crops. Frequent, light applications of irrigation water are needed, and length of the irrigation runs normally should not exceed 660 feet. Lining the irrigation ditches with concrete is desirable to prevent seepage. It is also desirable to conserve soil and water by returning all crop residue to the soil and thus adding organic matter.

CAPABILITY UNIT IVs-6 IRRIGATED

Only Pinamt very gravelly loam, 0 to 1 percent slopes, is in this capability unit. This nearly level soil is deep and well drained. It is on alluvial fans and terraces, where it occurs in long, narrow areas that extend into areas of Avondale and Gilman soils. The surface layer is very gravelly loam, the subsoil is very gravelly sandy clay loam or loam, and the substratum is very gravelly loam or sandy loam. Permeability is moderately slow. Available water capacity is 3 to 4 inches in the 60 inches to which roots normally penetrate. Runoff is slow, and erosion is not a hazard.

This soil is used for cultivated crops, mainly because it occurs within areas of more productive soils. It is better suited to crops that require little cultivation than to other kinds of crops. Irrigated areas are used mainly for cotton, alfalfa, barley, sorghum, citrus, and pasture.

Where the border or furrow method of irrigation is to be used, leveling is needed to eliminate most of the slope. This soil is deep enough that leveling has little or no effect on its suitability for crops. Length of irrigation runs should not exceed 1,320 feet. Frequent, light applications of irrigation water are needed. Additional important practices that provide protection from erosion and that conserve water are minimum tillage and return of crop residue to the soil.

CAPABILITY UNIT IVs-7 IRRIGATED

This capability unit consists of deep, excessively drained soils on flood plains and alluvial fans. These soils have slopes of 0 to 1 percent. They have a surface layer of fine sandy loam or gravelly loamy sand, and a substratum of very gravelly sand. Permeability is very rapid, and available water capacity is 3 to 4 inches in the 60-inch depth to which roots normally penetrate. Runoff is slow. The hazard of erosion is slight.

Cotton, alfalfa, sorghum, barley, and potatoes are grown on these soils.

Sprinkler irrigation is the best method of applying irrigation water. Where other methods are used, these soils can be leveled without affecting their suitability for crops to any extent. Necessary practices for effectively managing irrigation water consist of applying water frequently and using only a small amount of water each time. Where the border or furrow method of irrigation is used, irrigation runs should not exceed 330 feet. To prevent seepage, lining the irrigation ditches with concrete is desirable. Adding organic matter and returning crop residue to the soils are also beneficial practices.

Predicted yields and management by crop

In this part of the survey, predicted average acre yields are given for the principal irrigated crops commonly grown in the survey area. Also given for each specified crop are practices needed to obtain these yields.

PREDICTED YIELDS

Table 2 shows predicted average acre yields of the principal irrigated crops grown on the arable soils under a high level of management. The predictions are based on observations made by personnel of the Soil Conservation Service, the Agricultural Stabilization and Conservation Service, and the University of Arizona Agricultural Extension Service. Predictions are not given for miscellaneous land types or for soils not used for growing any of the crops listed in table 2. Where little or no information was available for a particular soil, estimates of yields were made by comparison with similar soils.

Information about these predicted yields is based on knowledge of current technology and plant varieties. Future improvements in crop breeding, in methods of controlling insects and diseases, in irrigation techniques,

TABLE 2.—*Predicted average yields per acre of principal crops under high-level management*

[Data are for arable soils. Absence of yield value indicates crop is not generally grown on the soil]

Mapping unit	Capability unit (irrigated)	Cotton (short staple)	Sorghum grain	Barley grain	Alfalfa hay	Sugar beets	Citrus				
							Grapefruit	Oranges: Valencia	Oranges: Navel	Lemons	Tangerines
		Bales	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Agualt fine sandy loam	IIs-7	2.75	3.75	2.25	8.5	16	11.5	4.8	3.4	12.6	5.0
Agualt loam	IIs-7	2.75	4.0	2.25	8.5	17	12.0	5.0	3.7	13.2	5.3
Antho sandy loam, 0 to 1 percent slopes	IIs-4	2.5	4.0	2.0	8.25	17	16.0	6.7	4.7	17.5	7.0
Antho sandy loam, 1 to 3 percent slopes	IIe-4	2.25	3.75	1.75	7.75	13	15.0	6.2	4.4	16.3	6.6
Antho gravelly sandy loam, 1 to 3 percent slopes	IIe-4	2.25	3.75	1.75	7.75	-----	14.0	5.9	4.2	15.5	6.2
Avondale clay loam	I-1	3.0	4.25	2.5	8.5	25	16.0	6.7	4.7	17.5	7.0
Carrizo gravelly loamy sand	IVs-7	1.25	2.0	1.25	5.5	-----	-----	-----	-----	-----	-----
Carrizo fine sandy loam	IVs-7	1.5	2.5	1.5	6.0	-----	-----	-----	-----	-----	-----
Cashion clay	IIIs-3	2.0	3.0	2.0	7.0	20	12.0	5.0	3.7	13.2	5.3
Contine clay loam	IIs-8	2.5	4.0	2.0	8.0	24	15.0	5.7	4.0	14.9	6.0
Estrella loam	I-1	3.0	4.0	2.0	9.0	20	17.0	7.0	5.0	18.5	7.4
Gilman fine sandy loam	I-2	3.0	4.0	2.5	8.5	18	16.5	6.8	4.8	18.0	7 2
Gilman loam	I-1	3.0	4.0	2.5	9.0	20	17.0	7.0	5.0	18.5	7.4
Glenbar clay loam	I-1	3.0	4.0	2.5	9.0	25	14.0	5.9	4.2	15.5	6.2
Laveen loam, 0 to 1 percent slopes	I-1	3.0	3.0	2.5	8.0	18	16.5	6.8	4.8	18.0	7.2
Laveen loam, 1 to 3 percent slopes	IIe-1	2.75	2.5	2.0	7.5	14	15.0	6.2	4.4	16.3	6.6
Laveen clay loam, 0 to 1 percent slopes	I-1	3.0	3.0	2.5	8.0	24	16.0	6.7	4.7	17.5	7.0
Mohall sandy loam	I-2	3.0	4.0	2.5	8.0	17	15.0	6.2	4.4	16.3	6.6
Mohall loam	I-1	3.0	4.0	2.5	9.0	20	16.0	6.7	4.7	17.5	7.0
Pimer clay loam	I-1	3.0	4.0	2.5	9.0	25	14.5	6.0	4.3	15.8	6.3
Pinal loam, moderately deep variant	IIs-5	2.5	2.0	2.0	5.0	15	13.0	5.3	3.8	14.0	5.6
Pinamt very gravelly loam, 0 to 1 percent slopes	IVs-6	-----	1.0	1.0	3.5	-----	11.0	4.5	3.2	12.0	4.8
Rillito gravelly loam, 0 to 1 percent slopes	IIs-6	2.5	2.0	1.75	6.0	13	15.0	6.2	4.4	16.3	6.6
Rillito gravelly loam, 1 to 3 percent slopes	IIe-6	2.0	2.0	1.5	5.0	-----	14.0	5.9	4.2	15.5	6.2
Tremant gravelly loam, 1 to 3 percent slopes	IIe-6	2.0	2.25	1.75	6.0	-----	14.5	6.0	4.3	15.8	6.3
Trix clay loam	I-1	3.0	4.0	2.5	9.0	25	14.0	5.9	4.2	15.5	6.2
Valencia sandy loam	I-2	3.0	4.0	2.5	8.0	17	16.0	6.7	4.7	17.5	7.0
Vecont clay	IIIs-3	2.5	3.0	2.0	7.0	20	12.0	5.0	3.7	13.2	5.3
Vint loamy fine sand	IIIs-7	2.5	2.5	2.0	6.0	12	12.0	5.0	3.7	13.2	5.3

and the like, are expected to make some of these yield predictions obsolete.

Two important limitations should be kept in mind when using the yield data given in table 2. First, the figures are predictions, or estimates, set forth by persons who have experience in growing crops. Secondly, the values shown are averages that may be expected over a period of years where a high level of farm management is used. In any given year, yields may be considerably higher or considerably lower than those given in the table.

In arriving at the values shown, it was assumed that a good quality of irrigation water would be available, that an adequate amount of fertilizer would be applied, and that a soil-conserving cropping system would be used in growing the crops listed. It is also assumed that cotton is solid planted and that alfalfa will be grown as a hay crop and will not be allowed to become dormant in summer.

MANAGEMENT BY CROP [4]

Predictions or estimates of yields are useful if the management is described through which such yields were obtained. In the pages that follow, management is described for each crop named in table 2, where that crop is grown on soils of specified capability units. All the soils in a capability unit require about the same management for a specified crop.

Water needs of the plants are given in terms of the gross irrigation requirement. The gross irrigation requirement is the total amount of water per acre needed annually by the plant, less the average effective precipitation. The irrigation requirement is calculated on the assumption that the irrigation system is 70 percent efficient.

For the purpose of managing the specified crops, chiefly to attain the efficient use of irrigation water, the soils of several capability units are grouped according to their available water capacity, slope, texture, and other characteristics that determine the kind of irrigation required. All the soils in each group require the same kind of irrigation and length of runs, and the same amounts and frequency of application of irrigation water.

In discussing management needed for the various crops, practices needed for the crops grown on the soils of group 1 are first discussed. Management needed for soils in the other groups is similar to that described for group 1, except that additional practices may be needed or different specifications for irrigating may be required. These variations in management from that shown for group 1 are described for each subsequent group of soils.

Management of Irrigated Cotton, Alfalfa, Barley, and Sorghum

Capability units of capability classes I through IV in the survey area have been placed in six groups for the purpose of describing management of irrigated cotton, alfalfa, barley, and sorghum. A discussion of each of these groups follows.

Group 1.—This group consists of soils of capability units I–1 and I–2. In general, the greatest efficiency in irrigating crops grown on the soils of these capability units results when the fields have been smoothed in the direction that irrigation water will flow so that they are level or nearly level and have little side fall. The border method is generally used for irrigating alfalfa and barley or other small grains. Where this method is used, differences in elevation across each border should be no greater than 0.1 foot. Barley or other small grains may be drilled in beds and supplied with water by means of furrow irrigation. Furrow irrigation is also commonly used for cotton and sorghum.

Cotton (*3*)

Cotton is among the principal crops grown in the survey area. Securing a good stand is one of the major problems of management. A poor stand can result if the seedlings are damaged by diseases, or if damage is caused by insects, poor preparation of the seedbed, low soil temperature, or crusting caused by rains. The need for weeding has been reduced by use of herbicides.

The amount of irrigation water needed for cotton varies considerably. The total amount of irrigation water required for a cotton crop, however, is about 5 acre-feet. Decisions about length of irrigation runs should be based on suggestions given in the individual capability units.

Cotton is normally planted about April 1. The peak month for use of water is mid-July to mid-August, when at least two irrigations of 6 inches per acre will be necessary. After a preplant irrigation has been completed and the young plants have emerged, the frequency of irrigation and the amount of water to apply to obtain maximum growth of the cotton by July 1 depend on soil temperature. If stressing for water is practiced to encourage a heavy set of bolls, it must be carefully controlled to avoid excessive stress. For this practice, specific recommendations should be obtained from the Extension Service or from others who are specialists in growing cotton. Irrigation is usually ended early in September to allow the plants to mature so that picking can be completed early. This procedure is also necessary to help in controlling the pink bollworm.

It is desirable to shred the cotton stalks as soon as feasible after harvest is completed. Deep plowing, preferably by using a moldboard plow, is a good practice and should be done as early as practical after harvest is completed. Plowing ought to be followed by disking and dragging to seal the surface.

Because cotton is susceptible to many insects and diseases, a carefully planned control program is needed. It should be based on current recommendations of the University of Arizona Agricultural Extension Service.

Alfalfa (*11*)

Soils of capability units in group 1 are especially well suited to alfalfa. Plowing, disking, harrowing, leveling, and other preliminary cultural practices must be completed before borders are established. Before the crop is planted, compacted soil layers, resulting from cultivation and the use of heavy equipment, should be broken by subsoiling or by chiseling.

[4] DALE E. HODGELL, soil conservationist, Soil Conservation Service, helped to prepare this section; DR. ROBERT H. HILGEMAN, horticulturist, University of Arizona Cooperative Extension Service, also helped to prepare the paragraphs on management of citrus; and R. S. LAMBDIN, district manager, Spreckles Sugar Company, helped to prepare the paragraphs on management of sugar beets.

The surface of the soil must be kept moist until the seedlings have reached a stage of growth where they have three leaves. For this purpose, the soils of capability unit I–2 will require more frequent light applications of water than the soils of capability unit I–1. For all the soils, a heavy application of irrigation water is desirable in winter to fill the root zone throughout its entire depth. The total amount of water required by alfalfa for the entire year is about 9 feet per acre. The peak use of water by this crop is during the period from May to July.

Alfalfa requires a large amount of plant nutrients, and phosphorus is especially necessary on most of these soils. A fertilizer high in content of phosphorus is commonly worked into the soil during preparation of the seedbed prior to seeding. Supplemental nitrogen is generally not required for alfalfa. October and November are the preferred months of seeding.

Among the numerous insects that damage alfalfa are the pea aphid, the lygusbug, and larvae of the alfalfa butterfly. Insects spread several virus diseases. Controlling insects by using a chemical spray, usually applied from an airplane, may be necessary. Several pathogens attack tissue of the roots and crowns of alfalfa. For those, no effective control measures have been found, except to use a good cropping system and to keep damage from heavy equipment and grazing to a minimum. Planting a resistant variety of alfalfa is the only known method for controlling root nematodes, and it helps in controlling some of the insects. Information about many different cultural programs and methods for harvesting alfalfa is available. When the soils are wet, care is necessary to prevent excessive compaction as the result of using heavy equipment for baling and cubing.

Barley (*4*)

Barley fits well in most cropping systems used in Arizona. Most of the water required by barley is needed in winter and in spring, at a time when use of water by most other crops is at a minimum. Barley is grown for pasture or for grain.

Care should be taken to prevent compaction of soils used for barley, for penetration of roots and water is restricted in a compacted soil. Keeping tillage to a minimum when the seedbed is prepared helps to prevent compaction. If barley is seeded after cotton or sorghum is harvested, only disking is required for preparing the seedbed. Barley can be planted in a dry seedbed and then irrigated. Planting in a dry seedbed eliminates the risk of working the soil when it is too wet. Preplanting irrigation, after the seedbed is prepared, has the advantage of allowing for a more uniform depth of seeding, and it causes weed seeds to germinate.

Barley gives excellent response to applications of nitrogen fertilizer. If barley follows cotton, alfalfa, or vegetables in the cropping system, less nitrogen is required than if it follows other crops. For barley, the total water requirement for irrigation is about 3 feet per acre. A preplant irrigation or an irrigation on the date of planting should fill the soil to field capacity to a depth of 5 or 6 feet. That amount of water normally lasts until March. Then, 5 or 6 inches per acre of irrigation water should be applied in spring, and that is followed in 3 weeks by the next irrigation. Two additional irrigations at intervals of 2 weeks should be ample for barley grown for grain. Applying chemicals may be necessary to control stinkbugs and aphids.

Sorghum

Grain sorghum is grown in the survey area both as a cash crop and as a feed crop. It is either grown as a second crop after barley is harvested or is grown as a full-season crop. Because sorghum is a warm-season crop, it usually is not planted until June or July. The crop is planted in beds, and one or two rows in each bed are left for furrow irrigation. The rate of seeding is generally about 12 pounds of seed per acre for rows spaced 20 inches apart. Sorghum responds to applications of nitrogen fertilizer.

The amount of irrigation water needed for grain sorghum ranges from 3 feet per acre, for sorghum that is double cropped after barley, to 4½ feet per acre for a full-season crop planted in April or May. The rate at which water is used by grain sorghum is lower than that of alfalfa or cotton. Therefore, intervals between irrigations are longer than for alfalfa or cotton. The usual interval is 2 to 3 weeks for soils of capability unit I–1 and about half that often for soils of capability unit I–2. About 4 inches of water per acre should be applied during each irrigation. Grain sorghum produces an abundance of leaves and stems that should be disked or plowed into the soils after harvest. This crop residue adds organic matter, and it thus helps to keep the soils in good tilth.

Group 2.—This group consists of soils of capability units IIs–4, IIs–5, IIs–6, IIs–7, and IIIs–7. The soils in this group hold from 5 to 7½ inches of water in their root zone, which extends to a depth of 5 feet. They require more frequent, but lighter, applications of irrigation water than the soils of group 1.

Group 3.—This group consists of soils of capability units IIe–1, IIe–4, and IIe–6. Most soils of this group have slopes of 1 to 3 percent. Therefore, a smaller stream size is needed in the irrigation furrows and the rows should be shorter than where the soils are more nearly level. Bench leveling or irrigating across the slope for row crops is also necessary to help to control erosion. Small grains should be planted in beds and irrigated by the furrow method. Where furrow irrigation is across the slope, borders should be spaced close together to help to control cross gullying.

Group 4.—In this group are soils of capability units IIs–8 and IIIs–3. These soils are mainly clay or clay loam throughout. As a result, they are slowly permeable and take in water slowly. Where alfalfa grown on these soils is irrigated, care is needed to prevent scalding. In hot weather the soils must not be saturated for long periods. Water should not stand on the field for more than a few hours after irrigation is completed. More frequent light applications of water are necessary than for the soils of group 1. Excessive irrigation also encourages such diseases as rhizoctonia and root rot.

Soils of this group are easily compacted and must not be worked when wet. Chiseling or subsoiling is necessary from time to time to counteract the effects of compaction.

It is important to incorporate into the soils all crop residue left in the fields.

Group 5.—Only Pinamt very gravelly loam, 0 to 1 percent slopes, of capability unit IVs–6 is in this group. This soil has low available water capacity. It normally holds less than 3.75 inches of water to a depth of 5 feet. Therefore, very frequent, light applications of irrigation water are required and the rows must be short. This soil is not especially well suited to general crops, because it is very gravelly. As a rule, it is farmed only when the areas are rather small and are within larger areas of more productive soils. Where the areas are extensive, sprinkler irrigation is advisable.

Group 6.—In this group are soils of IVs–7. These soils have low available water capacity. Because of their high content of gravel, they normally hold less than 3.75 inches of water to a depth of 5 feet. Very frequent, light applications of irrigation water are required, and the runs must be short. These soils are difficult to manage. Where small areas occur within areas of more productive soils, and where it is necessary to farm them, maintaining a higher content of organic matter than in the other soils is essential.

Management of Irrigated Oranges, Grapefruit, Lemons, and Tangerines

For the purpose of describing management of irrigated oranges, grapefruit, lemons, and tangerines, capability units of capability classes I through IV have been placed in five groups. A discussion of each of these groups follows.

Group 1.—Soils of capability units I–1 and I–2 are in this group. Citrus trees grown on these soils are sensitive to frost. Damage can occur to the fruit or to the trees when temperatures drop below freezing. Wind machines and orchard heaters provide some protection from frost, but natural air drainage is important. Grapefruit is the citrus crop most tolerant of frost. Following in decreasing order of tolerance are Valencia oranges, navel oranges, tangerines, and lemons.

Citrus trees are best set out in March. Buds 1 year old are grafted onto sour orange stock. For grapefruit, Valencia oranges, and tangerines, the proper spacing for each tree is 22 by 22 feet, or 90 trees per acre. Best for navel oranges is a space 20 by 20 feet, which provides 109 trees per acre. Lemon trees require a space 25 by 25 feet, or 70 trees per acre. Mature lemon trees should be trimmed every 2 or 3 years. Mature trees of most other citrus crops require only removal of dead wood and removal of suckers that cannot be trimmed to make productive branches.

Nitrogen fertilizer is needed for citrus to be produced economically. Specific recommendations concerning the kinds and amounts of fertilizer to apply can be obtained from the University of Arizona through the Agricultural Extension Service. Deficiencies in iron or zinc are sometimes noticeable.

About one-fourth of the total number of growers of citrus control weeds by spraying with a chemical herbicide and by refraining from tillage. Clean cultivation is practiced by the rest of the growers. Insects are controlled by applying chemical sprays. Thrips are the main kind of destructive insects.

Group 2.—This group consists of soils of capability units IIs–4, IIs–5, IIs–6, IIs–7, and IIIs–7. For these soils total available water capacity in the root zone of citrus trees is 5 to 7½ inches. Because of this lower available water capacity, more frequent and lighter applications of irrigation water are needed than for soils of group 1. Where the soils have been leveled to allow for maximum efficiency in applying irrigation water, the length of run should not exceed 440 feet for the Vint soil of unit IIIs–7 and should not exceed 880 feet for the other soils. For all except the Vint soil of unit IIIs–7, reasonable efficiency in applying irrigation water can be expected if the length of the irrigation run is 1,320 feet and the grade or slope is 0.2 foot per 100 feet in the direction of flow of the irrigation water.

Group 3.—In this group are soils of capability units IIe–1, IIe–4, and IIe–6. These soils have slopes of 1 to 3 percent. Where they are used for irrigated citrus trees, bench leveling, a smaller stream size in the furrows, a shorter length of run, or irrigation across the slope is necessary to reduce the irrigation grade and thus help to control erosion. Length of the run should not exceed 950 feet for the Laveen soil of capability unit IIe–1 and should not exceed 800 feet for soils of units IIe–4 and IIe–6.

Group 4.—Soils of capability units IIs–8 and IIIs–3 are in this group. These soils are mainly clay or clay loam throughout. As a result, they are slowly permeable and take in water slowly. Length of the irrigation runs should not exceed 1,320 feet. Irrigation water must be applied carefully to keep from saturating these soils and to prevent water from standing around the trees for long periods. Brown rot gummosis is likely to result if water is allowed to stand for long periods.

Group 5.—Only Pinamt very gravelly loam, 0 to 1 percent slopes, of capability unit IVs–6 is in this group. This soil has low available water capacity. Where it is used for irrigated citrus, a short length of run is required and applications of irrigation water must be frequent and light. Length of the irrigation run should not exceed 330 feet. Where this soil occurs in large areas, sprinkler irrigation is advisable.

Sugar Beets

For the purpose of describing management of irrigated sugar beets, capability units of classes I through IV are divided into four groups. Following is a discussion of each of these groups.

Group 1.—This group consists of soils of capability units I–1 and I–2. Cultural practices needed where sugar beets are grown consist of plowing, disking, land planning, and harrowing to permit precision operations. Preparation of the soils should be started in July, and preplanting irrigation should be done early in August. All deep tillage is completed prior to the preplanting irrigation.

Preemergence chemicals for use in controlling weeds are available, but they require special equipment for applying them and require a thorough knowledge of the chemicals. Precision cultivating is necessary to remove weeds between the rows. The soils can be safely cultivated only when they do not contain excess water. Mechanical thinning is done when the beets have four to six leaves.

For the most efficient use of irrigation water, level or nearly level soils are needed. Runs should be no longer than 1,320 feet for the soils of capability unit I–1, and no longer than 950 feet for the soils of capability unit I–2. Beets need adequate water at all times. Irrigating them is a common practice. A second and a third application of irrigation water may be necessary before the beets are thinned. Water must never be allowed to cover the row, for beets rot if the soils remain saturated for a long period of time during hot weather. When the weather is hot, time of application per set should not exceed 6 hours. A gross irrigation requirement of 5 to 8 feet of water per acre is necessary for sugar beets.

Group 2.—This group consists of soils of capability units IIs–4, IIs–5, IIs–6, IIs–7, and IIIs–7. The Vint soil of capability unit IIIs–7 holds only 3¾ to 5 inches of water to a depth of 5 feet. All of the other soils hold 5 to 7½ inches of water to that depth. All of the soils of this group require more frequent and lighter applications of irrigation water than do soils of group 1.

Group 3.—Soils of capability units IIe–1 and IIIe–4 are in this group. These soils have slopes of 1 to 3 percent. They require a smaller stream of water in the furrows and a shorter length of run than do soils of group 1. Irrigation across the slope or bench leveling is also necessary.

Group 4.—This group consists of soils of capability units IIs–8 and IIIs–3. These soils have a texture of clay or clay loam throughout the profile. They are slowly permeable and take in water slowly. To prevent water from covering the bed, deeper furrows are needed than for soils of group 1. The soils must not be saturated at any time. Therefore, irrigation water should be applied no oftener than every 16 days. and no more than 7 inches of water per acre should be applied during one irrigation.

Management of nonirrigated soils

Nonirrigated soils in the survey area are mainly in capability class VII and in subclasses VIIe, VIIs, and VIIc. They have little value for grazing. Nevertheless, some areas near the eastern and southeastern borders of the survey area are grazed for short periods after rains in summer and in winter. The principal range plants that supply forage are three-awn, Arizona cottontopgrass, other annual grasses, and alfilaria (filaree), which is a forb. Thin stands of shrubs and trees, sometimes used as browse, are desert saltbush, white bur-sage, mesquite, and palo verde.

Except that a few fences have been built and a small number of stock ponds have been constructed, practically no range management is practiced. After rains in summer and in winter, some water is caught and is held in the ponds for later use by livestock. Yearling cattle and sheep are the main kinds of livestock that graze these areas.

Capability class VII is defined in the section "Capability Grouping." The subclasses in that capability class are briefly discussed in the following paragraphs. Soils in each subclass can be determined by referring to the "Guide to Mapping Units" at the back of this publication.

Subclass VIIe.—In this subclass are gently sloping to very steep very gravelly loams and areas of Rough broken land. These soils are shallow to deep over bedrock or some other restrictive layer. Some areas are highly dissected and contain many different kinds of soil. Available water capacity ranges from low to high, and permeability ranges from rapid to slow. The hazard of water erosion is moderate to high.

During long periods of rainy weather and periods of intense rainfall, a moderate to large amount of water is supplied to plants through runoff. Plants on soils of this subclass receive enough moisture that they provide a limited amount of seasonal grazing for livestock. The annual grasses are short lived, however, and they must be grazed immediately after rains. It is important that the animals be removed early enough to allow the desirable grasses to produce seed. Other practices commonly used to improve the range are not practical. In most places these soils are too gravelly or too steep for general use as recreational areas.

Subclass VIIs.—In this subclass are well-drained, nearly level or gently sloping gravelly loamy sands to clays; very shallow and shallow soils; areas of Rock land in which from 50 to 70 percent of the acreage consists of outcrops of rock; and areas of Alluvial land and of Gravelly alluvial land. Some of these soils are high in content of lime. Available water capacity ranges from low to high, and permeability ranges from very rapid to slow. Runoff is generally slow, but on the gently sloping Pinal, Rillito, Pinamt, and Tremant soils, it is medium, and in areas of Rock land, it is very rapid. For most of the soils, the hazard of water erosion is slight.

Vegetation on these soils provides a limited amount of seasonal grazing. Managing these soils for range consists mainly of quickly harvesting the short-lived annual grasses after rainy periods and of then removing the grazing animals early enough to allow the desirable annual plants to produce seed. Other range management practices are not practical.

In general, soils of this subclass are well suited to use as recreation areas and wildlife habitat. Such gravelly soils as the Cavelt, the normal Pinal, the Pinamt, the Tremant, and areas of Gravelly alluvial land have moderate to severe limitations for these uses, as do soils, such as the Contine and Mohall, that have slow or moderately slow permeability. Clayey soils, as for example, the Cashion and Vecont, have severe limitations.

Subclass VIIc.—This subclass consists of soils that are severely limited by a climate that is too dry. These soils are deep, well drained, and nearly level or very gently sloping. They have moderate to moderately slow permeability. Runoff is slow, and the hazard of erosion is slight.

After periods of rainy weather, the vegetation on these soils provides a limited amount of grazing. Management of areas used as range consists of quickly harvesting the short-lived annual grasses after rains and of then removing the grazing animals early enough that the desirable annual plants can produce seed. Other range improvement practices are not feasible.

These soils are also used as recreation areas and wildlife habitat.

Use of the Soils for Recreational Development[5]

Maricopa County has the largest population of any county in Arizona. Therefore, the demand for recreational facilities constantly increases. This part of the survey contains soil interpretations that can help in selecting areas suitable for recreation. The information given is intended only to provide general guidelines to be used when considering areas for recreational purposes. It is not intended to be a substitute for onsite investigation or for other studies of sites proposed for recreation areas.

Table 3 gives interpretations for the soils of the survey area as sites for camping areas. lawns and golf fairways, paths and trails, picnic areas, and playgrounds. For each mapping unit, it gives the estimated degree of limitation for each use. Following are the three degrees of limitations used in this table and their meanings:

Slight.—Limitations, if any, are of only minor consequence and are easy to overcome.

Moderate.—Limitations are of a magnitude to require careful planning, design, and management. The cost of correcting or of overcoming them is an important consideration.

Severe.—Limitations are serious enough that the cost of overcoming them may be too high to justify the intended use of the soil or site.

Where the limitation is moderate or severe, the limiting feature is given.

In table 3 the kind of limitation is expressed in terms of soil characteristics, or properties. Soil properties considered in making the interpretations are slope, hazard of flooding, permeability, texture, presence of coarse fragments on the surface, rockiness, depth to bedrock and to the water table, available water capacity, salinity, and alkalinity. Some of the terms used may not be found in a standard dictionary, or they may have special meaning in soil science. These terms are defined in the Glossary at the back of this survey.

In addition to soil properties, other site factors that should be considered in planning recreational developments are size, location, and accessibility of the area; availability of water and sanitary facilities; vegetation; climate; and legal and economic feasibility.

[5] By RONALD F. BATCHELOR, wildlife biologist, Soil Conservation Service.

TABLE 3.—*Degree and kind of limitation of soils for recreational development*

Soil series, land types, and map symbols	Camping areas	Lawns and golf fairways	Paths and trails	Picnic areas	Playgrounds
Agualt: Af, Ag	None to slight	None to slight	None to slight	None to slight	None to slight.
Alluvial land: Am	Severe: mainly sand and gravel.	Severe: rock fragments; very rapid permeability.	Severe: rock fragments.	Severe: rock fragments.	Severe: sand; rock fragments.
Antho:					
AnA	None to slight	None to slight	None to slight	None to slight	None to slight.
AnB	None to slight	Slight to moderate: slope.	None to slight	None to slight	Slight to moderate: slope.
AoB	Slight to moderate: 15 to 25 percent gravel.	Moderate: gravelly sandy loam; 15 to 25 percent gravel; 1 to 3 percent slopes.	Slight to moderate: 15 to 25 percent gravel.	Slight to moderate: 15 to 25 percent gravel.	Moderate to severe: 15 to 25 percent gravel; 1 to 3 percent slopes.
Avondale: Av	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.
Carrizo:					
Ca	None to slight	Severe: available water capacity less than 3.75 inches to depth of 5 feet.	None to slight	None to slight	None to slight.
Cb	Moderate: gravelly loamy sand surface layer; about 25 percent gravel.	Severe: gravelly loamy sand; very rapid permeability; available water capacity less than 3.75 inches to depth of 5 feet.	Moderate: gravelly loamy sand surface layer; about 25 percent gravel.	Moderate: gravelly loamy sand surface layer; about 25 percent gravel.	Severe: loamy sand; about 25 percent gravel.

TABLE 3.—*Degree and kind of limitation of soils for recreational development*—Continued

Soil series, land types, and map symbols	Camping areas	Lawns and golf fairways	Paths and trails	Picnic areas	Playgrounds
Cashion: Cc	Severe: clay surface layer; slow permeability.	Severe: clay surface layer; slow permeability.	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer; slow permeability.
Cavelt: CeC	Moderate: gravel in surface layer.	Severe: hardpan at depth of less than 20 inches; available water capacity less than 3.75 inches to depth of 5 feet.	Moderate: gravel in surface layer.	Moderate: gravel in surface layer.	Severe: gravel in surface layer; hardpan at depth of less than 20 inches.
Contine: Co	Moderate: clay loam surface layer; slow permeability.	Severe: clay loam surface layer; slowly permeable subsoil.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer; slowly permeable subsoil.
Estrella: Es	Slight to moderate: moderately slow permeability.	Moderate: moderately slow permeability.	None to slight	None to slight	Slight to moderate: moderately slow permeability.
Gilman: Gf, Gm	None to slight	None to slight	None to slight	None to slight	None to slight.
Glenbar: Gn	Moderate: clay loam surface layer; moderately slow permeability.	Moderate: clay loam surface layer; moderately slow permeability.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer; moderately slow permeability.
Gravelly alluvial land: Gr.	Moderate to severe: sandy loam and loamy sand; 35 to 70 percent gravel.	Severe: sandy loam and loamy sand; 35 to 70 percent gravel; available water capacity less than 3.75 inches to depth of 5 feet.	Moderate to severe: sandy loam and loamy sand; 35 to 70 percent gravel.	Moderate to severe: sandy loam and loamy sand; 35 to 70 percent gravel.	Severe: sandy loam and loamy sand; 35 to 70 percent gravel.
Laveen:					
LaA, LaB	None to slight	None to slight in LaA. Slight to moderate in LaB; slope.	None to slight	None to slight	None to slight in LaA. Slight to moderate in LaB; slope.
LeA	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.
Mohall: Mo, Mv	Slight to moderate: moderately slow permeability.	Moderate: moderately slow permeability.	None to slight	None to slight	Moderate: moderately slow permeability.
Pimer: Pm	Moderate: clay loam surface layer; moderately slow permeability.	Moderate: clay loam surface layer; moderately slow permeability.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer; moderately slow permeability.
Pinal:					
PnA, PnC	Moderate: surface layer 15 to 30 percent gravel; very slow permeability in hardpan.	Severe: lime-silica hardpan at depth of less than 20 inches; available water capacity less than 3.75 inches to depth of 5 feet.	Slight to moderate: surface layer 15 to 30 percent gravel.	Slight to moderate: surface layer 15 to 30 percent gravel.	Severe: lime-silica hardpan at depth of less than 20 inches; very slow permeability in hardpan.
Po	None to slight	Moderate: lime-silica hardpan at depth of 20 to 40 inches.	None to slight	None to slight	Moderate: lime-silica hardpan at depth of 20 to 40 inches.

TABLE 3.—*Degree and kind of limitation of soils for recreational development*—Continued

Soil series, land types, and map symbols	Camping areas	Lawns and golf fairways	Paths and trails	Picnic areas	Playgrounds
Pinamt: PvA, PvC	Severe: surface layer 50 to 65 percent gravel.	Severe: surface layer 50 to 65 percent gravel; available water capacity less than 3.75 inches to depth of 5 feet.	Severe: surface layer 50 to 65 percent gravel.	Severe: surface layer 50 to 65 percent gravel.	Severe: surface layer 50 to 65 percent gravel.
Rillito: RlA, RlB	Slight to moderate: surface layer 15 to 30 percent gravel.	Moderate: gravelly loam surface layer.	Slight to moderate: surface layer 15 to 30 percent gravel.	Slight to moderate: surface layer 15 to 30 percent gravel.	Moderate to severe: surface layer 15 to 30 percent gravel.
Rock land: Ro	Severe: slopes of 9 to 75 percent; exposed rock on 50 to 70 percent of area.	Severe: slopes of 9 to 75 percent; exposed rock is 50 to 70 percent of area.	Severe: slopes of 9 to 75 percent; exposed rock is 50 to 70 percent of area.	Severe: slopes of 9 to 75 percent; exposed rock is 50 to 70 percent of area.	Severe: slopes of 9 to 75 percent; exposed rock is 50 to 70 percent of area.
Rough broken land: Ru.	Moderate to severe: surface layer 35 to 50 percent gravel; slopes of 5 to 60 percent.	Severe: surface layer 35 to 50 percent gravel; slopes of 5 to 60 percent.	Moderate to severe: surface layer 35 to 50 percent gravel; slopes of 5 to 60 percent.	Moderate to severe: surface layer 35 to 50 percent gravel; slopes of 5 to 60 percent.	Severe: surface layer 35 to 50 percent gravel; slopes of 5 to 60 percent.
Tremant: TrB	Moderate: surface layer 45 percent gravel; moderately slow permeability.	Moderate: surface layer 45 percent gravel; slopes of 1 to 3 percent; moderately slow permeability.	Moderate: surface layer 45 percent gravel.	Slight to moderate: surface layer 45 percent gravel.	Severe: surface layer 45 percent gravel.
Trix: Tx	Moderate: clay loam surface layer.	Moderate: clay loam surface layer; moderately slow permeability.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer; moderately slow permeability.
Valencia: Va	Slight to moderate: moderately slow permeability in subsoil.	Slight to moderate: moderately slow permeability in subsoil.	None to slight	None to slight	Slight to moderate: moderately slow permeability in subsoil.
Vecont: Ve	Severe: clay surface layer.	Severe: slow permeability.	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.
Vint: Vf	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.

Use of the Soils for Wildlife [6]

Wildlife is a product of the habitat in which it lives. The habitat largely determines the kinds and the numbers of birds and animals in a given area. Many game and nongame birds and animals live in the Eastern Maricopa and Northern Pinal Counties Area. Each species of wildlife is most abundant where it can find its choice foods, protective cover, and water. These elements in each kind of habitat depend directly on suitability of the soils for plants required by wildlife and on decisions of the landowner regarding suitable plants to grow and maintain. Some species of birds and animals eat nothing but insects, fish, or other animal foods. Others eat only vegetable foods. Still others prefer a combination of the two.

Irrigated soils that are suited to field crops, hay, or improved pasture are also suited to the development of favorable habitat for such game species as dove, pheasant, Gambel's quail, and cottontail rabbit. Without irrigation, these soils are less well suited to development of habitat for these species of birds and animals.

Soils on the higher side slopes and in rocky areas where surface drainage is rapid are generally unfavorable for the development and maintenance of wildlife habitat, except where they can be used for Gambel's quail and for some other nongame species.

Landowners can obtain help from their local Soil Con-

[6] By RONALD F. BATCHELOR, wildlife biologist, Soil Conservation Service.

servation district in evaluating soils for establishing and maintaining plants. They can also obtain information about practices suitable for developing habitat for wildlife in the survey area.

Engineering Uses of the Soils [7]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of roads, airports, pipelines, building foundations, water storage facilities, erosion control structures, and drainage systems. Among the soil properties most important in engineering are permeability, shear strength, density, shrink-swell potential, water-holding capacity, grain-size distribution, plasticity, and reaction.

Information concerning these and related properties is given in tables 4, 5, and 6. The estimates and interpretations of soil properties in these tables can be used to—

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties that will help in planning agricultural irrigation systems and farm ponds.
3. Make preliminary evaluations of soil conditions that will aid in selecting sites for highways, airports, and pipelines and in planning detailed investigations at the selected sites.
4. Locate probable sources of sand, gravel, or other construction material.
5. Make more accurate estimates of runoff, erosion, and drainage characteristics for use in designing structures for controlling flooding and erosion; in planning dams and other structures for soil and water conservation; and in designing culverts and bridges.
6. Determine the suitability of soil mapping units for cross-country movement of vehicles and construction equipment.
7. Correlate performance of engineering structures with soils and thus provide information that will be useful in designing and maintaining the structures.
8. Supplement information obtained from other published maps and reports and from aerial photographs for the purpose of making soil maps and reports that can be readily used by engineers.
9. Develop preliminary estimates pertinent to proposed structures in a particular area.

With the soil map for identification of soil areas, the engineering interpretations reported here can be useful for many purposes. It should be emphasized, however, that these interpretations do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and excavations deeper than the depth of layers here reported.

Some terms used by soil scientists have a special meaning in soil science that may not be familiar to engineers. These terms are defined in the Glossary.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system used by the SCS engineers, Department of Defense, and others (*10*), and the AASHO system adopted by the American Association of State Highway Officials (*1*). The explanations are taken largely from the PCA Soil Primer (*5*).

In the Unified system, soils are classified according to particle size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example ML–CL.

The AASHO system (*1*) is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and the A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHO classification for tested soils, with group index numbers in parentheses, is shown in table 4. The estimated classification, without group index numbers, is given in table 5 for all soils mapped in the survey area.

Soil test data

Table 4 contains engineering test data for representative profiles of four extensive series mapped in the survey area. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Moisture-density (compaction) data are important in earthwork. If a soil material is compacted at successively higher moisture content, assuming that the compactive efforts remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

[7] By RALPH ARRINGTON, assistant State conservation engineer, Soil Conservation Service.

TABLE 4.—*Engineering*

[Tests performed by Materials Division, Arizona Highway Department, Phoenix, Ariz.

Soil name and location	Parent material	Arizona report No.	Depth from surface	Moisture density [1]	
				Maximum dry density	Optimum moisture
				Lb./cu. ft.	*Pct.*
Contine clay loam: 75 ft. S. and 50 ft. E. of NW. corner of sec. 14, T. 1 S., R. 6 E.	Mixed alluvium derived from acid and basic igneous material.	65–15512	0–12	105	17
		65–15513	25–38	103	19
		65–15514	47–66	111	15
Gilman loam: 950 ft. W. and 40 ft. N. of E¼ corner of sec. 1, T. 2 S., R. 6 E.	Mixed alluvium derived from granite and other acid and basic igneous rocks.	65–15515	0–13	114	13
		65–15516	22–60	111	15
Laveen loam: 500 ft. W. from center of sec. 32, T. 1 N., R. 5 E.	Calcareous alluvium derived from granite and other acid and basic igneous rocks.	65–15491	0–14	110	15
		65–15492	14–34	111	15
Vint loamy fine sand: 1,250 ft. W. and 100 ft. S. of NE. corner of sec. 7, T. 2 S., R. 7 E.	Mixed alluvium derived from acid basic igneous and sedimentary rocks.	65–15517	0–17	114	12
		65–15518	17–31	107	15
		65–15519	44–73	116	11

[1] Based on AASHO Designation: T 99–70, Method A (*1*).

[2] Mechanical analysis according to AASHO Designation: T 88–70 (*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS procedure,

TABLE 5.—*Estimates of soil properties*

[Absence of data indicates properties were not estimated.

Soil series, land types, and map symbols	Hydrologic soil group	Depth to hardpan or bedrock	Depth from surface	Classification		
				USDA texture	Unified	AASHO
		Ft.	*In.*			
Agualt: Af, Ag	B	>5	0–26	Loam and very fine sandy loam (Af); fine sandy loam (Ag).	ML	A–4
			26–65	Sand	SM or SP–SM	A–1 or A–3
Alluvial land: Am	A or B	>5	0–60	Variable	GM or SM	A–1, A–2, or A–4.
Antho:						
AnA, AnB	B	>5	0–46	Sandy loam	SM	A–4 or A–2
			46–60	Heavy loam	CL	A–6
AoB	B	>5	0–60	Gravelly sandy loam	SM	A–1 or A–2
Avondale: Av	B	>5	0–13	Clay loam	CL	A–6
			13–60	Loam and very fine sandy loam	ML	A–4
Carrizo: Ca, Cb	A	>5	0–15	Fine sandy loam (Cb); gravelly loamy sand (Ca).	SM	A–4
			15–70	Very gravelly sand	GP or GP–GM	A–1

test data

Tests summarized and Unified classification provided by William Mildner, SCS]

Mechanical analysis [2]									Liquid limit	Plasticity index	Classification	
Percentage passing sieve—						Percentage smaller than—						
¾ in.	⅜ in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.02 mm.	0.005 mm.	0.002 mm.			AASHO	Unified
------	------	100	98	94	73	51	41	22	40	23	A-6(13)	CL
------	------	100	98	90	70	57	47	34	63	43	A-7-6(18)	CH
------	------	100	99	93	67	38	28	16	42	24	A-7-6(12)	CL
------	------	------	100	98	62	27	16	7	23	3	A-4(5)	ML
------	------	------	100	98	87	50	29	12	29	12	A-6(9)	CL
------	------	------	100	94	72	40	28	15	32	14	A-6(9)	CL
------	------	100	99	92	64	37	25	13	31	14	A-6(8)	CL
------	------	100	98	81	25	8	5	2	[3] NP	NP	A-2-4(0)	SM
100	99	97	94	70	17	6	3	3	NP	NP	A-2-4(0)	SM
------	100	98	95	71	8	3	1	1	NP	NP	A-3(0)	SP-SM

the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes for soils.

[3] NP means nonplastic.

significant to engineering

The symbol > means more than; < less than]

Percentage passing sieve—				Permeability	Available water capacity	Salinity	Shrink-swell potential	Corrosivity to untreated steel
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	*In./hr.*	*In./in. of soil*	*Mmhos./cm.*		
95–100	95–100	70–95	50–60	0.63–2.0	0.16–0.18(Af) 0.13–0.15(Ag)	<2	Low	Low.
90–100	80–95	45–60	5–20	6.3–20.0	0.05–0.07	<2	Low	Low.
40–70	40–70	35–65	0–45	0.63–20.0	0.05–0.18	<2	Low	Low.
90–100	85–95	50–60	25–40	2.0–6.3	0.11–0.13	<2	Low	Low.
95–100	90–100	80–90	60–75	0.63–2.0	0.16–0.18	<2	Moderate	Low.
75–85	65–75	35–45	15–30	2.0–6.3	0.08–0.10	<2	Low	Low.
100	95–100	85–95	70–80	0.20–0.63	0.19–0.21	2–4	Moderate	Moderate.
90–100	90–95	80–90	55–65	0.63–2.0	0.15–0.18	2–4	Low to moderate	Moderate.
90–100	85–100	70–85	35–50	2.0–6.3	0.11–0.15(Cb) 0.05–0.07(Ca)	<2	Low	Low.
15–55	10–50	5–40	0–15	>20.0	0.03–0.05	<2	Low	Low.

TABLE 5.—*Estimates of soil properties*

Soil series, land types, and map symbols	Hydrologic soil group	Depth to hardpan or bedrock	Depth from surface	Classification		
				USDA texture	Unified	AASHO
		Ft.	*In.*			
Cashion: Cc	C	>5	0–28	Clay	CH	A–7
			28–60	Fine sandy loam	SM	A–4
Cavelt: CeC	D	½–1½	0–10	Gravelly loam	ML or SM	A–4
			10	Indurated lime hardpan		
Contine: Co	C	>5	0–12	Clay loam	CL	A–6
			12–38	Clay	CH	A–7
			38–66	Clay loam and loam	CL	A–6 or A–7
Estrella: Es	B	>5	0–26	Loam	ML	A–4
			26–60	Clay loam	CL	A–6
Gilman: Gf, Gm	B	>5	0–60	Loam; fine sandy loam in places	ML or CL	A–4 or A–6
Glenbar: Gn	B	>5	0–60	Clay loam and heavy silt loam	CL	A–6
Gravelly alluvial land: Gr	A	>5	0–60	Very gravelly sandy loam or loamy sand.	GP–GM or GP	A–1
Laveen: LaA, LaB, LeA	B	>5	0–60	Loam; clay loam in LeA	ML, CL or CH	A–7, A–6 or A–4.
Mohall: Mo, Mv	B	>5	0–60	Loam and clay loam	ML or CL	A–4 or A–6
Pimer: Pm	B	>5	0–60	Clay loam and loam	CL	A–6
Pinal: PnA, PnC	D	½–1½	0–18	Gravelly loam	ML or SM	A–4
			18	Indurated lime-silica hardpan.		
Pinal, moderately deep variant: Po.	C	2½–3½	0–38	Loam	ML	A–4
			38	Indurated lime-silica hardpan.		
Pinamt: PvA, PvC	B	>5	0–60	Very gravelly sandy clay loam and very gravelly loam.	GC or GM	A–1
Rillito: RlA, RlB	B	>5	0–60	Gravelly loam	SM	A–2 or A–4
Rock land: Ro. Variable, not estimated.						
Rough broken land: Ru. Variable, not estimated.						
Tremant: TrB	B	>5	0–16	Gravelly sandy clay loam	SC	A–4
			16–60	Gravelly loam and gravelly sandy loam.	SM	A–2
Trix: Tx	B	>5	0–60	Clay loam	CL	A–6
Valencia: Va	B	>5	0–26	Sandy loam	SM	A–2 or A–4
			26–45	Sandy clay loam	SC	A–4
			45–60	Sandy loam	SM	A–2 or A–4
Vecont: Ve	C	>5	0–64	Clay and clay loam	CH	A–7
Vint: Vf	B	>5	0–60	Loamy fine sand	SM	A–2

significant to engineering—Continued

Percentage passing sieve—				Permeability	Available water capacity	Salinity	Shrink-swell potential	Corrosivity to untreated steel
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)					
				In./hr.	*In./in. of soil*	*Mmhos./cm.*		
95–100	95–100	90–100	85–95	0.06–0.20	0.14–0.16	2–4	High	High.
95–100	90–100	80–95	35–45	2.0–6.3	0.13–0.15	2–4	Low	Moderate.
80–95	70–85	55–75	40–60	0.63–2.0	0.11–0.13	2–4	Low	Moderate.
				<0.06				
95–100	90–100	85–95	65–75	0.20–0.63	0.19–0.21	<2	Moderate	Moderate.
95–100	85–100	80–90	70–80	0.06–0.20	0.14–0.16	<2	High	High.
95–100	85–100	85–95	65–75	0.20–0.63	0.19–0.21	<2	Moderate	Moderate.
95–100	90–100	80–90	60–70	0.63–2.0	0.16–0.18	<2	Low	Low.
95–100	95–100	85–95	70–80	0.20–0.63	0.19–0.21	<2	Moderate	Moderate.
100	100	70–100	60–85	0.63–2.0	0.16–0.18	2–4	Low	Moderate.
100	95–100	85–95	80–90	0.20–0.63	0.19–0.21	<2	Moderate	Moderate.
40–50	30–40	20–30	0–20	>20.0	0.03–0.05	<2	Very low	Low.
95–100	85–100	85–95	65–75	0.63–2.0	0.16–0.18	2–4	Low	Moderate.
95–100	90–100	80–90	50–70	0.20–0.63	0.17–0.19	<2	Moderate	Moderate.
95–100	95–100	85–95	80–90	0.20–0.63	0.19–0.21	<2	Moderate	Moderate.
80–95	70–85	55–75	40–60	0.63–2.0	0.11–0.13	2–4	Low	Moderate.
90–95	80–90	70–80	50–60	0.63–2.0	0.14–0.16	2–4	Low	Moderate.
20–55	15–50	10–45	5–25	0.2–0.63	0.05–0.07	<2	Low	Low.
55–90	50–85	45–80	30–45	0.63–2.0	0.09–0.12	<2	Low	Low.
70–90	65–85	45–55	35–45	0.2–0.63	0.10–0.12	<2	Low	Moderate.
70–90	65–85	35–45	20–30	0.63–2.0	0.07–0.11	<2	Low	Low.
95–100	95–100	90–100	80–90	0.20–0.63	0.19–0.21	<2	Moderate	Moderate.
95–100	90–100	60–70	30–40	2.0–6.3	0.11–0.13	<2	Low	Low.
95–100	95–100	80–95	35–50	0.2–0.63	0.14–0.16	<2	Moderate	Moderate.
95–100	90–100	60–70	30–40	2.0–6.3	0.11–0.13	<2	Low	Low.
95–100	95–100	90–100	80–90	0.06–0.20	0.14–0.16	<2	High	High.
95–100	90–100	70–80	15–25	2.0–6.3	0.07–0.09	<2	Low	Low.

TABLE 6.—*Interpretations of*

Soil series, land types, and map symbols	Degree and kind of limitation for—			Suitability as a source of—	
	Septic tank absorption fields	Dwellings without basements	Local roads and streets	Road fill	Sand
Agualt: Af, Ag	Slight	Slight	Slight to moderate: A–2 and A–4.	Good to fair: A–2 or A–4.	Not suitable in upper 20 to 40 inches; ML. Poor below depth of 20 to 40 inches; SM; too many fines.
Alluvial land: Am.	Severe: variable material; hazard of ground water contamination.	Slight to moderate: variable material; short, steep slopes; contains fines.	Slight to moderate: variable material; contains fines.	Good in most places. Fair where excessive fines occur.	Good in most places. Fair where excessive fines occur.
Antho: AnA, AnB, AoB.	Slight	Slight	Slight	Good or fair: sandy loam and appreciable amount of fines.	Poor: mainly sandy loam.
Avondale: Av	Slight to moderate: moderate permeability.	Moderate: low to moderate shrink-swell potential.	Moderate: mainly A–4; low to moderate shrink-swell potential.	Fair: mainly A–4; low to moderate shrink-swell potential.	Not suitable: mainly very fine sandy loam and loam.
Carrizo: Ca, Cb	Slight: hazard of ground water contamination.	Slight	Slight	Good	Poor to depth of 13 inches. Good to fair below 13 inches; GP or GM.
Cashion: Cc	Slight	Severe: upper layer clay; high shrink-swell potential. Slight in sandy underlying layer.	Severe: upper layer clay; A–7. Moderate in sandy underlying layer; A–4.	Poor: A–7; high shrink-swell potential. Fair in underlying layer; A–4.	Not suitable: mainly clay and loam.
Cavelt: CeC	Severe: lime hardpan at depth of 5 to 20 inches.	Severe: lime hardpan at depth of 5 to 20 inches.	Severe: lime hardpan at depth of 5 to 20 inches.	Fair: A–4; hardpan at depth of 5 to 20 inches.	Not suitable: mainly loam; hardpan at depth of 5 to 20 inches.
Contine: Co	Severe: slow permeability.	Severe: high shrink-swell potential.	Severe: A–6 and A–7; high shrink-swell potential.	Poor: A–6 and A–7.	Unsuited: mainly fines.
Estrella: Es	Severe: moderately slow permeability.	Moderate: moderate shrink-swell potential.	Moderate to severe: A–4 and A–6; moderate shrink-swell potential.	Fair to poor: A–4 and A–6.	Unsuited: loam and clay loam.
Gilman: Gf, Gm	Slight to moderate: moderate permeability.	Slight	Moderate to severe: A–4 and A–6.	Fair to poor: A–4 and A–6.	Unsuited: mainly loam.

engineering properties of soils

Suitability as a source of—Continued		Soil features affecting—		
Topsoil	Gravel	Pond reservoir areas	Embankments, dikes, and levees	Irrigation
Good to a depth of 20 to 40 inches.	Not suitable: mainly loam and sandy loam.	Very rapid permeability below depth of 20 to 40 inches.	Medium to low shear strength; medium to high compressibility; medium to low compacted permeability; medium to high susceptibility to piping; poor to good compaction.	Moderate permeability; moderate available water capacity.
Generally poor: mainly sand, loamy sand, and gravel. Good in some areas.	Good: main source of gravel in survey area.	Moderate to very rapid permeability.	High shear strength; high compacted permeability; low compressibility; low susceptibility to piping; good compaction.	Very low available water capacity; moderate to very rapid permeability.
Good in AnA and AnB. Poor in AoB; gravel.	Not suitable: mainly sandy loam.	Moderately rapid permeability.	Medium to low shear strength; medium to low compressibility; medium to low compacted permeability; fair to good compaction; medium to high susceptibility to piping.	Moderate available water capacity; AnB and AoB have slopes of 1 to 3 percent.
Fair in upper 13 inches; clay loam. Good below depth of 13 inches.	Not suitable: mainly loam and very fine sandy loam.	Moderate permeability below depth of 13 inches.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; medium to high susceptibility to piping; good to poor compaction.	High available water capacity; moderately slow intake rate; moderate permeability below depth of 13 inches.
Poor: sand and gravel.	Fair to good: gravelly sand and very gravelly sand.	Very rapid permeability.	High shear strength; fair to good compaction; high compacted permeability; low compressibility; medium to low susceptibility to piping.	Very low available water capacity; very rapid permebility.
Poor in upper layer; clay. Good in underlying material.	Not suitable: mainly clay and loam.	Moderately rapid permeability below clay upper layer.	Clay layer has high compressibility, low shear strength; low compacted permeability; low susceptibility to piping; fair to poor compaction. Underlying layer has medium shear strength; low to medium compressibility; low to medium compacted permeability; fair compaction; medium to high susceptibility to piping.	High available water capacity; slow intake rate; slow permeability in clay layer; moderately rapid permeability below clay layer.
Poor: mainly loam; hardpan at depth of 5 to 20 inches.	Not suitable: mainly loam; hardpan at depth of 5 to 20 inches.	Lime hardpan at depth of 5 to 20 inches.	Medium to low shear strength; low to medium compressibility; low to medium compacted permeability; medium to high susceptibility to piping; fair compaction.	Low available water capacity; gravelly; lime hardpan at depth of 5 to 20 inches.
Moderate: upper 12 inches clay loam.	Unsuited: mainly fines.	Slow permeability	Medium to low shear strength; low compacted permeability; low to medium susceptibility to piping; medium to high compressibility; fair compaction.	High available water capacity; slow permeability; moderately slow intake rate.
Good in upper 26 inches. Fair below 26 inches; clay loam.	Unsuited: loam and clay loam.	Moderate and moderately slow permeability.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; medium to high susceptibility to piping; fair compaction.	High available water capacity; moderate intake rate; moderate to moderately slow permeability.
Good	Unsuited: mainly loam.	Moderate permeability.	Medium to low shear strength; medium to low compacted permeability; medium compressibility; high susceptibility to piping; fair compaction.	High available water capacity; moderate intake rate; moderate permeability.

TABLE 6.—*Interpretations of engineering*

Soil series, land types, and map symbols	Degree and kind of limitation for—			Suitability as a source of—	
	Septic tank absorption fields	Dwellings without basements	Local roads and streets	Road fill	Sand
Glenbar: Gn	Severe: moderately slow permeability.	Moderate: moderate shrink-swell potential.	Severe: A–6; moderate shrink-swell potential.	Poor: A–6; moderate shrink-swell potential.	Unsuited: mainly clay loam.
Gravelly alluvial land: Gr.	Severe: variable material; hazard of ground water contamination.	Slight to moderate: material variable and contains fines; short, steep slopes.	Slight to moderate: material variable and contains fines.	Good: variable in content of fines.	Poor to fair: variable in content of fines.
Laveen: LaA, LaB, LeA.	Slight to moderate: moderate permeability.	Slight	Severe: A–4 and A–6.	Fair to poor: A–4 and A–6.	Unsuited: mainly loam.
Mohall: Mo, Mv	Severe: moderately slow permeability.	Moderate: moderate shrink-swell potential.	Moderate to severe: A–4 and A–6; moderate shrink-swell potential.	Fair to poor: A–4 and A–6.	Unsuited: mainly clay loam.
Pimer: Pm	Severe: moderately slow permeability.	Moderate: moderate shrink-swell potential.	Severe: A–6; moderate shrink-swell potential.	Poor: A–6	Unsuited: mainly clay loam.
Pinal: PnA, PnC	Severe: lime-silica hardpan at depth of 4 to 20 inches.	Severe: lime-silica hardpan at depth of 4 to 20 inches.	Severe: lime-silica hardpan at depth of 4 to 20 inches.	Fair: A–4; hardpan at depth of 4 to 20 inches.	Unsuited: loam and sandy loam; hardpan at depth of 4 to 20 inches.
Pinal, moderately deep variant: Po.	Severe: lime-silica hardpan at depth of 30 to 40 inches.	Moderate: lime-silica hardpan at depth of 30 to 40 inches.	Moderate: A–4; lime-silica hardpan at depth of 30 to 40 inches.	Fair: A–4	Unsuited: mainly loam.
Pinamt: PvA, PvC.	Severe: moderately slow permeability.	Slight	Slight	Good	Unsuited: mainly very gravelly sandy clay loam.
Rillito: RlA, RlB.	Slight to moderate: moderate permeability.	Slight	Slight to moderate: A–2 or A–4.	Fair to good: A–2 or A–4.	Unsuited: excessive fines.
Rock land: Ro	Severe: rock outcrop; shallow and very shallow soil.	Severe: rock outcrop; shallow and very shallow soil.	Severe: rock outcrop; shallow and very shallow soil.	Poor: rock outcrop; shallow and very shallow soil.	Unsuited: rock outcrop; shallow and very shallow soil.
Rough broken land: Ru.	Severe: soil variable and steep.	Severe: soil variable and steep.	Severe: soil variable and steep.	Poor: soil variable and steep.	Unsuited: soil variable and steep.
Tremant: TrB	Slight to moderate: moderate permeability below depth of 16 inches.	Slight	Slight to moderate: A–2 and A–4.	Good to fair: A–2 and A–4.	Poor: excessive fines.

properties of soils—Continued

Suitability as a source of—Continued		Soil features affecting—		
Topsoil	Gravel	Pond reservoir areas	Embankments, dikes, and levees	Irrigation
Fair: mainly clay loam.	Unsuited: mainly clay loam.	Moderately slow permeability.	Medium to low shear strength; medium to low susceptibility to piping; medium compressibility; low compacted permeability; fair to good compaction.	High available water capacity; moderately slow permeability.
Poor: contains gravel.	Poor to fair: variable in content of fines.	Very rapid permeability.	Medium to high shear strength; medium to low compressibility; medium to low compacted permeability; medium to low susceptibility to piping; fair to good compaction.	Low available water capacity; very rapid permeability.
Good in LaA and LaB. Fair in LeA; upper 12 inches clay loam.	Unsuited: mainly loam.	Moderate permeability.	Medium to low shear strength; medium to low compacted permeability; medium compressibility; medium to high susceptibility to piping; fair to good compaction.	High available water capacity; moderate permeability.
Fair: clay loam or sandy clay loam at depth of 15 inches.	Unsuited: mainly clay loam.	Moderately slow permeability.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; medium to high susceptibility to piping; fair to poor compaction.	High available water capacity; moderately slow permeability.
Fair: clay loam	Unsuited: mainly clay loam.	Moderately slow permeability.	Medium to low shear strength; medium to low susceptibility to piping; medium compressibility; low compacted permeability; fair to good compaction.	High available water capacity; moderately slow permeability; moderately slow intake rate.
Poor: gravelly; hardpan at depth of 4 to 20 inches.	Unsuited: loam and sandy loam; hardpan at depth of 4 to 20 inches.	Lime-silica hardpan at depth of 4 to 20 inches.	Medium to low shear strength; medium to low compressibility; medium to low compacted permeability; medium to high susceptibility to piping; fair to good compaction.	Low available water capacity; lime-silica hardpan at depth of 4 to 20 inches.
Fair: contains gravel.	Unsuited: mainly loam.	Lime-silica hardpan at depth of 30 to 40 inches.	Medium to low shear strength; medium to low compacted permeability; medium compressibility; high susceptibility to piping; good to poor compaction.	Moderate available water capacity; moderate permeability; lime-silica hardpan at depth of 30 to 40 inches.
Poor: very gravelly.	Poor: fairly high content of fines.	Moderately slow permeability.	Medium shear strength; low to medium compressibility; low compacted permeability; medium to low susceptibility to piping; good to fair compaction.	Low available water capacity; moderately slow permeability; very gravelly; slope.
Poor: gravelly and limy.	Poor: excessive fines.	Moderate permeability.	Medium shear strength; low to medium compressibility; low to medium compacted permeability; medium to high susceptibility to piping; fair to good compaction.	Moderate available water capacity; moderate permeability; gravelly and limy.
Poor: rock outcrop; shallow and very shallow soil.	Unsuited: rock outcrop; shallow and very shallow soil.	Rock outcrop; shallow and very shallow soil.	Rock outcrop; shallow and very shallow soil.	Rock outcrop; shallow and very shallow soil.
Poor: soil variable and steep.	Unsuited: soil variable and steep.	Steep; high potential for seepage.	Soil variable; steep	Soil variable and steep.
Poor: gravel	Unsuited: excessive fines.	Moderate permeability below depth of 16 inches.	Medium shear strength; low to medium compressibility; medium to low compacted permeability; medium susceptibility to piping; fair to good compaction.	Moderate available water capacity; moderately slow permeability; slope.

TABLE 6.—*Interpretations of engineering*

Soil series, land types, and map symbols	Degree and kind of limitation for—			Suitability as a source of—	
	Septic tank absorption fields	Dwellings without basements	Local roads and streets	Road fill	Sand
Trix: Tx	Severe: moderately slow permeability.	Moderate: moderate shrink-swell potential.	Severe: A-6; moderate shrink-swell potential.	Poor: A-6; moderate shrink-swell potential.	Unsuited: excessive fines.
Valencia: Va	Severe: moderately slow permeability.	Moderate: moderate shrink-swell potential.	Slight to moderate: A-2 and A-4.	Good to fair: A-2 and A-4.	Poor to unsuited: SM poor; SC unsuited; excessive fines.
Vecont: Ve	Severe: slow permeability.	Severe: high shrink-swell potential.	Severe: A-7; high shrink-swell potential.	Poor: A-7; high shrink-swell potential.	Unsuited: clay
Vint: Vf	Slight: hazard of ground water contamination.	Slight	Slight	Good	Poor: excessive fines.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from the plastic state to a liquid. The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the soil material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range in moisture content within which a soil material is in a plastic condition.

Soil properties significant to engineering

Several estimated soil properties significant in engineering are given in table 5. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 5.

Hydrologic soil groups are used to estimate runoff from rainfall. Soil properties are considered that influence the minimum rate of infiltration obtained for a bare soil after prolonged wetting. These properties are depth to a seasonal high water table, intake rate, permeability after prolonged wetting, and depth to a very slowly permeable layer. The influence of ground cover is treated independently—not in hydrologic soil groupings. The soils have been classified into four hydrologic groups, A through D.

Soils in group A have low runoff potential and have a high (rapid) infiltration rate, even when thoroughly wetted. They consist chiefly of deep, well drained to excessively drained sand or gravel. These soils have a high rate of water transmission.

Soils in group B have moderately low runoff potential and have a moderate infiltration rate when thoroughly wetted. They consist chiefly of moderately deep and deep, moderately well drained and well drained soils that have moderately fine to moderately coarse texture and moderately slow to moderately rapid permeability. These soils have a moderate rate of water transmission.

Soils in group C have moderately high runoff potential and have a slow infiltration rate when thoroughly wetted. They consist chiefly of soils that contain a layer that impedes downward movement of water, that have a moderately fine or fine texture, that have a slow infiltration rate because of salts or alkali, or that have a moderate water table. These soils may be somewhat poorly drained or they may be well drained or moderately well drained, and they contain a slowly or very slowly permeable layer (fragipan, hardpan, hard bedrock, and the like) at a depth of 20 to 40 inches.

Soils in group D have high runoff potential and have a very slow infiltration rate when thoroughly wetted. They consist chiefly of clay soils that have a high swelling potential; of soils that have a permanently high water table, a claypan or clay layer at or near the surface, and a very slow infiltration rate because of salts or alkali; and of soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Depth to bedrock is distance from the surface of the soil to the upper surface of the rock layer.

Permeability refers to the rate at which water moves through the soil material. It depends largely on the texture and structure of the soil and is estimated for uncompacted soil.

Available water capacity is the amount of water a *properties of soils*—Continued

Suitability as a source of—Continued		Soil features affecting—		
Topsoil	Gravel	Pond reservoir areas	Embankments, dikes, and levees	Irrigation
Fair: clay loam	Unsuited: excessive fines.	Moderately slow permeability.	Medium to low shear strength; medium to low susceptibility to piping; medium compressibility; low compacted permeability; fair to good compaction.	High available water capacity; moderately slow permeability.
Good	Unsuited: SM and SC; excessive fines and low content of gravel.	Moderately slow permeability to depth of 45 inches.	Medium shear strength; low to medium compressibility; low to medium compacted permeability; medium susceptibility to piping; fair to good compaction.	High available water capacity; moderately slow permeability; moderately rapid intake rate.
Poor: clay	Unsuited: clay	Slow permeability	Low shear strength; low compacted permeability; low susceptibility to piping; fair to good compaction; high compressibility.	High available water capacity; slow permeability; slow intake rate.
Poor: loamy sand and fine sand.	Unsuited: low content of gravel.	Moderately rapid permeability.	Medium shear strength; low to medium compressibility; low to medium compacted permeability; medium to high susceptibility to piping; fair to good compaction.	Moderately low available water capacity; moderately rapid permeability.

soil can hold available for plants. It is the water held in the range between field capacity and wilting point.

Shrink-swell potential is that quality of a soil that determines its volume change with changes in moisture content. It is estimated primarily on the basis of the amount and kind of clay in the soil.

Corrosivity refers to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties, such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Soil reaction, or pH value, of the soils in the survey area is not shown in table 5, because all the soils have similar reaction. The pH value of most of the soils ranges from 7.9 to 8.4, which is considered moderately alkaline. This degree of alkalinity does not adversely affect the commonly grown crops.

Engineering interpretations of soils

The estimated interpretations in table 6 are based on the engineering properties of soils shown in table 5, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Maricopa and Pinal Counties. In table 6 ratings are used to summarize limitation or suitability of the soils for all specified purposes other than for pond reservoir areas; embankments, dikes, and levees; and irrigation. For these particular uses, table 6 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means soil properties generally favorable for the rated use, or in other words, limitations that are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties so unfavorable and so difficult to correct or overcome as to require major soil reclamation and special designs.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 6.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Dwellings, as rated in table 6, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support a load and resist settlement under a load, and those that relate to ease of excavation. Soil properties that affect capacity to support a load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Soil limitations for local streets and roads are based on properties of undisturbed soils that limit use of the soils for construction and maintenance (*2*).

The suitability of soil material for road fill is based upon the performance of the material when excavated and used as borrow for highway subgrade. Generally, the soils rated A–1 and A–2 are the best for this purpose because of their ability to sustain heavy loads. Soils rated A–6 and A–7 are the poorest because of their high water-holding capacity, low strength, and high shrink-swell potential. As a rule, soils rated A–1 and A–2 are good material for road fill. Those rated A–4 and A–5 are considered only fair, and soils rated A–6 and A–7 are poor material for this purpose.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 6 provide guidance about where to look for probable sources. Except within river channels, most of the soils in the survey area are poor sources of sand and gravel.

Suitability of soils as a source of topsoil is evaluated on the basis of quality and quantity.

Pond reservoir areas require slow permeability rates to hold seepage to a minimum.

Embankments, dikes, and levees require soil material of moderate to high shear strength, low compressibility, low to medium compacted permeability, and low susceptibility to piping. Good workability for compaction is essential.

Soil features that make irrigation difficult are a slow rate of infiltration, low available water capacity, and shallowness over a fragipan or other layer that restricts movement of water. Slope and erosion also impose restrictions on the use of a soil for irrigation.

The following engineering properties have not been defined but are evaluated in table 6:

Shear strength of a soil indicates the relative resistance of the soil to sliding or deformation when supporting a load. It is related to internal friction and cohesion of a soil. Highest resistance to sliding occurs in soils that are composed of clean gravel; the lowest occurs in fine-grained organic soils. Shear strength decreases as the content of fines increases.

Compressibility of a soil refers to the decrease in volume of the mass when supporting a load. Compressibility is lowest in coarse-grained soils having grains that are in contact. Compressibility increases as the content of fines increases, and it is highest in fine-grained soils containing organic matter.

Compacted permeability of a soil indicates the rate at which water moves through the soil. Coarse-grained soils that contain large, continuous pores when compacted transmit water rapidly and are said to have high compacted permeability. Fine-grained soils contain small discontinuous pores, and water flows through these soils very slowly. These soils are said to have low compacted permeability.

Piping or internal erosion refers to the likelihood of removal of soil particles by water moving through pores or cracks in a compacted soil mass. Highly susceptible soil materials are those that have large pores through which water moves rapidly, yet in which soil particles are fine enough and sufficiently lacking in cohesion so that individual grains move readily. The most susceptible materials are fine sand and nonplastic silt (plasticity index less than 5).

Compaction characteristics, called "compaction" in table 6, indicate the relative response to be expected of a soil to compactive effort. Given satisfactory moisture control, a soil rated *good* can be compacted to a high degree with less effort than a soil rated *poor*.

Formation and Classification of the Soils

This section tells how the factors of soil formation have affected the development of soils in the survey area, and it discusses processes that have affected the formation of soil horizons. It also explains the current system of soil classification, places the soils in some categories of this system, and provides information about results of chemical and physical analyses of selected soils.

Factors of Soil Formation

Soil is the product of soil-forming processes acting on material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the soil parent material; (2) the climate under which the soil material has accumulated and has existed since it accumulated; (3) the plant and animal life on and in the soil; (4) the relief or lay of the land; and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and vegetation are the active factors of soil genesis. They act on the parent material and slowly change it to a natural formation that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that forms. Finally, time is needed for the changing of the parent material into a soil profile. Time is always required for the forces of the soil-forming factors to produce soil horizons. Generally, several thousand years are required to produce a B horizon in a soil.

Parent material

Parent material is the unconsolidated material in which the soil profile forms. It may have weathered in place from rock, or it may have been transported by water, wind, or ice. The parent material of most of the soils in the survey area was transported by water.

The parent material of the soils in the survey area was derived from several sources. Part of it was washed from the Phoenix and Salt River Mountains on the western side of the survey area, and part originated in the San Tan Mountains on the southeastern side. Still other material was derived from rocks of the Superstition and the

Goldfield Mountains, just outside and northeast of the survey area. Those rocks are mainly granite, schist, and andesite, but they include some diorite and tuff. Rocks many miles away from the survey area also contributed material. The parent material from these distant sources consists of recent alluvium that was transported into the survey area by waters of the Salt River and the Queen Creek Wash. It consists of particles of material that are variable in size and in mineralogical composition. Most of the soils in the survey area have formed in mixed alluvial material that is many feet thick.

Climate

The climate of the survey area is arid; only 6 to 8 inches of rainfall is received annually. Winters are mild, summers are hot, and the humidity is generally low.

Climate strongly influences the amount and the kind of vegetation in an area. It also strongly influences the rate at which organic matter builds up in the soils and the rate at which organic matter decomposes. In addition it affects the rate at which different minerals weather, the nature of the weathering products, and the removal or accumulation of minerals in the different soil horizons. Because of the small amount of rainfall and the high temperatures in the survey area, the cover of plants is sparse. Hence, only a small amount of organic matter accumulates in the soils, and that amount is rapidly decomposed as the result of the rapid increase and growth of micro-organisms. The high temperatures and low rainfall in the survey area allow only a small amount of chemical reaction and only slight movement of material within the soil horizons.

Such soils as the Mohall and Contine, which have a thick, relatively strong structural B horizon and have clay films on the surfaces of the peds, probably formed under a cooler climate than the present one. They probably formed at a time when the amount of rainfall was greater than that received in the survey area at the present time. The average annual rainfall at the present time would not provide enough water to leach out calcium carbonates and clay separates to the depths where they have concentrated in the profiles of these soils.

Under the present amount of annual rainfall, soils that originally contained a moderate amount of calcium carbonate could only have the calcium carbonate leached out of the surface layer. In those soils only a thin B horizon has formed. The most recent alluvial parent material deposited by water has not had the calcium carbonate leached from the surface layer. Consequently, soils that formed in that parent material lack a zone of lime accumulation in the soil profile.

Plant and animal life

Plants and animals, including micro-organisms, are important in the formation of soils. Where the temperature is suitable for their growth, plants begin to grow as soon as they receive a suitable amount of water and a supply of plant nutrients. When the plants die, they are decomposed by living organisms and are added to the soils as organic matter. Plants influence the temperature of the soil by providing shade during warm periods and by helping to retain moisture in the soils.

Along with plants and animals, earthworms, spiders, beetles, and rodents help to convert nutrients in the soils to a form available for plants. These processes, in turn, contribute to the formation of soils.

Relief

Relief, as a factor of soil formation, is closely related to the other four factors. Relief and runoff influence the formation of soils through their effects on drainage, erosion, soil temperature, and plant cover. The thickness and the kinds of soil horizons depend on the amount of water that percolates through the parent material. More water normally enters a nearly level or gently sloping soil than enters a soil that is strongly sloping or steep. Soils throughout the survey area are nearly level or gently sloping.

Most of the recently deposited soil-forming material in the survey area is on alluvial fans and flood plains along the Salt River and Queen Creek Wash. Soils formed in this recently deposited material are younger than those on the adjacent old alluvial fans and terraces at a higher elevation. They have not been influenced so long by the factors of soil formation as have those at the higher elevation. Soils on the higher fans and terraces generally have more slope than the soils on the flood plains. As a result, more of the water from rainfall runs off and does not enter the soil. The amount of runoff depends somewhat, however, on the texture of the soil material. Coarse-textured soils take in water more rapidly than do fine-textured ones. Therefore, less water is lost through runoff.

Time

The length of time necessary for a soil to form depends upon the other factors of soil formation. If other factors have not operated long enough for definite horizons to have formed, the soil is considered young or immature. In this survey area, the youngest soils and the ones that show the least development of a soil profile are on flood plains and alluvial fans of the large streams. The parent material of those soils may have been in place only a few years. Among the soils formed in this kind of parent material are the Avondale, Gilman, and Vint.

Soils of the survey area that have an A horizon, a relatively thick Bt horizon, and a lower horizon that contains an accumulation of lime are on old alluvial fans and terraces. Examples of such soils are the Mohall and Contine. The depths to which calcium carbonate and clay have moved downward in the soil profile of these soils reflect both the age of these soils and the amount of water that has moved downward through the profile. This suggests the possibility that these soils formed, at least in part, under a climate that was more moist than the one at the present time. At least, these soils have been forming over a longer period of time than the soils that are forming in recent alluvium on flood plains and alluvial fans.

Processes of Horizon Formation

Several processes are involved in the formation of soil horizons. These are (1) accumulation of organic matter, (2) leaching of calcium carbonates, (3) translocation of silicate clay minerals, and (4) accumulations of soluble salts.

Accumulating organic matter in the upper part of the soil profile is important in the formation of an A horizon. This organic matter gives the surface layer a darker color and increases the fertility of the soil. Most of the organic matter in soils that have never been cultivated or disturbed in other ways comes from the decay of plants. Because the desert vegetation in the survey area is sparse, only a small amount of organic matter is added to the soils. In some places silted water has been applied during irrigation and crop residue has been returned to the soils. In those areas the soils have a higher content of organic matter than they had when they were under native vegetation. In only a few soils is the content of organic matter in the A horizon greater than 1 percent.

The leaching of calcium carbonate from the surface layer has been an important process in the formation of soil horizons. During this process, a zone of lime accumulation is formed at the level to which water from natural rainfall penetrates.

Clay is moved from the A horizon by water and is redeposited in the B horizon, above the Cca horizon, where calcium carbonate has accumulated. The B horizon generally has clay films on the surfaces of the peds. In this survey area, the Contine and Mohall soils are examples of soils that have clay films on the surfaces of peds in the B horizon. It is probable that these soils and some of the other soils that have a thick B horizon have formed under a climate in which rainfall was greater than at the present time.

Soluble salts accumulate in soils of arid regions because of the small amount of rainfall and the high rate of water evaporation. The amount of salt in the profile depends on how much salt was originally present in the parent material of the soil. After many years of irrigation, the soils used for crops in the survey area have had a large part of the soluble salts leached below the depth to which roots normally penetrate.

Classification of the Soils

The purpose of soil classification is to help us remember the significant characteristics of soils, assemble our knowledge about the soils, see their relationships to one another and to the whole environment, and develop principles relating to their behavior and their response to manipulation. First through classification and then through the use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The current system of soil classification (*9*) was adopted by the Cooperative Soil Survey in 1965. It is a comprehensive system, designed to accommodate all soils. In this system classes of soils are defined in terms of observable or measurable properties. The properties chosen are primarily those that result in the grouping of soils of similar genesis, or mode of origin. Genesis does not, however, appear in the definitions of the classes.

The current system of classification has six categories. Beginning with the most inclusive, the categories are the order, the suborder, the great group, the subgroup, the family, and the series. Table 7 shows the classification of the soils of the Eastern Maricopa and Northern Pinal Counties Area according to this system. A brief description of each of the six categories follows.

ORDER.—Ten soil orders are recognized in the current system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate orders are those that tend to give broad climatic groupings of soils. Two exceptions to this generalization are the Entisols and the Histosols, both of which occur in many different climates. Three of the ten orders are represented in the Eastern Maricopa and Northern Pinal Counties Area. They are Entisols, Mollisols, and Aridisols.

SUBORDER.—Each order is divided into suborders, mainly on the basis of soil characteristics that result in

TABLE 7.—*Soil series classified by higher categories*

Series	Family	Subgroup	Order
Agualt	Coarse-loamy over sandy or sandy-skeletal, mixed, calcareous, hyperthermic.	Typic Torrifluvents	Entisols.
Antho	Coarse-loamy, mixed, calcareous, hyperthermic	Typic Torrifluvents	Entisols.
Avondale	Fine-loamy, mixed, hyperthermic	Torrifluventic Haplustolls	Mollisols.
Carrizo	Sandy-skeletal, mixed, hyperthermic	Typic Torriorthents	Entisols.
Cashion	Clayey over loamy, mixed, hyperthermic	Cumulic Haplustolls	Mollisols.
Cavelt	Loamy, mixed, hyperthermic, shallow	Typic Paleorthids	Aridisols.
Contine	Fine, mixed, hyperthermic	Typic Haplargids	Aridisols.
Estrella	Fine-loamy, mixed, calcareous, hyperthermic	Typic Torrifluvents	Entisols.
Gilman	Coarse-loamy, mixed, calcareous, hyperthermic	Typic Torrifluvents	Entisols.
Glenbar	Fine-silty, mixed, calcareous, hyperthermic	Typic Torrifluvents	Entisols.
Laveen	Coarse-loamy, mixed, hyperthermic	Typic Calciorthids	Aridisols.
Mohall	Fine-loamy, mixed, hyperthermic	Typic Haplargids	Aridisols.
Pimer	Fine-silty, mixed, hyperthermic	Cumulic Haplustolls	Mollisols.
Pinal	Coarse-loamy, mixed, hyperthermic	Typic Durorthids	Aridisols.
Pinal, moderately deep variant.	Coarse-loamy, mixed, hyperthermic	Typic Durorthids	Aridisols.
Pinamt	Loamy-skeletal, mixed, hyperthermic	Typic Haplargids	Aridisols.
Rillito	Coarse-loamy, mixed, hyperthermic	Typic Calciorthids	Aridisols.
Tremant	Fine-loamy, mixed, hyperthermic	Typic Haplargids	Aridisols.
Trix	Fine-loamy, mixed, calcareous, hyperthermic	Typic Torrifluvents	Entisols.
Valencia	Coarse-loamy, mixed, calcareous, hyperthermic	Typic Torrifluvents	Entisols.
Vecont	Fine, mixed, hyperthermic	Typic Haplargids	Aridisols.
Vint	Sandy, mixed, hyperthermic	Typic Torrifluvents	Entisols.

grouping soils according to the genetic similarity. The climatic range is narrower than that of the order. The properties used are mainly those that reflect either the presence or absence of waterlogging or differences in climate or vegetation.

GREAT GROUP.—Each suborder is divided into great groups on the basis of similarity in the kind and sequence of the major horizons and in major soil properties. The horizons considered are those in which clay, iron, or humus have accumulated and those in which pans that interfere with the growth of roots and the movement of water have formed. The properties are soil temperature, chemical composition (mainly content of calcium, magnesius, sodium, and potassium), and the like.

SUBGROUP.—Each great group is divided into subgroups, one that represents the central (typic) concept of the group, and others, called intergrades, that have one or more properties of another great group, suborder, or order.

FAMILY.—Families are established within each subgroup, primarily on the basis of properties important to the growth of plants or properties significant in engineering. Texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence are among the properties considered.

SERIES.—Because a discussion of soil series is given in the section "How This Survey Was Made," the series will not be discussed here. In brief, a series is a group of soils that have horizons similar in arrangement in the profile and similar in all important characteristics, except for the texture of the surface layer.

Laboratory Analysis

Data obtained by analysis of a few soils in the survey area are given in table 8. Results of the analysis are useful to soil scientists in classifying soils and in developing concepts of soil genesis. They are also helpful for estimating available water capacity, fertility, tilth, and other soil properties that affect soil management.

All samples used to obtain the data were collected from carefully selected soil profiles. In making the tests, standard methods of the Soils Laboratory of the University of Arizona, Tucson, Ariz., and of the U.S. Department of Agriculture Soil Laboratory at Riverside, Calif., were used.

General Nature of the Area

This section was prepared mainly for those not familiar with Maricopa and Pinal Counties. It discusses briefly the history of farming, geology, physiography, drainage, and climate. It also gives facts concerning the sources of irrigation water and about utilities and industries.

According to historians and archaeologists (*6*), several thousand people, known as the Hohokam, lived in the area that is now Maricopa and Pinal Counties in about the year 200 B.C. For several hundred years, these people farmed the fertile alluvial soils and irrigated their crops with water from the Salt River. They built 125 miles of canals, using stone axes and hoes, and they farmed about 40,000 acres. Many of the irrigation canals of the present day are in the same places where these earlier canals were located.

The exact date that the Hohokams vanished from this area is not known. White settlers first arrived in the area in the early 1860's, however, and they established homes near the present sites of the cities of Tempe and Phoenix. By March of 1868, approximately 100 permanent residents lived in the area and the first canal, known as the Salt River Canal, had been completed. By 1888, more than 100,000 acres was under cultivation. The Consolidated Canal, completed in 1892, was the tenth large canal completed within a span of 24 years.

Dams of rocks and brush, placed in the riverbed, were originally used to divert water from the river to irrigation canals. These dams were frequently washed out by flooding in spring. As a result, the farmer had little water in summer, and in many years his crops wilted and died. Need for water became so critical that farmers of the area appointed a committee to investigate the feasibility of building a water system on the Salt River. Through the work of this committee, the Reclamation Act, which provided funds to be used in certain western areas for reclamation development, was passed. Funds provided by this Act were used for constructing the Roosevelt Dam on the Salt River, which was begun in 1903 and was completed in 1911. During the time the Roosevelt Dam was under construction, the Granite Reef Diversion Dam was completed. The Mormon Flat Dam, which forms the Canyon Lake on the Salt River, was completed in 1925; the Horse Mesa Dam, which forms the Apache Lake on the Salt River, was completed in 1930; the Bartlett Dam on the Verde River was completed in 1939; and the Horseshoe Dam, just above the Bartlett, was completed in 1946. The storage system of these five dams has a capacity of 2,072,050 acre-feet. A large part of the water supply is used to irrigate farms in the survey area.

Irrigated soils in the survey area are used to grow crops, mostly for commercial use. For many years the principal cash crops have been cotton, alfalfa, small grains, vegetables, grapes, citrus and other fruits, and pecans. Sugar beets have been grown only since 1967. Crops mainly used on the farm are grasses and legumes grown for hay and pasture.

Geology, Physiography, and Drainage [8]

The major part of the survey area consists of a broad valley that is filled with alluvial material as much as several hundred feet thick. In the rest of the survey area, there are a few scattered mountains composed of granite and schist of Precambrian age, conglomerate of Cretaceous-Tertiary age, and andesite of Tertiary age.

The mountains are generally rugged and steep, though they attain only a moderate height. Maximum difference in elevation between the floor of the valley and the tops of the mountains is about 2,420 feet. The valley floor is occupied by nearly level or gently sloping soils; in most places slopes are less than 1 percent. In most areas the transitional area between the mountains and the valley is not more than a few miles wide. Soils in this transitional area are moderately sloping to steep.

[8] By W. F. MILDNER, geologist, Soil Conservation Service.

TABLE 8.—*Analytical data for selected soil profiles*

[Analyses made by Soils Laboratory, University of Arizona, Tucson, Ariz., and USDA Soils Laboratory, Riverside, Calif. Dashes in columns indicate no analysis available]

Soil	Horizon	Depth from surface	Very coarse sand (2.0–1.0 mm.)	Coarse sand (1.0–0.5 mm.)	Medium sand (0.5–0.25 mm.)	Fine sand (0.25–0.10 mm.)	Very fine sand (0.10–0.05 mm.)	Total sand (2.0–0.05 mm.)	Silt (0.05–0.002 mm.)	Clay (less than 0.002 mm.)	Reaction: Saturated paste	Reaction: 1:10 solution	Organic carbon	Calcium carbonate equivalent	Electrical conductivity (EC x 10^3)	Sum of exchangeable bases
		In.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*pH*	*pH*	*Pct.*	*Pct.*	*Mmhos./cm. at 25° C.*	*Meq./100 gm. soil*
Antho sandy loam.	Ap	0–12	------	------	------	------	------	76. 0	15. 0	9. 0	7. 6	8. 6	0. 14	------	------	8. 2
	C1	12–36	16. 0	22. 0	13. 0	16. 0	9. 0	76. 0	13. 0	11. 0	8. 1	9. 3	------	------	0. 54	7. 2
	C2	36–60	18. 0	27. 0	14. 0	15. 0	8. 0	82. 0	12. 0	6. 0	8. 1	9. 3	------	------	. 40	4. 3
Avondale clay loam.	Ap	0–10	------	------	------	------	------	------	------	------	------	------	1. 06	------	------	------
	C1	10–18	. 2	1. 0	2. 5	12. 2	15. 5	31. 4	37. 2	31. 4	------	------	. 56	------	------	------
	C2	18–20	. 2	1. 0	5. 8	20. 0	16. 0	43. 0	32. 0	25. 0	------	------	------	------	------	------
	C3	20–30	. 2	1. 1	3. 3	17. 7	22. 6	44. 9	35. 7	19. 4	------	------	. 25	------	------	------
	C4	30–60	. 1	1. 4	4. 4	21. 2	26. 6	53. 7	35. 5	10. 8	------	------	------	------	------	------
Mohall sandy loam.	A11	0–1	2. 3	6. 6	8. 1	25. 1	16. 1	58. 2	28. 0	13. 8	6. 9	7. 8	. 98	------	. 50	13. 4
	A12	1–5	3. 3	8. 7	9. 0	23. 6	15. 8	60. 4	23. 0	16. 6	6. 6	7. 5	. 26	------	. 47	10. 9
	B1t	5–9	2. 5	7. 2	8. 7	23. 2	15. 9	57. 5	21. 7	20. 8	6. 9	7. 5	------	------	. 25	11. 4
	B2t	9–18	1. 6	4. 0	5. 3	18. 4	16. 6	45. 9	24. 5	29. 6	7. 5	8. 4	------	------	. 20	6. 2
	B31	18–26	1. 4	3. 2	4. 2	14. 6	16. 0	39. 4	31. 2	29. 4	7. 9	8. 9	------	3	. 20	19. 6
	B32ca	26–33	1. 5	3. 2	3. 7	11. 6	12. 4	32. 4	31. 3	36. 3	8. 0	9. 1	------	8	. 20	17. 4
	B33ca	33–43	1. 4	2. 4	2. 9	10. 7	13. 8	31. 2	39. 4	29. 4	8. 1	9. 2	------	15	. 30	5. 9
	B34ca	43–51	1. 2	2. 4	3. 4	12. 3	14. 6	33. 9	40. 0	26. 1	8. 1	9. 4	------	16	. 23	9. 2
	Cca	51–63	1. 1	2. 3	3. 3	12. 1	14. 6	33. 4	43. 4	23. 2	8. 3	9. 5	------	18	. 96	8. 7
Vecont clay.	Ap1	0–10	1. 0	1. 7	1. 7	7. 7	7. 6	19. 7	32. 5	47. 8	7. 6	8. 6	. 91	1	2. 14	33. 4
	Ap2	10–16	1. 3	2. 1	1. 7	7. 3	7. 1	19. 5	32. 7	47. 8	7. 6	8. 7	. 52	1	. 40	21. 9
	B21ca	16–23	1. 0	1. 9	1. 6	6. 7	7. 8	19. 0	33. 4	47. 6	7. 7	8. 9	. 16	2	. 50	33. 7
	B22ca	23–31	1. 1	2. 1	1. 8	7. 0	7. 4	19. 4	32. 1	48. 5	7. 7	9. 0	. 15	2	. 30	26. 1
	B3ca	31–46	1. 1	2. 5	2. 2	8. 6	7. 6	22. 0	30. 8	47. 2	7. 8	9. 2	. 10	3	. 50	32. 4
	C	46–65	1. 1	2. 4	2. 1	9. 1	8. 6	23. 3	29. 2	47. 5	8. 2	9. 5	. 04	5	. 40	28. 9

The physiographic feature that forms the transitional area between the mountains and the valley is a waste apron composed of debris that has eroded from the highlands. Deposits of rubble, gravel, and sand are at the upper end of the apron, where the soils are moderately sloping to strongly sloping. Slightly farther down the apron are mostly gently sloping Cavelt, Pinamt, and Tremant soils. Still farther down are nearly level or gently sloping Antho and Valencia soils, and at the extreme lower end are nearly level Mohall, Contine, and Vecont soils.

Superimposed on the soils at the lower end of the apron, and in areas cut into these soils, are areas of recent soils that have formed in alluvium deposited by streams on flood plains and on recent alluvial fans. Adjacent to the streams are Agualt, Vint, Gilman, Avondale, Pimer, and Glenbar soils. On terraces along some of these streams are Laveen, Pinal, and Rillito soils.

The major stream is the Salt River, which traverses the northern part of the survey area in an east-west direction. This river, now only a dry riverbed, was a perennial stream before storage reservoirs were constructed on the upper part of the watershed. All the other streams are intermittent. Queen Creek Wash, the only other large stream, cuts across the southern part of the survey area, also in an east-west direction. Before this large stream was confined to a channel by man, the streamflow spread out over the floor of the valley.

Climate [9]

The survey area has a dry climate. Average monthly precipitation exceeds 1 inch only during August and December. Rains in summer are frequently associated with thunderstorms that form over the mountains to the east during the afternoon and spread out over the surrounding valley early in the evening. Precipitation tends to be moderate to heavy, but it rarely lasts more than 30 minutes. Many times, these storms produce little more than gusty winds and light rain showers. In some years, however, an unusually large amount of precipitation is received or prolonged wet periods in summer are caused as the result of a weak tropical disturbance moving northward from the Pacific Ocean. These unusual storms sometimes produce an amount of rainfall during a 24-hour period as great as that normally received during an entire summer. Table 9 gives facts about temperature and precipitation in the survey area, taken from records kept at the Granite Reef Dam and considered to be representative for the entire area. Table 10 gives probabilities of the last freezing temperatures in spring and the first in fall.

Precipitation is much less dependable in winter than in summer, and the amount of precipitation varies greatly from year to year. Most precipitation in winter is associated with middle-latitude storms that have moved inland from the Pacific Ocean. The most severe weather occurs either when these storms move unusually far south or when they intensify off the coast of Southern California. Then, cloudy skies and intermittent showers sometimes prevail for several days. Snow is rare in most of the survey area. During December, January, and February, traces of snow have been received at the Granite Reef Dam and at the Mesa Experiment Farm, but the snow usually melts soon after falling. Mountain peaks above 4,000 feet, however, often receive significant amounts.

Precipitation can be excessive at times. Estimated return periods of excessive precipitation have been computed for Phoenix, which is immediately west of the survey area. Once in 100 years, the following amounts of precipitation can be expected to fall in the stated period of time: 2.66 inches in 1 hour; 2.97 inches in 3 hours; 3.35 inches in 6 hours; 3.69 inches in 12 hours; and 4.04 inches in 24 hours. This means, for example, that one can expect about 4.04 inches of precipitation to fall during a 24-hour period in Phoenix about once every 100 years.

Summers are warm. From early in June until late in September, the average daily temperature is higher than 80 degrees. It ranges from about 70 degrees near sunrise to 100 degrees in early afternoon. Readings of 110° F. or higher occur regularly between the last week in June and the beginning of the rainy season in summer. During this period, the air is extremely dry and solar heating is at a maximum. The warmest days are generally followed by cool evenings, during which the temperature often falls to the low sixties.

From late in fall until early in spring, the climate of the survey area is mild. In winter the temperature ranges from the high thirties or low forties, near daybreak, to the high sixties, in the afternoon. During warmer periods, the maximum temperature in the afternoon sometimes exceeds 80 degrees. Freezing temperatures are not common. They generally occur on about 15 mornings in a normal winter. Readings of below 20 degrees are unusual.

The length of the frost-free period can be computed from table 10. This table gives the probabilities that a stated temperature will occur before or after a specified date. In 1 year in 10, for example, a temperature of 32° or lower in spring will probably occur at the Granite Reef Dam as late as March 24, and in 5 years in 10, a temperature of 32° or lower will probably occur after February 23. In fall, in 1 year in 10, a temperature of 32° or lower will probably occur at Granite Reef Dam earlier than November 14. In 5 years in 10, a temperature of 32° or lower will probably occur earlier than December 11.

This is among the most wind-free areas in Arizona. In spring, winds from the southwest and west are predominant and are associated with the passage of low-pressure troughs. During the part of the year when thunderstorms are most prevalent, local winds are often gusty, and they usually flow in an easterly direction. Periods in which winds remain under 10 miles per hour occur throughout the year, and they are often several days in length.

About 86 percent of the possible amount of sunshine is received in the survey area. The amount ranges from a minimum monthly average of 77 percent, in December and January, to a maximum monthly average of 94 percent, in June.

[9] By PAUL C. KANGIESER, climatologist for Arizona, National Weather Service, United States Department of Commerce.

TABLE 9.—*Temperature and precipitation, 1938–67*

GRANITE REEF DAM, ELEVATION 1,325 FEET

Month	Temperature				Precipitation		
	Average daily maximum	Average daily minimum	2 years in 10 will have at least 4 days with— Maximum temperature equal to or higher than—	2 years in 10 will have at least 4 days with— Minimum temperature equal to or lower than—	Average total	1 year in 10 will have— Less than—	1 year in 10 will have— More than—
	°F.	°F.	°F.	°F.	In.	In.	In.
January	66	38	77	25	1.0	0.1	2.2
February	70	39	83	28	.8	(1)	1.6
March	76	43	86	34	.9	0	2.3
April	85	50	96	40	.4	0	1.7
May	94	56	104	41	.1	0	.6
June	102	63	110	53	.1	0	.6
July	105	74	112	64	.8	(1)	2.3
August	103	73	109	66	1.5	.2	3.6
September	95	67	108	58	.8	0	2.5
October	88	58	101	44	.5	0	1.4
November	80	46	90	36	.7	0	1.8
December	66	42	77	29	1.3	(1)	4.6
Year	86	54	(2) 114	(3) 23	8.9	4.6	15.2
MESA EXPERIMENT FARM, ELEVATION 1,230 FEET							
January	65	35	77	26	.8	(1)	1.7
February	69	37	81	28	.6	(1)	1.6
March	74	43	85	35	.7	0	1.7
April	83	50	96	41	.3	0	1.4
May	92	55	103	48	.1	0	.8
June	101	64	110	54	.1	0	.5
July	104	74	110	67	.8	(1)	2.1
August	102	73	108	66	1.2	.2	3.0
September	99	66	107	56	.7	(1)	2.1
October	88	54	101	44	.5	(1)	1.7
November	75	41	83	35	.5	0	1.3
December	67	37	75	28	1.0	0	4.0
Year	85	52	(2) 112	(3) 23	7.3	4.1	11.0

[1] Trace. [2] Average annual maximum. [3] Average annual minimum.

The average lake evaporation in the survey area is about 70 inches per year. The maximum amount of evaporation occurs in summer, and the minimum occurs in winter.

Sources of Irrigation Water

Water for irrigating crops grown in the survey area is derived from several sources. Part comes from privately owned deep wells, part is supplied by the Roosevelt Water Conservation District, and part is supplied by the Salt River Valley Water Users' Association. About 75,000 acres on the east side of the survey area, including parts of both Maricopa County and Pinal County, is irrigated with water from privately owned deep wells. Just west of this tract, in the Roosevelt Water Conservation District, about 37,000 acres is irrigated with water supplied by the Roosevelt Water Conservation District. About two-thirds of the water supplied by the District comes from deep wells, and one-third comes from water storage systems on the Salt and the Verde Rivers.

Except for water that is taken from a few privately owned wells, the Salt River Valley Water Users' Association provides water for the rest of the survey area. The Association owns deep wells that supply approximately one-third of this irrigation water. The rest comes from storage reservoirs controlled and managed by the Salt River Valley Water Users' Association. These reservoirs are on the Salt and the Verde Rivers.

Utilities in the Survey Area

Natural gas is available to most parts of the survey area. In the few isolated areas where it is not available, butane gas is used.

TABLE 10.—*Probabilities of last freezing temperature in spring and first in fall*

GRANITE REEF DAM, 1948–67

Probability	Dates for stated probability and temperature			
	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:				
1 year in 10 later than	(1)	(1)	March 8	March 24
2 years in 10 later than	(1)	(1)	(1)	March 14
5 years in 10 later than	(1)	(1)	(1)	February 23
Fall:				
1 year in 10 earlier than	(1)	(1)	December 8	November 14
2 years in 10 earlier than	(1)	(1)	(1)	November 23
5 years in 10 earlier than	(1)	(1)	(1)	December 11

MESA EXPERIMENT FARM, 1936–65

Probability	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:				
1 year in 10 later than	January 19	February 10	March 13	April 7
2 years in 10 later than	(1)	January 30	February 28	March 27
5 years in 10 later than	(1)	(1)	February 8	March 3
Fall:				
1 year in 10 earlier than	January 10	December 12	November 8	November 2
2 years in 10 earlier than	(1)	December 21	November 19	November 9
5 years in 10 earlier than	(1)	(1)	December 14	November 24

[1] Threshold did not occur frequently enough during period of record to compute this probability level.

Electricity is available in most places. Hydroelectric plants located at dams on the Salt River and three steam-powered generator plants in the valley produce a large amount of electricity. The city of Mesa obtains its electricity from hydroelectric plants on the Colorado River.

The cities of Phoenix, Scottsdale, and Tempe obtain their supplies of domestic water mainly from storage reservoirs on the Salt and the Verde Rivers, but partly from wells. Chandler, Mesa, Gilbert, and all other communities in the survey area obtain water for domestic use from wells.

Industries

Many different kinds of industries are located in the survey area. They include about 10 dairies; 6 cattle-feeding lots, with a capacity of 500 to more than 60,000 cattle each; about 20 cottongins, scattered throughout the survey area; a sugar beet processing plant, which has a capacity for processing about 4,500 tons of beets per day and is located southeast of Chandler; and 7 food-processing and food-packaging plants that each employs more than 40 persons and processes citrus, vegetables, other canned foods, and dairy products.

Feed for farm animals is produced and is mixed at about six factories in the survey area. Fertilizer is produced and is mixed by about four fertilizer companies and is then sold to local farmers. Five meatpacking plants are also located in this area. Products other than those produced or used on the farm are manufactured by about 20 companies, each of which employs about 40 persons. One electronic corporation has three separate plants and employs a total of 20,000 or more people.

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Glossary

Alluvial fan. A fan-shaped deposit of sand, gravel, and fine material dropped by a stream where its gradient lessens abruptly.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. In this survey, the available capacity in a rooting depth of 60 inches is defined as—

High	7.5 to 13 inches	Moderately low	3.7 to 5 inches
Moderate	5 to 7.5 inches	Low	Less than 3.7 inches

Bottom lands. The flood plain of a stream, part of which may be flooded at infrequent intervals.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Chlorosis. A yellowing between veins on upper foliage that results from chlorophyll deficiency. Many factors, including heredity, cause chlorosis.

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 clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Depth of soil. Thickness of soil over a specified layer, generally one that does not permit the growth of roots. Classes used in this survey are—

Deep	40 inches or more.	Shallow	4 to 20 inches.
Moderately deep	20 to 40 inches.		

Effervescense, soil. The rate or amount of fizzing or bubbling that takes place as carbon dioxide escapes due to a chemical reaction when 10 percent hydrochloric acid is added to the soil to determine the relative amount of lime in the soil. The terms used are as follows:

Noneffervescent.—No fizzing or bubbles are observed due to the lack of lime in soil.

Slightly effervescent.—Fizzing and bubbles are readily observed due to the amount of lime present.

Strongly effervescent.—Fizzing and bubbles are numerous enough to form a low foam because of high lime content in the soil.

Violently effervescent.—Fizzing and bubbling are so vigorous that a thick foam immediately forms due to the very high lime content of the soil.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

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 been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

Gravel. Rounded pebbles or angular fragments of rock 2 millimeters to 3 inches in diameter. The content of gravel is not used in determining the textural class of the soil, but if the soil is as much as 15 percent gravel, the word "gravelly" is added as a prefix to the textural soil name. In the Unified Engineering Classification, a coarse-grained soil, more than 50 percent of which is retained on a No. 4 (4.7 millimeters) screen.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

Leaching, soil. The removal of soluble materials from soils or other materials by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state. In engineering, a high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads.

Maximum density, soil. In engineering the greatest amount of soil that can be compacted into any unit of volume; expressed as pounds of dry soil material per cubic foot.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Noncalcareous. As used in this report, a soil that does not contain enough free lime to effervesce (fizz) with dilute hydrochloric acid.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Classes of permeability used in this survey refer to the following percolation rates:

Class	*Rates, inches per hour*
Very slow	Less than 0.06
Slow	0.06 to 0.20
Moderately slow	0.20 to 0.63
Moderate	0.63 to 2.00
Moderately rapid	2.00 to 6.30
Rapid	6.30 to 20.00
Very rapid	Over 20.00

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 a semisolid to a plastic state.

Productivity, soil. The present capability of a soil for producing a specified plant or sequence of plants under a specified system of management.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subgrade (engineering). The soil material prepared and compacted to support a pavement.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

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."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which plants (specifically sunflower) wilt so much that they do not recover when placed in a dark, humid atmosphere.

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GUIDE TO MAPPING UNITS

For a full description of a mapping unit read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. Management of nonirrigated soils is defined on page 37. Other information is given in tables as follows:

Acreage and extent, table 1, page 6.
Estimated yields, table 2, page 33.

Soil limitations for recreational facilities, table 3, page 38.
Engineering uses of the soil, tables 4, 5, and 6, pages 42 through 51.

Map symbol	Mapping unit	Described on page	Capability unit Irrigated Symbol	Irrigated Page	Nonirrigated Symbol
Af	Agualt fine sandy loam	6	IIs-7	31	VIIs
Ag	Agualt loam	6	IIs-7	31	VIIs
Am	Alluvial land	7	-----	--	VIIs
AnA	Antho sandy loam, 0 to 1 percent slopes	7	IIs-4	31	VIIs
AnB	Antho sandy loam, 1 to 3 percent slopes	7	IIe-4	31	VIIs
AoB	Antho gravelly sandy loam, 1 to 3 percent slopes	8	IIe-4	31	VIIs
Av	Avondale clay loam	9	I-1	30	VIIc
Ca	Carrizo gravelly loamy sand	9	IVs-7	32	VIIs
Cb	Carrizo fine sandy loam	10	IVs-7	32	VIIs
Cc	Cashion clay	10	IIIs-3	32	VIIs
CeC	Cavelt gravelly loam, 1 to 5 percent slopes	11	-----	--	VIIs
Co	Contine clay loam	12	IIs-8	32	VIIs
Es	Estrella loam	12	I-1	30	VIIc
Gf	Gilman fine sandy loam	13	I-2	30	VIIc
Gm	Gilman loam	13	I-1	30	VIIc
Gn	Glenbar clay loam	15	I-1	30	VIIc
Gr	Gravelly alluvial land	15	-----	--	VIIs
LaA	Laveen loam, 0 to 1 percent slopes	16	I-1	30	VIIc
LaB	Laveen loam, 1 to 3 percent slopes	16	IIe-1	30	VIIc
LeA	Laveen clay loam, 0 to 1 percent slopes	16	I-1	30	VIIc
Mo	Mohall sandy loam	17	I-2	30	VIIc
Mv	Mohall loam	18	I-1	30	VIIc
Pm	Pimer clay loam	20	I-1	30	VIIc
PnA	Pinal gravelly loam, 0 to 1 percent slopes	20	-----	--	VIIs
PnC	Pinal gravelly loam, 1 to 3 percent slopes	20	-----	--	VIIs
Po	Pinal loam, moderately deep variant	21	IIs-5	31	VIIs
PvA	Pinamt very gravelly loam, 0 to 1 percent slopes	22	IVs-6	32	VIIs
PvC	Pinamt very gravelly loam, 3 to 5 percent slopes	22	-----	--	VIIe
RlA	Rillito gravelly loam, 0 to 1 percent slopes	23	IIs-6	31	VIIs
RlB	Rillito gravelly loam, 1 to 3 percent slopes	23	IIe-6	31	VIIs
Ro	Rock land	23	-----	--	VIIs
Ru	Rough broken land	23	-----	--	VIIe
TrB	Tremant gravelly loam, 1 to 3 percent slopes	24	IIe-6	31	VIIs
Tx	Trix clay loam	26	I-1	30	VIIc
Va	Valencia sandy loam	26	I-2	30	VIIc
Ve	Vecont clay	27	IIIs-3	32	VIIs
Vf	Vint loamy fine sand	28	IIIs-7	32	VIIs