SOIL SURVEY OF

Ponce Area of Southern Puerto Rico

United States Department of Agriculture
Soil Conservation Service
In cooperation with the
University of Puerto Rico
College of Agricultural Sciences

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

Major fieldwork for this soil survey was performed in the period 1966–1970. Soil names and descriptions were approved in 1971. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1970. This survey was made cooperatively by the Soil Conservation Service and the University of Puerto Rico College of Agricultural Sciences. It is part of the technical assistance furnished to the Sur and Caribe Soil Conservation Districts.

How To Use This Soil Survey

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

Locating soils

All the soils of the Ponce Area of Southern Puerto Rico 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.

Finding and using information

The "Guide to Map Units" lists all the soils of the area in alphabetic order by map symbol and shows the page where each soil is described. It also shows the capability classification of each soil and the woodland group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of the 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 on the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those that have a moderate limitation can be colored yellow, and those that have 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 discussion of the capability units and the woodland groups.

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

Community planners and others may be interested in the section "General soil map for broad land use planning" where broad patterns of soils are described. And they can read about soil properties that affect the choice of sites for houses, industrial buildings, and recreation areas in the sections "Recreation" and "Engineering uses of the soils."

Engineers and builders can find, in the section "Engineering uses of the soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation, morphology, and classification of the soils."

Cover: Guineagrass pasture in an area of Fraternidad-Paso Seco soil association.

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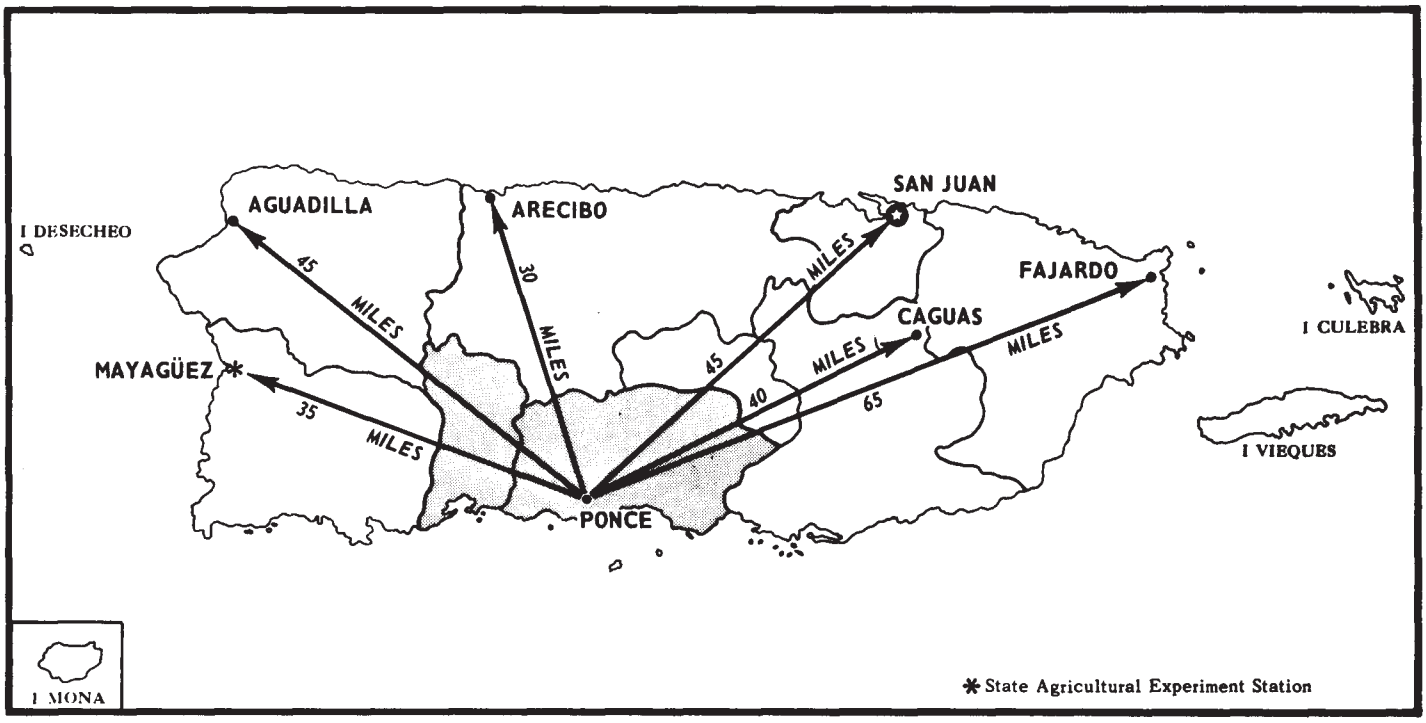

Location of Ponce Area of Southern Puerto Rico.

Soil Survey of the Ponce Area of Southern Puerto Rico

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General nature of the area

The Ponce Area of Southern Puerto Rico takes in an area of 305,402 acres, or 477 square miles. Ponce, which is 71 miles from San Juan, is the largest city in the area. Other municipalities in the survey area are Adjuntas, Coamo, Guayanilla, Juana Diaz, Penuelas, Santa Isabel, and Villalba. Coamo, Juana Diaz, Santa Isabel, and Villalba are within the Caribe Soil Conservation District, and Adjuntas, Guayanilla, Penuelas, and Ponce are within the Sur Soil Conservation District. This survey area is bordered in the south by the Caribbean Sea.

In 1970, the population of the survey area was 309,316. About 58 percent of the population lived in urban areas, and 42 percent lived in rural areas. Industry and commerce have increased greatly in the last 10 years, mainly in and around Ponce. Petrochemical industries have been established in Guayanilla and Penuelas. Fort Allen, a U. S. Navy Base, is in this survey area.

Dairy farms are scattered throughout the survey area. Many areas are in brush. The climate generally is favorable for farming, livestock, orchard fruits, and woodland products.

About 80 percent of the soils of this survey area is on the uplands where the slope is more than 20 percent. And about 60 percent of the acreage of these soils is in the humid area where most of the food crops in the survey area are grown. Only about 8 percent of the soils on the humid uplands is suitable for cultivation. These soils have such limitations as steep slopes, shallowness, rapid runoff, and an erosion hazard.

The semiarid uplands are used mainly for pasture because of low, poorly distributed rainfall. Long droughty periods are common in most years from November to May. The climate is unfavorable for general farming, but it is favorable for raising poultry and livestock. There are many dairy farms in the semiarid uplands and some farms that raise beef cattle. A large acreage is in brush, especially in the limestone area.

The soils on the flood plains and the coastal plains in the semiarid area are used to grow sugarcane. Sugarcane is the major crop in the survey area. A large acreage of these soils is irrigated. Open drains are used on slowly permeable soils to remove excess water. Some soils that have an excess of soluble salts need to be drained and reclaimed. Some of the well drained soils on the bottom lands have been used for vegetables, mainly tomatoes.

Two agricultural experiment substations are in the area, the Fortuna Substation, between Ponce and Juana Diaz, and the Adjuntas Substation, in Barrio Limani of Adjuntas.

Climate

In most of the Ponce area the days are hot and the nights are warm throughout the year. Winds from the sea lower the midday temperatures slightly on some days. In the mountains of the interior, temperatures are appreciably lower than elsewhere, but freezing temperatures are unknown anywhere in the area. Rainfall is heavy from about April through November. It is lightest near the coast, where irrigation is necessary for greatest crop yield, and heaviest in the mountains.

Table 1 gives data on temperature and precipitation for the survey area. The data were recorded at the Adjuntas Substation in the mountains and at Ponce on the south coast.

At Ponce, in winter the average temperature is 77 degrees F, and the average daily minimum temperature is 67 degrees. The lowest temperature on record, which occurred on February 3, 1954, is 54 degrees. In summer the average temperature is 82 degrees, and the average daily maximum temperature is 89 degrees. The highest recorded temperature, which occurred on August 25, 1966, is 99 degrees.

At Adjuntas, in winter the average temperature is 67 degrees F, and the average daily minimum temperature is 55 degrees. The lowest temperature on record, which occurred on February 7, 1975, is 44 degrees. In summer the average temperature is 72 degrees, and the average daily maximum temperature is 84 degrees. The highest recorded temperature, which occurred on May 29, 1973, is 90 degrees.

Of the total annual precipitation, 21 inches at Ponce and 40 inches at Adjuntas, or 60 percent, usually falls in April through September. In 2 years out of 10, the

TABLE 1.—*Temperature and precipitation*

Month	Temperature						Precipitation			
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have—		Average number of growing degree days [1]	Average	2 years in 10 will have—		Average number of days with 0.10 inch or more
				Maximum temperature higher than—	Minimum temperature lower than—			Less than—	More than—	
	°F	°F	°F	°F	°F	Units	In	In	In	
Recorded at Adjuntas, 1970–74										
January	78.5	54.7	66.6	83	46	205	3.32	1.25	4.97	5
February	79.2	53.7	66.5	83	45	182	2.61	1.11	3.82	4
March	79.9	54.3	67.1	85	47	220	4.01	1.38	6.11	7
April	80.9	56.1	68.5	86	49	255	4.41	2.13	6.26	6
May	81.9	59.4	70.6	87	50	329	3.88	1.63	5.70	7
June	83.5	61.3	72.4	89	55	372	5.47	2.61	7.80	8
July	84.0	60.4	72.2	89	55	378	6.16	3.09	8.65	9
August	83.9	61.5	72.7	88	54	394	7.61	6.62	8.56	14
September	83.8	61.0	72.4	88	56	372	12.12	7.65	16.16	14
October	82.4	61.0	71.7	88	55	363	11.54	8.30	14.53	15
November	81.1	58.7	69.9	85	51	297	6.64	4.70	8.43	10
December	77.9	57.0	67.5	84	47	233	3.43	2.38	4.40	8
Year	81.4	58.3	69.8	90	45	3,600	71.20	65.67	76.61	107
Recorded at Ponce, 1951–74										
January	84.3	66.1	76.3	91	59	505	.78	.14	1.26	2
February	86.1	66.3	76.2	90	59	454	.72	.18	1.14	2
March	86.8	66.9	76.8	91	59	521	.86	.15	1.39	2
April	87.3	69.2	78.2	91	63	546	1.92	.52	3.04	4
May	88.0	72.2	80.1	92	65	623	2.92	.87	4.56	4
June	88.9	73.8	81.4	93	68	642	3.13	1.10	4.75	5
July	89.6	73.7	81.7	94	68	673	2.91	1.26	4.25	5
August	89.8	73.3	81.6	96	68	670	4.45	2.20	6.27	6
September	89.7	72.9	81.3	94	68	639	5.26	2.53	7.48	7
October	89.2	72.2	80.7	94	67	642	5.63	2.03	8.51	7
November	88.4	69.9	79.2	92	62	576	3.18	.87	5.02	5
December	87.0	67.7	77.4	92	61	539	1.20	.27	1.93	3
Year	87.9	70.4	79.2	96	58	7,030	32.96	23.66	41.54	52

[1] A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (60 F).

rainfall in April through September is less than 15 inches at Ponce and 33 inches at Adjuntas. The heaviest 1-day rainfall during the period of record was 6.75 inches at Ponce on August 28, 1970, and 11.99 inches at Adjuntas on September 16, 1975. Thunderstorms occur on about 40 days each year, and most occur in summer.

The average relative humidity in midafternoon is 70 percent. Humidity is higher at night, and the average at dawn is 80 percent. The percentage of possible sunshine is 60 in summer and winter. The prevailing wind is from the northeast. Average windspeed is highest, 14 miles per hour, in July.

During the rainy season, an occasional tropical depression skirts or crosses the area and rainfall is extremely heavy, causing severe flash flooding in narrow valleys. Every 10 or 20 years a hurricane approaches or crosses the area and causes wind damage and flooding.

Climatic data for this survey area were specially prepared for the Soil Conservation Service by the National Climatic Center, Asheville, North Carolina.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers,

or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in areas nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After classifying and naming the soils, the soil scientists drew the boundaries of the map units on aerial photographs. These photographs show woodlands, buildings, field borders, roads, 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 soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil. Map units are discussed in the section "Description of the soils."

While a soil survey is in progress, samples of soils are taken for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their characteristics may be modified during the course of the survey. New interpretations are made for local use, mainly through field observation of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is usable to farmers, managers of pastureland and woodland, engineers, planners, developers and builders, home buyers, and others.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, soil associations that have a distinct pattern of soils and of relief and drainage. Each association is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map provides a broad perspective of the soils and landscape in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one association differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

The soil associations in this survey area have been placed into two broad groups. These groups and the soil associations are described on the following pages.

Soils of the humid area

Two soil associations are in this group. They are in the northern half of the survey area. The soils in these associations formed in material that was derived from basic volcanic rock. They are mostly moderately steep to very steep and are used mainly for coffee trees, food crops, and native pasture. These soils receive rain throughout the year and have sufficient moisture for the common crops.

1. Caguabo-Mucara-Quebrada association

Moderately steep to very steep, well drained, medium acid to neutral, loamy and clayey soils over weathered and hard rock; on side slopes and ridges on the volcanic uplands

This association extends from east to west across the entire width of the survey area, from the town of Coamo to Guayanilla. The landscape is mountainous and is highly dissected by intermittent streams. Narrow ridges are common.

This association makes up about 32 percent of the survey area. Caguabo soils make up about 31 percent of the association; Mucara soils, 31 percent; Quebrada soils, 17 percent; and minor soils, 21 percent.

The Caguabo soils are loamy and shallow to hard rock. They are well drained and occur mainly on very steep side slopes. In some places, rocks cover more than 75 percent of the surface. The Mucara soils are clayey and moderately deep to volcanic rock. They are on moderately steep to very steep hills. The Quebrada soils are loamy and deep to volcanic rock. They are on foot slopes, side slopes, and ridges.

The minor soils of the association are the well drained, loamy Morado and Maraguez soils and the moderately well drained, clayey Montegrande soils. The Morado and Maraguez soils are in the same places as the Mucara and Quebrada soils, and the Montegrande soils are on narrow foot slopes. Also in this association are well drained Toa soils and excessively drained Reilly soils in some narrow strips along rivers and streams.

Generally, the soils of this association are not suitable for cultivation because of the hazard of erosion, the steep slopes, and the limited depth. They are suited to use as pasture and woodland, but clearing most areas for pasture is difficult and expensive. The use of machinery is not feasible.

A large acreage is in brush and brushy pasture. Many coffee farms have been abandoned, but small areas of shade-grown coffee trees are still under cultivation, especially on the gentler slopes. In some areas the soils have been planted to grasses, such as pangolagrass and stargrass, and the soils on some middle slopes and foot slopes are planted periodically to food

crops. A few small dairy farms are scattered throughout the association.

Because of the slope, the soils of this association generally have severe limitations that affect their use for buildings or other intensive development.

2. Humatas-Maricao-Los Guineos association

Steep and very steep, well drained and moderately well drained, very strongly acid, clayey soils over thick layers of highly weathered rock; on side slopes and hilltops in the volcanic uplands

This association extends from east to west across the northern part of the survey area. The largest acreage is in the municipality of Adjuntas. The landscape is mountainous and is highly dissected by many intermittent streams. Rounded hilltops are common. Some areas are at an elevation of more than 550 meters above sea level. Some areas have many rocks and boulders on the surface.

This association makes up about 19 percent of the survey area. Humatas soils make up about 36 percent of the association; Maricao soils, 20 percent; Los Guineos soils, 23 percent; and minor soils, 21 percent.

The Humatas soils are steep to very steep, well drained, and deep to highly weathered rock. They are mainly on side slopes and hilltops. Some of the Humatas soils have gravel throughout their profile. The Maricao soils are very steep, well drained, and shallow to highly weathered rock. They are mostly on side slopes and narrow ridges. The Los Guineos soils are moderately well drained and deep to weathered rock. They are on side slopes and rounded hilltops.

The minor soils of this association are the well drained, clayey Alonso, Consumo, Daguey, and Adjuntas soils on side slopes; the moderately well drained, clayey Lares soils on terraces; and the somewhat excessively drained, loamy Pellejas soils and the well drained, loamy Lirios soils on side slopes. Also in this association are a few narrow strips of deep, well drained Toa soils and shallow, excessively drained Reilly soils along the rivers and streams.

A large acreage of this association is not suitable for cultivation because of steep slopes, rapid and very rapid runoff, and the hazard of erosion, but the less sloping soils are suitable for cultivation if they are properly managed to control erosion. Lime and fertilizer are necessary for good yields. The use of machinery is not feasible on most soils of the association.

Most of the food crops in the survey area are grown in this association. Some areas are planted to shade-grown coffee trees, and some are in sun-grown coffee trees. Many coffee farms have been abandoned. A large acreage is in brush and brushy pasture. Some areas belong to the government; these are in forest and brush. There are some small dairy farms that have good improved pastures, and part of the area to be mined for copper is in this association.

Because of the slope, the soils of this association generally have severe limitations that affect their use for buildings and other intensive development.

Soils of the semiarid area

Four soil associations are in this group. They are in the southern half of the survey area. Some of the soils in these associations formed in material that weathered from volcanic and limestone rocks, and others formed in sediment that washed from the limestone and volcanic uplands. Some saline soils and some soils that have expansive clays are included in these associations. The soils in the associations are nearly level to very steep. Those on the bottom lands are used for irrigated sugarcane, and the steeper soils are used for pasture. Because of the poor distribution of rainfall, the soils do not receive rainfall the year round, so for most of the year they lack sufficient moisture for the common crops.

3. Callabo association

Moderately steep to very steep, well drained, slightly acid to neutral, loamy soils over weathered rock; on side slopes, foot slopes, and hilltops on the volcanic uplands

This association is the largest in the semiarid part of the survey area. It extends from the municipality of Coamo in the eastern end of the survey area to Pastillo Bajo in Ponce. The landscape is mostly mountainous, but some foot slopes are gently sloping to strongly sloping.

This association makes up about 19 percent of the survey area. Callabo soils make up about 75 percent of the association, and minor soils make up the rest.

The Callabo soils are moderately deep to semiconsolidated rock, well drained, and loamy. They are mainly moderately steep to very steep.

The minor soils are the clayey Llanos soils on footslopes and the Jacana soils on rounded hills; loamy Juana Diaz soils that are shallow to sandstone; and calcareous, clayey Guanabano soils. All of these soils are well drained.

Most of the soils of this association are not suitable for cultivation because of the hazard of erosion. Long droughty periods are common in most years from November to May or June. Irrigation is possible only on the Jacana and Llanos soils on the lower slopes, but it is not feasible because of the scarcity of water for irrigation in the area. Almost all the water available for irrigation is used on the bottom lands that are planted to sugarcane. Machinery can be used, for the most part, only on the lower slopes.

Because rainfall is low and poorly distributed, most of the soils are in native pasture, mainly guineagrass and Angletongrass. Some of the Callabo soils on uplands are occasionally planted to food crops despite the hazard of erosion and difficulty of cultivation. Soils on many of the higher ridges are in brushy forest. Many small and medium-sized dairy farms are scattered throughout the association.

Because of the slope, the soils of this association generally have severe limitations that affect their use for buildings and other intensive development.

4. Aguilita-Tuque association

Steep and very steep, well drained, moderately alkaline, loamy and clayey soils that have gravel and stones over limestone; on foot slopes, side slopes, and hilltops on the limestone uplands

This association is the second largest in the semiarid part of the survey area. It is in the southwestern part

of the survey area and extends from Ponce to Guayanilla. A large part of this association in the area of Ponce and Penuelas is bordered on the south by the sea. The landscape is mountainous with rounded hilltops and gravelly foot slopes. Some foot slopes are free of gravel and stones.

This association makes up about 13 percent of the survey area. Aguilita soils make up about 69 percent of the association; Tuque soils, about 18 percent; and minor soils, 13 percent.

The Aguilita soils are loamy and shallow to soft gravelly limestone. They are mainly steep to very steep and occupy side slopes and hilltops. Some of these soils have stones on the surface. The Tuque soils are loamy, are shallow to a caliche horizon, and are underlain by soft gravelly limestone. They are mostly steep to very steep and on side slopes; on some hilltops they are less steep. Aguilita soils and Tuque soils are well drained.

The minor soils of the association are well drained, gravelly, clayey Ensenada soils on terraces and well drained, loamy Yauco soils on foot slopes.

The soils of this association generally are not suitable for cultivation because of slope, runoff, the large amount of gravel and stones, and shallowness to limestone. Rainfall is low and poorly distributed throughout the year, and long droughty periods are common in most years. Almost all the acreage of the Tuque and Aguilita soils west of Ponce are in brush. Clearing this area for pasture is difficult and expensive. Much of the acreage of Aguilita gravelly clay loam is in native pasture of low carrying capacity. Some patches of guineagrass and Angletongrass are scattered throughout this area. Some Ensenada and Yauco soils on foot slopes are planted to irrigated sugarcane. The use of machinery is feasible only on these lower slopes.

Because of slope and the large amount of stones, the soils of this association have severe limitations for use as housing sites and for intensive industrial development. Soil material from this association is used as fill for highway and housing construction.

5. Constancia-Jacaguas-San Anton association

Nearly level, somewhat poorly drained and well drained, neutral to moderately alkaline, loamy and clayey soils that are deep or shallow to sand and gravel; on the river flood plains

This association is in the southernmost part of the Ponce Area. It extends from east to west across the survey area and is bordered on the south by the sea. It is made up of bottom lands along the major rivers. Many rivers and streams in the association overflow in some years. Loamy soils are dominant in the association, but clayey and sandy soils are included. Some of the soils are saline.

This association makes up about 12 percent of the survey area. Constancia soils make up about 20 percent of the association; Jacaguas soils, 16 percent; San Anton soils, 14 percent; and minor soils, the remaining 50 percent.

Constancia soils are somewhat poorly drained and clayey. The water table is at a depth of 17 to 48 inches after the soils have been drained. The Jacaguas soils are well drained and loamy. They are underlain by sand and gravel at a depth of 12 to 20 inches. These soils are closer to the rivers and are subject to more frequent flooding than the other soils of the association. The San Anton soils are deep, well drained, and loamy. They are easily worked and are the best soils for farming in the association.

The minor soils of the association are deep, well drained Cortada soils that are easily worked; poorly drained, clayey Machuelo and Cintrona soils; saline Serrano and Teresa soils; Meros sands; and loamy, shallow Cuyon soils that are closer to the riverbanks. Some areas of Hydraquents; Hydraquents, saline; and Tidal flats are also in the association. These areas have no value for farming.

The soils of this association are the best soils for farming in the Ponce area. Long droughty periods are common in most years, and because rainfall is low and poorly distributed, the soils need to be irrigated. Many lakes and ponds provide water for irrigation. In some years the entire area is flooded as a result of heavy rains during the period from August to October. The slowly permeable soils retain water on the surface for a few days after they are flooded, and most of the slowly permeable soils are artificially drained to remove excess water. Saline soils in the association are difficult and expensive to reclaim. Farm machinery can be used in most areas of the association.

Sugarcane is the major cash crop, and almost all the sugarcane grown in the survey area is grown in this association. Some areas are planted to vegetables.

The soils of this association generally have severe limitations for use as housing sites because of the hazard of flooding, but in areas close to cities, towns, and villages, these limitations are being overcome so that the soils can be used for housing and industry. Some of the soils close to the rivers have good potential as a source of gravel.

6. Fraternidad-Paso Seco association

Gently sloping to strongly sloping, moderately well drained, neutral to moderately alkaline, clayey soils that are deep or moderately deep to sand and gravel; on terraces, alluvial fans, and foot slopes on the coastal plain

This association is the least extensive in the survey area. It is on the coastal plain slightly above the river flood plains. The largest part extends from Coamo Lake, in the eastern part of the survey area, to Coto Laurel, near the city of Ponce. A small area is near the town of Cayures, northeast of Santa Isabel. Some of the soils of this association are saline.

This association makes up about 5 percent of the survey area. Fraternidad soils make up about 75 percent of the association; Paso Seco soils, 18 percent; and minor soils, the remaining 7 percent.

Fraternidad soils are gently sloping to strongly sloping and are mainly on terraces. The Paso Seco soils are underlain by sand and gravel at a depth of 2 to 3 feet. They are on terraces and alluvial fans.

The minor soils of the association are the somewhat poorly drained Fe soils, which are saline and clayey.

The soils of this association are generally suitable for intensive cultivation if they are properly managed, drained, and irrigated. They are best suited to irri-

gated sugarcane, and most of the acreage has been in sugarcane that is furrow irrigated. There are many small ponds to store water for irrigation in this association. The use of machinery is feasible, but care should be taken to avoid moving the earth when the soils are wet.

The saline soils of this association are not extensive and are barren or are in salt-tolerant weeds. No attempts have been made to reclaim areas of these saline soils. Some areas where irrigation is not feasible are in pasture (fig. 1). There are some small dairy farms in this association.

Generally, the soils have some limitations that affect housing and industrial development because of the shrink-swell behavior of the expansive clays.

Description of the soils

This section describes the soil series and map units in the Ponce Area of Southern Puerto Rico. Each soil series is described in detail, and then each map unit in that series is briefly described. Unless mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the map units in that series. Thus, to get full information about any one map unit, it is necessary to read both the description of the map unit and the description of the soil series to which it belongs.

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

Figure 1.—**Some areas of the Fraternidad-Paso Seco association, where irrigation is not feasible, are in pasture.**

described for the series, the differences are stated in the description of the map unit, or they are differences that are apparent in the name of the map unit.

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed. Listed at the end of each description of a map unit is the capability unit and woodland group in which the map unit has been placed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

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

Not all map units are phases of a soil series. Hydraquents, for example, are a broader group of soils and do not belong to a series. They are, however, listed in alphabetic order along with the soil series.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Juana Diaz clay loam, 12 to 20 percent slopes, is one of several phases within the Juana Diaz series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes and soil associations.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Caguabo-Rock land complex is an example.

A *soil association* is made up of soils that are geographically associated and are shown as one unit on the map because it is not practical to separate them. A soil association has considerable regularity in geographic pattern and in the kinds of soil that are a part of it. The extent of the soils can differ appreciably from one delineation to another; nevertheless, interpretations can be made for use and management of the soils. Los Guineos-Maricao association is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas;* they are delineated on the soil map and given descriptive names. Riverwash is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 2, and additional information on properties and limitations for many soil uses is given for each kind of soil in other tables. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary, and detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*3*).[1]

Adjuntas series

The Adjuntas series consists of well drained, very steep soils. Slope ranges from 40 to 60 percent. These soils formed in fine textured residuum of weathered volcanic rock that is high in quartz. These soils occur on short side slopes and narrow ridgetops of the strongly dissected humid uplands. The annual rainfall ranges from 80 to 90 inches. The annual temperature ranges from 75° to 77°F.

In a representative profile, the surface layer is dark brown clay about 5 inches thick. The subsoil is about 19 inches thick. In the upper 5 inches it is dark brown and strong brown, firm clay; in the 7 inches below that it is strong brown, firm clay; and in the lowermost 7 inches it is yellow, white, and brownish yellow, firm clay with red mottles. The substratum, to a depth of 48 inches, is strongly and partly weathered volcanic rock. Semiconsolidated rock is at a depth of more than 4 feet.

These soils are moderately permeable. They have moderate available water capacity and low natural fertility. They are somewhat difficult to work. Runoff is very rapid. These soils are highly susceptible to erosion.

The Adjuntas soils have been in native pasture and brush for many years. A few acres are in coffee. The soils are suited to native pasture, pangolagrass, and woodland.

Representative profile of Adjuntas clay, 40 to 60 percent slopes, eroded, 320 meters east of school at dead end of Highway 602:

Ap—0 to 5 inches; dark brown (10YR 3/3) clay; moderate fine and medium granular structure; firm, slightly sticky and plastic; many fine roots; few fine and medium volcanic rock fragments; few fine quartz grains; many fine pores; very strongly acid; clear smooth boundary.

B1—5 to 10 inches; dark brown (7.5YR 4/4) and strong brown (7.5YR 5/6) clay; weak fine subangular blocky structure; firm, slightly sticky and plastic; common fine roots; few patchy clay films; few fine and medium volcanic rock fragments; few fine quartz grains; many fine pores;

[1] Italic numbers in parentheses refer to References, p. 78.

TABLE 2.—*Acreage and proportionate extent of the soils*

Soil	Acres[1]	Percent	Soil	Acres[1]	Percent
Adjuntas clay, 40 to 60 percent slopes, eroded	360	0.1	Llanos clay, 5 to 12 percent slopes, eroded	6,000	2.0
Aguilita gravelly clay loam, 12 to 20 percent slopes	920	.3	Los Guineos clay, 20 to 40 percent slopes	2,560	.8
Aguilita gravelly clay loam, 20 to 60 percent slopes	14,680	4.8	Los Guineos clay, 40 to 60 percent slopes	6,470	2.1
Aguilita stony clay loam, 20 to 60 percent slopes	11,710	3.8	Los Guineos-Maricao association, steep	7,040	2.3
Alonso clay, 20 to 40 percent slopes, eroded	1,200	.4	Los Guineos-Maricao-Stony rock land association, steep	2,000	.7
Alonso clay, 40 to 60 percent slopes, eroded	1,980	.6	Machuelo clay	1,770	.6
Caguabo gravelly clay loam, 20 to 60 percent slopes, eroded	23,900	7.8	Maraguez silty clay loam, 40 to 60 percent slopes, eroded	6,460	2.1
Caguabo-Rock land complex, 20 to 60 percent slopes	6,600	2.2	Maricao clay, 20 to 60 percent slopes, eroded	8,840	2.9
Callabo silty clay loam, 12 to 20 percent slopes	5,100	1.7	Meros sand	1,240	.4
Callabo silty clay loam, 20 to 40 percent slopes	9,260	3.0	Montegrande clay, 2 to 12 percent slopes	2,990	1.0
Callabo silty clay loam, 40 to 60 percent slopes eroded	29,702	9.7	Morado clay loam, 20 to 40 percent slopes, eroded	870	.3
Cintrona clay	1,390	.5	Morado clay loam, 40 to 60 percent slopes, eroded	9,760	3.2
Constancia silty clay	7,190	2.4	Mucara silty clay, 12 to 20 percent slopes, eroded	530	.2
Consumo clay, 40 to 60 percent slopes, eroded	2,120	.7	Mucara silty clay, 20 to 40 percent slopes, eroded	1,770	.6
Cortada silty clay loam	3,760	1.2	Mucara silty clay, 40 to 60 percent slopes, eroded	27,950	9.2
Cuyon loam, 0 to 5 percent slopes	1,910	.6	Paso Seco clay, 2 to 5 percent slopes	2,820	.9
Daguey clay, 12 to 20 percent slopes	1,780	.6	Pellejas clay loam, 40 to 60 percent slopes, eroded	730	.2
Ensenada gravelly clay, 2 to 12 percent slopes	390	.1	Quebrada silty clay loam, 12 to 20 percent slopes, eroded	1,210	.4
Fe clay	870	.3	Quebrada silty clay loam, 20 to 40 percent slopes, eroded	1,910	.6
Fraternidad clay, 2 to 5 percent slopes	9,460	3.1	Quebrada silty clay loam, 40 to 60 percent slopes, eroded	13,800	4.5
Fraternidad clay, 5 to 12 percent slopes, eroded	2,890	.9	Reilly gravelly loam	1,000	.3
Guanabano clay, 40 to 60 percent slopes	920	.3	Riverwash	200	.1
Humatas clay, 20 to 40 percent slopes, eroded	3,590	1.2	San Anton clay loam	5,850	1.9
Humatas clay, 40 to 60 percent slopes, eroded	15,760	5.2	Serrano sand	950	.3
Humatas complex, 20 to 60 percent slopes	1,060	.3	Teresa clay	3,740	1.2
Hydraquents	170	.1	Tidal flats	330	.1
Hydraquents, saline	2,240	.7	Toa silty clay loam	1,160	.4
Jacaguas silty clay loam	6,100	2.0	Tuque stony clay loam, 12 to 60 percent slopes	7,750	2.5
Jacana clay, 5 to 12 percent slopes	2,020	.7	Yauco silty clay loam, 2 to 5 percent slopes	1,100	.4
Juana Diaz clay loam, 12 to 20 percent slopes	440	.1	Yauco silty clay loam, 5 to 12 percent slopes	2,300	.8
Juana Diaz clay loam, 20 to 40 percent slopes	280	.1	Total	305,402	100.0
Lares clay, 5 to 12 percent slopes	390	.1			
Lirios clay loam, 40 to 60 percent slopes, eroded	590	.2			
Llanos clay, 2 to 5 percent slopes	3,570	1.2			

[1] Map unit acreages have been adjusted to the official survey a rea acreage of 305,402.

very strongly acid; clear smooth boundary.

B2—10 to 17 inches; strong brown (7.5YR 5/6) clay; weak fine and medium subangular blocky structure; firm, slightly sticky and plastic; few fine roots; common patchy clay films; few fine volcanic rock fragments; few fine quartz grains; many fine pores; very strongly acid; clear wavy boundary.

B3—17 to 24 inches; yellow (10YR 7/6), white (10YR 8/2), and brownish yellow (10YR 6/8) clay; common fine prominent red (2.5YR 4/6) mottles; weak medium subangular blocky structure; friable, slightly sticky and plastic; few fine roots; many fine pores; many quartz grains; very strongly acid; clear wavy boundary.

C—24 to 48 inches; strongly and partly weathered volcanic rock.

The solum is 20 to 32 inches thick. The Ap horizon ranges from dark brown (10YR 3/3) to brown (10YR 4/3). Depth to semiconsolidated rock ranges from 48 to 72 inches.

Adjuntas soils occur on the same landscape as the Consumo, Daguey, Humatas, and Maraguez soils. Adjuntas soils are less red and more shallow to volcanic rock than Consumo, Daguey, and Humatas soils. Adjuntas soils are more acid and have finer texture than Maraguez soils.

AaF2—Adjuntas clay, 40 to 60 percent slopes, eroded. This is a very steep soil on short side slopes and narrow ridges of the strongly dissected, humid uplands. It generally is in areas of more than 100 acres.

Included with this soil in mapping are a few small areas of Consumo clay and Maraguez silty clay loam. Also included are some areas, on narrow foot slopes, where the slope is less than 40 percent.

Runoff is very rapid, and erosion is a hazard. Deep gullies are common in drainageways. Slippage is a hazard in roadbanks, ditches, and drainageways. Clearing of brushy areas is costly. Liming and fertilizing are difficult and costly. Because of the steep

slopes, diversion ditches are difficult to lay out, construct, and maintain. This soil has a deep root zone.

Because of the steep slopes, rapid runoff, and erosion hazard, this soil has severe limitations for cultivation. It should be maintained under permanent vegetation.

This soil has been mostly in brush and native pastures of low carrying capacity. A few acres are in shade-grown coffee.

Capability unit VIIe–1; woodland suitability group 3r1.

Aguilita series

The Aguilita series consists of well drained, calcareous, moderately steep to very steep soils on foot slopes, side slopes, and rounded hilltops in the semiarid area. Slope ranges from 12 to 60 percent. These soils formed in moderately fine textured residuum of soft limestone. The annual rainfall ranges from 25 to 45 inches. The annual temperature ranges from 78° to 80° F.

In a representative profile, the surface layer is very dark grayish brown gravelly clay loam about 8 inches thick. The subsoil, extending to a depth of 13 inches, is dark brown and pale yellow, friable gravelly clay loam. The substratum, to a depth of 60 inches, is pale yellow, white, and gray, friable, soft gravelly limestone; the substratum consists of more than 50 percent hard limestone fragments.

Aguilita soils are moderately permeable. They have low available water capacity and high natural fertility. Because of the high content of calcium carbonate, the depth of the root zone is restricted. The organic matter content generally is high in the surface layer.

Aguilita soils have been in native pasture and brush for many years. They are well suited to native pasture, especially Angletongrass and guineagrass (fig. 2). They are used mainly as a source of roadfill because of the physical properties of the limestone and because they are in areas close to the cities.

Representative profile of Aguilita gravelly clay loam, 20 to 60 percent slopes, in an area 150 meters north of kilometer marker 3.7 on Highway 149:

A1—0 to 8 inches; very dark grayish brown (10YR 3/2) gravelly clay loam; moderate fine granular structure; firm, slightly sticky and slightly plastic; many fine roots; 40 percent fine and coarse limestone fragments; moderately alkaline; abrupt smooth boundary.

AC—8 to 13 inches; 40 percent dark brown (10YR 3/3) and 60 percent pale yellow (2.5Y 7/4) gravelly clay loam; weak fine granular structure; friable, slightly sticky and slightly plastic; many fine roots; 40 percent fine and coarse limestone fragments; moderately alkaline; clear smooth boundary.

C—13 to 60 inches; pale yellow, white, and gray friable soft gravelly limestone; more than 50 percent, by volume, hard limestone gravel.

In some areas, stones and rocks are scattered on 30 to 60 percent of the surface. The A1 horizon is 7 to 12 inches thick. It has value and chroma of 3 or less. The AC horizon has value and chroma of 3 or higher. Depth to the soft limestone ranges from 11 to 18 inches. The amount of fine and coarse hard limestone fragments in the profile ranges from 40 to more than 50 percent.

Aguilita soils are on the same landscape as the Yauco and Tuque soils. Aguilita soils are shallower to the soft limestone than the Yauco soils, and they have gravel throughout the profile. Unlike the Tuque soils, Aguilita soils do not have an indurated caliche layer.

AgD—Aguilita gravelly clay loam, 12 to 20 percent slopes. This moderately steep soil is on side slopes, foot slopes, and rounded hilltops of the semiarid uplands. It generally is in areas of about 5 to 20 acres. This soil is similar to the one described as typical of the series, except that the surface layer is slightly thicker.

Included with this soil in mapping are small areas that have 10 to 20 percent cobbles on the surface. Also included are some areas of soils that are not gravelly in the surface layer.

Runoff is medium on this soil, and erosion is a hazard. This soil is fertile, but some measures for controlling erosion are needed if the soil is to be used for cultivated crops. Because rainfall is low and unevenly distributed throughout the year, there are few adapted species of grasses on this soil. Long droughty periods are common. Irrigation is not feasible. The soil has a limited root zone because of the high content of calcium carbonate.

This soil generally is not suitable for cultivation because of slope, medium runoff, and the erosion hazard. It should be maintained in permanent vegetation. Angletongrass and guineagrass are the best adapted grasses on this soil.

This soil has been used mainly for grazing. Some areas are in brush. A good stocking rate is necessary to avoid overgrazing and to maintain a good stand of pasture.

Capability unit VIe–2; woodland suitability group 2x1.

AgF—Aguilita gravelly clay loam, 20 to 60 percent slopes. This steep to very steep soil is on side slopes and ridges in the semiarid area. It generally is in areas of more than 100 acres. It is the soil described as representative of the series. Cobbles and stones are scattered on 5 to 15 percent of the surface.

Included with this soil in mapping are small areas of soils that do not have gravel in the surface layer and many small severely eroded spots where soft limestone is in the surface layer.

Runoff is rapid to very rapid, and erosion is a hazard. This soil is not suitable for cultivation. Because rainfall is low and is poorly distributed during the year, the use of this soil is restricted to range, but few adapted species of grasses are grown. Long periods of drought are common in most years. Irrigation is not feasible. Seeding and fertilizing are difficult and costly.

This soil has been mainly in pasture and brush. Clearing the brush for pasture is costly. The limitations for cultivation are severe because of slope, shallow depth to soft limestone, and the erosion hazard. Permanent vegetation should be maintained. A controlled stocking rate is necessary to avoid overgrazing.

Figure 2.—**The Aguilita soils are shallow to soft limestone, but they are well suited to guineagrass pasture if properly managed.**

Capability unit VIIe–4; woodland suitability group 3x1.

AhF—Aguilita stony clay loam, 20 to 60 percent slopes. This steep and very steep soil is on side slopes and ridges in the semiarid area. It generally is in areas of more than 100 acres. It is similar to the soil described as typical of the series, except that stones and rocks cover 40 to 60 percent of the surface.

Included with this soil in mapping are a few hilltops where stones and rocks cover more than 80 percent of the surface. Also included are some severely eroded soils on ridges that have soft limestone in the surface layer.

Runoff on this soil is rapid to very rapid, and erosion is a hazard. The soil is not suitable for cultivation. Because rainfall is low and is poorly distributed, the use of this soil is largely restricted to range, but few adapted species of grasses are grown. Long periods of drought are common. Irrigation is not feasible. Seeding and fertilizing and clearing of brush for pasture are difficult and costly.

This soil has been mostly in brush and brushy pasture of very low carrying capacity. It has severe limitations for cultivation because of slope, depth to soft limestone, the erosion hazard, and the large amount of stones and rocks. This soil should be kept under permanent vegetation.

Capability unit VIIs–2; woodland suitability group 3x1.

Alonso series

The Alonso series consists of well drained, steep to very steep soils on side slopes, foot slopes, and hilltops

of the strongly dissected humid uplands. Slope ranges from 20 to 60 percent. These soils formed in fine textured residuum of highly weathered pinkish volcanic rock. The annual rainfall ranges from 80 to 90 inches. The annual temperature ranges from 72° to 74° F.

In a representative profile, the surface layer is dark reddish brown clay about 6 inches thick. The subsoil is about 47 inches thick. In the upper 11 inches it is dusky red, firm clay; in the 16 inches below that it is dark reddish brown, firm clay; in the next 15 inches it is dark reddish brown and dark red, firm clay; and in the lowermost 6 inches it is dark reddish brown and red friable clay. The substratum between depths of 53 and 60 inches is reddish brown, red, very dark gray, pale green, and white, friable clay.

These soils are moderately permeable. They have moderate to high available water capacity and moderate natural fertility. Because of the high content of clay, they are difficult to work. The organic-matter content is moderate, and crops respond well to fertilizer. Runoff is rapid to very rapid.

Alonso soils have been planted to food crops, coffee, and pasture for many years. They are well suited to tanniers, plantains, bananas, yams, dasheens, and pangolagrass and stargrass. They are also suited to use as woodland.

Representative profile of Alonso clay, 20 to 40 percent slopes, eroded, about 15 meters east of kilometer marker 67 on Highway 135:

Ap—0 to 6 inches; dark reddish brown (5YR 3/3) clay; weak medium subangular blocky structure parting to granular; firm, slightly sticky and plastic; many fine roots, very strongly acid; clear smooth boundary.

B21t—6 to 16 inches; dusky red (10R 3/2) clay; moderate medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; few thin patchy clay films; very strongly acid; clear wavy boundary.

B22t—16 to 25 inches dark reddish brown (2.5YR 3/4) clay; moderate fine and medium subangular blocky structure; firm, slightly sticky and plastic; common fine roots; many thin patchy clay films; very strongly acid; clear wavy boundary.

B23t—25 to 32 inches; dark reddish brown (2.5YR 3/4) clay; moderate fine subangular blocky structure; firm, slightly sticky and plastic; few fine roots; few patchy clay films; very strongly acid; clear wavy boundary.

B24t—32 to 47 inches; 90 percent dark reddish brown (5YR 3/3) and 10 percent dark red (2.5YR 3/6) clay; weak fine and medium subangular blocky structure; firm, slightly sticky and plastic; few fine roots; few thin patchy clay films; very strongly acid; clear wavy boundary.

B3—47 to 53 inches; dark reddish brown (5YR 3/3) and red ((2.5YR 3/6) clay; weak fine subangular blocky structure; friable, slightly sticky and plastic; very few thin patchy clay films; 15 percent of horizon is saprolite; very strongly acid; gradual wavy boundary.

C—53 to 60 inches; variegated colors of the clay saprolite; reddish brown, red, very dark gray, pale green, and white; massive; friable, slightly sticky and plastic; very strongly acid.

The solum is 40 to 60 inches thick. The Ap horizon ranges from dark reddish brown (5YR 3/3) to dusky red (2.5YR 3/2). The B2t horizon ranges from dark reddish brown (5YR 3/4) to dusky red (2.5YR 3/2). The structure of the B2 horizon ranges from weak to moderate and fine to medium subangular blocky. The B3 horizon is 10 to 35 percent saprolite.

The Alonso soils are on the same landscape as the Daguey, Humatas, Consumo, and Morado soils. The Alonso soils have a thicker B2t horizon than the Consumo soils, and the color of their B2t horizon has a lower chroma than that of the Daguey and Humatas soils. The Alonso soils are deeper to semiconsolidated volcanic rock than the Morado soils.

AnE2—Alonso clay, 20 to 40 percent slopes, eroded. This is a steep soil on side slopes and hilltops of the strongly dissected humid uplands. It is generally in areas of about 50 to 100 acres. Its profile is the one described as representative of the series.

Included with this soil in mapping are small spots, mostly along drainageways, of soils that have slopes greater than 40 percent. Also included are some soils, on narrow foot slopes, that have slopes of 12 to 20 percent.

Runoff is rapid, and erosion is a hazard because of the steep slopes. Deep gullies are common in drainageways. Slippage is common especially on roadbanks and in ditches and drainageways. Some measures for controlling erosion are needed if this soil is to be used for cultivated crops. This soil is difficult to work because of the stickiness and plasticity of the clay. It should be tilled at optimum moisture content to prevent big clods from forming. The soil has a deep root zone and is medium in fertility. Crops respond well to heavy applications of lime and fertilizer. The use of machinery is not feasible on this soil.

This soil has some limitations for cultivated crops because of the steep slopes, rapid runoff, and the hazard of erosion. If crops are rotated and lime and fertilizer are applied and if practices that help control erosion are used, this soil is suited to all the crops grown in the area.

This soil has been planted to a variety of crops including shade-grown coffee, plantains, yams, and tanniers. Some areas are in brush; others are in native and adapted grasses. Pangolagrass and stargrass grow well on this soil. Controlling the stocking rate helps prevent overgrazing and leaves a good stand of grass.

Capability unit IVe–1; woodland suitability group 2c1.

AnF2—Alonso clay, 40 to 60 percent slopes, eroded. This is a very steep soil on side slopes and narrow ridges of the humid uplands. It generally is in areas of more than 100 acres. Except for having a slightly thinner solum, this soil is similar to the one described as representative of the series. It has been greatly affected by erosion and slippage.

Included with this soil in mapping are soils, on a

few rounded hilltops, that have slopes of less than 40 percent.

Because of the steep slopes, runoff is very rapid and erosion is a hazard. Deep gullies are common in drainageways. Slippage is common especially on roadbanks and in ditches and drainageways. Liming and fertilizing are costly and difficult on this soil, and ditches are difficult to lay out, construct, and maintain. This soil has a deep root zone.

This soil generally is not suitable for cultivation because of the steep slopes, very rapid runoff, and erosion hazard. It is suited to woodland use and to native pasture.

This soil has been planted to shade-grown coffee, bananas, and oranges. Most of the coffee farms have been abandoned and are now in brush. Some areas of this soil are in native pasture of low carrying capacity, and others are in brushy pasture.

Capability unit VIe–1; woodland suitability group 3c1.

Caguabo series

The Caguabo series consists of well drained, moderately steep to very steep soils on short side slopes and narrow ridgetops of the strongly dissected humid uplands. The soils are shallow to hard volcanic rock. Slope ranges from 20 to 60 percent. These soils formed in moderately fine textured residuum of weathered basic volcanic rock. The annual rainfall ranges from 75 to 85 inches, and the temperature ranges from 74° to 76° F.

In a representative profile, the surface layer is dark yellowish brown gravelly clay loam about 5 inches thick. The subsoil, between depths of 5 and 12 inches, is dark yellowish brown, firm, slightly sticky and slightly plastic, gravelly clay loam. The substratum, between depths of 12 and 17 inches, consists of highly weathered and partly weathered volcanic rock fragments. The semiconsolidated volcanic rock is at a depth of 17 inches.

These soils are moderately permeable. They have a low available water capacity and high natural fertility. The root zone is restricted. Runoff is rapid to very rapid, and the soils are highly susceptible to erosion.

Caguabo soils have been in native pasture. Small and scattered patches have been planted to shallow-rooted crops. Large areas are in brush.

Representative profile of Caguabo gravelly clay loam, 20 to 60 percent slopes, eroded, 100 meters west of kilometer marker 8.75 on Highway 503:

Ap—0 to 5 inches; dark yellowish brown (10YR 3/4) gravelly clay loam; moderate fine granular structure; firm, slightly sticky and slightly plastic; many fine roots; neutral; clear smooth boundary.

B—5 to 12 inches; dark yellowish brown (10YR 3/4) gravelly clay loam; weak fine subangular blocky structure parting to granular structure; firm, slightly sticky and slightly plastic; common fine roots; 35 percent, by volume, fine volcanic rock fragments; neutral; gradual wavy boundary.

C—12 to 17 inches; highly weathered and partly weathered volcanic rock fragments; massive; neutral.

R—17 inches; hard, semiconsolidated volcanic rock.

The solum is 9 to 14 inches thick. The Ap horizon has hue of 10YR, value of 3 and 4, and chroma of 2 and 4. The B2 horizon has hue of 7.5YR and 10YR, value of 3 and 4, and chroma of 3 and higher. It has weak, fine, and medium subangular blocky to granular structure. The Ap and B2 horizons are neutral to slightly acid. Depth to the semiconsolidated rock ranges from 12 to 20 inches. The fine volcanic fragments range from 20 to 30 percent in the Ap horizon and from 30 to 40 percent in the B2 horizon.

Caguabo soils are on the same landscape as the Mucara, Maraguez, Morado, and Quebrada soils. Caguabo soils have hard, semiconsolidated volcanic rock at a depth of 12 to 20 inches, and volcanic fragments make up 30 to 40 percent of their B2 horizon. The Mucara, Maraguez, Morado, and Quebrada soils are deeper to volcanic rock and have fewer volcanic fragments than Caguabo soils. Unlike the Morado soils, which have a dark reddish gray surface layer, the Caguabo soils have a dark yellowish brown surface layer.

CbF2—Caguabo gravelly clay loam, 20 to 60 percent slopes, eroded. This steep and very steep soil is on short side slopes and narrow ridges on the humid uplands. It generally is in areas of more than 500 acres. It is the soil described as representative of the series.

Included in mapping are very small areas of soils that have stones and boulders on the surface and a few areas of soils that do not have gravel in the surface layer.

Runoff is rapid and very rapid, and erosion is a hazard because of the steepness of the slopes. The shallowness to hard rock limits root penetration. Ditches are difficult to lay out, construct, and maintain because of steep slopes and shallowness to hard rock. Fertilizing is costly and difficult.

This soil is not suitable for cultivation. The use of this soil is restricted largely to grazing because of steep and very steep slopes, rapid and very rapid runoff, the effects of past erosion, the shallowness to rock, and the erosion hazard. Deferred grazing helps control erosion.

A large acreage of this soil has been in brushy woodland and brushy pasture for many years. There are small spots of native pasture of low carrying capacity. In some of the less steep areas this soil is planted to pigeonpeas and other food crops.

Capability unit VIIs–3; woodland suitability group 4d1.

CdF—Caguabo-Rock land complex, 20 to 60 percent slopes. This steep and very steep complex is on side slopes and narrow ridges on the humid volcanic uplands. The Caguabo soil makes up about 60 percent of the complex, and Rock land makes up 40 percent. The areas generally are more than 500 acres in size. The Caguabo soil is similar to the soil described as representative of the series. Rock land consists of areas where volcanic rock, boulders, and cobbles cover 90 to 100 percent of the surface. The soils between the rocks are not classified and vary in depth, texture, and color.

The Caguabo soil and Rock land occur in such an

intricate pattern that mapping them separately at the scale of the soil map was not practical.

Because of shallowness to hard rock, steepness of slopes, and the large amount of rocks, cultivating these areas is not feasible. Most of the acreage has been in brush and brushy pasture. Clearing these areas is too costly and impractical. This complex provides good habitat for wildlife.

Capability unit VIIs–3; not in a woodland suitability group.

Callabo series

The Callabo series consists of well drained, moderately steep to very steep soils on foot slopes, long and short side slopes, hilltops, and ridgetops in the semiarid uplands. Slope ranges from 12 to 60 percent. These soils formed in moderately fine textured residuum of weathered volcanic rock. The annual rainfall ranges from 25 to 50 inches, and the temperature ranges from 78° to 80° F.

In a representative profile, the surface layer is very dark grayish brown silty clay loam about 5 inches thick. The subsoil is about 14 inches thick. In the upper 8 inches it is dark brown and very dark grayish brown, firm silty clay loam, and in the lower 6 inches it is dark yellowish-brown, friable clay loam. The substratum, between depths of 19 and 27 inches, is highly weathered volcanic rock. Semiconsolidated rock is at a depth of 27 inches.

These soils are moderately permeable. They have low available water capacity and high natural fertility. The organic-matter content is high in the surface layer. Runoff is medium to very rapid.

The Callabo soils have been in native pasture for many years. They are well suited to guineagrass and Angletongrass. In many places the lower slopes and the steep slopes are plowed and planted to food crops. There are small patches of brush.

Representative profile of Callabo silty clay loam, 20 to 40 percent slopes, 100 meters west of kilometer marker 2.3 on Highway 512:

Ap—0 to 5 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate medium granular structure; friable, slightly sticky and slightly plastic; many fine roots; 10 percent angular volcanic rock fragments; few worm holes; slightly acid; clear smooth boundary.

B2—5 to 13 inches; 70 percent dark brown (10YR 4/3) and 30 percent very dark grayish brown (10YR 3/2) silty clay loam; weak medium and coarse subangular blocky structure; firm, slightly sticky and slightly plastic; common fine roots; 10 percent angular volcanic rock fragments; few worm holes; neutral; clear wavy boundary.

B3—13 to 19 inches; dark yellowish brown (10YR 4/4) clay loam; weak coarse subangular blocky structure; friable, slightly sticky and slightly plastic; few fine roots; 15 percent fine angular volcanic rock fragments; neutral; clear wavy boundary.

C—19 to 27 inches; highly weathered volcanic rock; neutral.

R—27 inches; semiconsolidated volcanic rock.

The solum is 14 to 24 inches thick. The Ap horizon has value of 3 or 4 and chroma of 2 or 3. The B2 horizon has value of 3 or higher and chroma of 2 to 4. It has weak, medium or coarse, subangular blocky structure. The B3 horizon is clay loam or silty clay loam. Depth to the semiconsolidated rock ranges from 20 to 36 inches.

The Callabo soils are on the same landscape as the Jacana, Guanabano, Juana Diaz, and Llanos soils. The Callabo soils are coarser textured than the Jacana soils. Unlike the Guanabano soils, Callabo soils are noncalcareous. The Callabo soils have a finer textured B horizon than the Juana Diaz soils. The Callabo soils are coarser textured and shallower to rock than the Llanos soils.

CoD—Callabo silty clay loam, 12 to 20 percent slopes. This is a moderately steep soil on side slopes, foot slopes, and rounded hilltops in the semiarid uplands. It generally is in areas of about 20 to 50 acres. It is similar to the soil described as representative of the series, but the surface layer is slightly thicker.

Included with this soil in mapping are Llanos clay in narrow strips along drainageways, Jacana clay on short foot slopes, and some severely eroded soils on hilltops.

Erosion is a hazard because of the slope, and some measures for controlling erosion are needed if crops are to be grown. The soil is easily worked, and crops respond well to fertilizer. Long periods of drought are common. Because rainfall is low and poorly distributed throughout the year, the choice of plants and the time of year for planting are limited. Irrigation is not feasible because of the slope.

This soil is not suitable for cultivation because of the slope, medium runoff, and the poor distribution of rainfall. It is suitable for grazing, but there are few suited species of grass. Grazing should be deferred to protect the soil.

A large acreage of this soil is in native pasture, mainly guineagrass and Angletongrass. During the short rainy season, some areas are planted to pigeonpeas, corn, pumpkins, and other food crops. Other areas are in brushy pastures of low carrying capacity.

Capability unit IVe–3; woodland suitability group 3d1.

CoE—Callabo silty clay loam, 20 to 40 percent slopes. This is a steep soil generally in areas of more than 100 acres on side slopes and ridges in the semiarid uplands. It is the soil described as representative of the series.

Included with this soil in mapping, especially on hilltops, are small excessively eroded areas where the surface layer has been washed away and material from the subsoil is exposed. Also included are some areas that have a large amount of rocks and boulders on the surface and some small areas, mainly along drainageways, where slopes are more than 40 percent.

Because rainfall is low and poorly distributed, the choice of pasture plants is limited. Irrigation is not feasible. The layout, establishment, and maintenance of ditches is difficult and expensive. Fertilizer is rarely used because of the high cost of application.

This soil is not suitable for cultivation, because of

the steep slopes, rapid runoff, hazard of erosion, and effects of past erosion. It is better suited to range than to most other uses. Grazing should be deferred, and a permanent cover of vegetation should be maintained.

A large acreage of this soil is in brushy pasture and weeds. Some areas are in brush, and others are in guineagrass and Angletongrass. A few areas are in pigeonpeas. In past years many areas were planted to tobacco and corn.

Capability unit VIe–4; woodland suitability group 3d1.

CoF2—Callabo silty clay loam, 40 to 60 percent slopes, eroded. This very steep soil is on side slopes and very narrow ridges in the semiarid uplands. It generally is in areas of more than 100 acres. It is similar to the soil described as representative of the series, but it has a thinner surface layer and subsoil.

Included with this soil in mapping are a few areas that have a large number of boulders and stones on the surface. Also included are small excessively eroded areas where the highly weathered volcanic rock is on the surface and a few areas where slopes are less than 40 percent.

Because rainfall is low and poorly distributed throughout the year, the pasture species growing on this soil are limited. The use of fertilizer is costly and impractical. Ditches are difficult to lay out, establish, and maintain because of very steep slopes and the shallowness of the soil. Deep gullies are common in drainageways.

This soil is largely limited to grazing because of the very steep slopes, very rapid runoff, hazard of erosion, and effects of past erosion. Grazing should be deferred to keep a good cover of vegetation and to control erosion.

This soil has been mostly in brushy pasture of low carrying capacity. Some areas are in brush, and others are in guineagrass and Angletongrass. A small acreage has been planted to pigeonpeas and tobacco, despite the slope.

Capability unit VIIe–3; woodland suitability group 4d2.

Cintrona series

The Cintrona series consists of poorly drained, calcareous, nearly level soils on slightly concave terrain in the flood plains of the semiarid area. Slopes range from 0 to 2 percent. These soils formed in fine textured and moderately fine textured sediment of mixed origin that washed from volcanic and limestone hills. The water table is at a depth of 36 to 60 inches. The annual rainfall ranges from 25 to 40 inches, and the temperature ranges from 78° to 80° F.

In a representative profile, the surface layer is very dark gray clay about 8 inches thick. The subsoil is about 23 inches thick. In the upper 8 inches it is dark gray, firm clay and has dark yellowish brown mottles. In the 8 inches below that it is dark gray, firm clay and has yellowish brown and dark greenish gray mottles; and in the next 7 inches it is very dark grayish brown, firm clay and has dark yellowish brown and black mottles. The mottled substratum, between depths of 31 and 60 inches, is mainly very dark grayish brown, dark greenish gray, and dark gray clay.

These soils are slowly permeable. They have a high available water capacity, high natural fertility, and high organic matter content. Runoff is slow. The soils are difficult to work. If irrigated, they are well suited to sugarcane. They have been planted to this crop for many years.

Representative profile of Cintrona clay, 46 meters east of a dirt road which is 1.3 kilometers north of kilometer marker 113 of Highway 1:

Ap—0 to 8 inches; very dark gray (10YR 3/1) clay; weak fine and medium granular structure; firm, sticky and plastic; many fine roots; common fine volcanic rock and limestone fragments; strong effervescence; clear smooth boundary.

B1g—8 to 16 inches; dark gray (10YR 4/1) clay; few fine faint dark gray (N 4/0) and few fine distinct dark yellowish brown (10YR 3/4) mottles; weak medium subangular blocky structure; firm, sticky and plastic; many fine roots; common fine volcanic rock and limestone fragments; few shell fragments; strong effervescense; clear smooth boundary.

B2gca—16 to 24 inches; dark gray (10YR 4/1) clay; few fine distinct dark yellowish brown (10YR 3/4) mottles, common medium faint dark gray (N 4/0) mottles, and fine prominent dark greenish gray (5GY 4/1) mottles; weak coarse subangular blocky structure; firm, sticky and plastic; many decayed roots; common fine volcanic rock fragments; numerous soft calcium carbonate accumulations; violent effervescence; clear smooth boundary.

B3g—24 to 31 inches; very dark grayish brown (10YR 3/2) clay; few fine faint dark yellowish brown (10YR 3/4) mottles and few fine prominent black (10YR 2/1) mottles; weak medium subangular blocky structure; firm, sticky and plastic; many decayed roots; common fine volcanic rock fragments; violent effervescence; clear smooth boundary.

C1g—31 to 38 inches; very dark grayish brown (10YR 3/2) clay; few fine prominent dark greenish gray (5G 4/1) mottles, many medium distinct very dark gray (N 3/0) mottles, and fine faint dark yellowish brown (10YR 4/4) mottles; massive; firm, sticky and plastic; many decayed roots; violent effervescence; abrupt smooth boundary.

C2g—38 to 46 inches; 60 percent dark greenish gray (5G 4/1), 15 percent greenish gray (5G 5/1), 10 percent dark gray (5Y 4/1), 10 percent very dark gray (N 3/0), and 5 percent dark yellowish brown (10YR 4/4) clay; massive; firm, slightly sticky and plastic; many decayed roots; violent effervescence; abrupt smooth boundary.

C3g—46 to 60 inches; dark greenish gray (5GY

4/1) clay; few fine prominent dark yellowish brown (10YR 4/4) mottles and few fine distinct light olive brown (2.5Y 5/6) mottles; massive; firm, slightly sticky and plastic; strong effervescence.

The solum is 24 to 38 inches thick. If the soil is drained, the depth to the water table ranges from 36 to 60 inches. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1. The B horizon has hue of 10YR or 2.5Y, value of 3 and 4, and chroma of 1 or 2. Its structure is weak medium to weak coarse subangular blocky. Effervescence is strong to violent throughout the profile.

Cintrona soils are on the same landscape as the Cortada, Jacaguas, Machuelo, San Anton, and Constancia soils. Cintrona soils are more poorly drained, have a darker colored surface layer, and are finer textured than the Cortada, Jacaguas, San Anton, and Constancia soils; they have a darker colored surface layer than the Machuelo soils.

Cr—Cintrona clay. This nearly level soil is on slightly concave slopes in the flood plains of the semiarid area. It is generally in areas of about 20 to 50 acres. Slopes are 0 to 2 percent.

Included with this soil in mapping are a few small areas of Machuelo clay and a few spots that are saline.

Runoff is slow, and the soil is not subject to erosion. It can be cropped intensively without soil loss, if properly drained and irrigated. It is subject to flooding in some years, generally from August to October. Because of slow permeability, this soil may be saturated for long periods after heavy rains.

Land leveling and smoothing are difficult and costly because of the poor workability of the soil. The soil should be worked at the optimum moisture content. Crops on this soil respond well to fertilizer.

This soil has been in sugarcane for many years. If properly drained and irrigated, it is suitable for sugarcane and rice.

Capability unit IIIw–1, irrigated; VIs–2, not irrigated. Not in a woodland suitability group.

Constancia series

The Constancia series consists of somewhat poorly drained, calcareous, nearly level soils on flood plains in the semiarid area. Slope ranges from 0 to 2 percent. These soils formed in recent fine-textured sediment of mixed origin that washed from volcanic and limestone hills. The water table is at a depth of 36 to 60 inches. The annual rainfall ranges from 25 to 40 inches, and the temperature ranges from 78° to 80° F.

In a representative profile, the surface layer is very dark grayish brown silty clay about 12 inches thick. The subsoil is about 17 inches thick. In the upper 5 inches it is very dark grayish brown, firm silty clay and has yellowish brown and dark gray mottles; in the lower 12 inches it is very dark grayish brown, yellowish brown, dark gray, and dark yellowish brown, firm silty clay. The mottled substratum, between depths of 29 and 65 inches, is mainly dark gray and yellowish brown, firm clay.

Constancia soils are slowly permeable. They have a moderate to high available water capacity, high natural fertility, and a high content of organic matter. They are difficult to work. Runoff is slow. If properly drained and irrigated, Constancia soils are suitable for sugarcane. They have been planted to this crop for many years.

Representative profile of Constancia silty clay, 2.6 kilometers south of kilometer marker 125.1 on Highway 1:

Ap—0 to 12 inches; very dark grayish brown (10YR 3/2) silty clay; weak fine and medium granular structure; firm, slightly sticky and plastic; many fine roots; few fine volcanic fragments; slightly compacted; strong effervescence; abrupt smooth boundary.

B1—12 to 17 inches; very dark grayish brown (10YR 3/2) silty clay; few fine distinct yellowish brown (10YR 5/6) mottles and common fine distinct dark gray (5Y 4/1) mottles; weak fine and medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; few fine volcanic fragments; strong effervescence; clear smooth boundary.

B2ca—17 to 24 inches; 30 percent very dark grayish brown (10YR 3/2), 30 percent yellowish brown (10YR 5/6), 30 percent dark gray (5Y 4/1), and 10 percent dark yellowish brown (10YR 3/4) silty clay; dark grayish brown (10YR 4/2) when crushed; weak medium and coarse subangular blocky structure; firm, slightly sticky and plastic; few soft small rounded calcium carbonate accumulations; few fine roots; few fine volcanic fragments; few fine shell fragments; strong effervescence; clear smooth boundary.

B3ca—24 to 29 inches; 40 percent very dark grayish brown (10YR 3/2), 40 percent dark gray (5Y 4/1), 15 percent yellowish brown (10YR 5/6), and 5 percent dark yellowish brown (10YR 3/4) silty clay; weak medium subangular blocky structure; firm, slightly sticky and plastic; few fine roots; few fine volcanic fragments; few soft small rounded calcium carbonate accumulations; few fine shell fragments; few fine limestone fragments; strong effervescence; clear smooth boundary.

C1g—29 to 37 inches; dark gray (5Y 4/1) clay; many medium distinct yellowish brown (10YR 5/6) and common medium distinct very dark grayish brown (10YR 3/2) mottles; firm, sticky and plastic; few fine roots; few fine volcanic fragments; few fine shell fragments; few fine limestone fragments; strong effervescence; clear smooth boundary.

C2g—37 to 50 inches; dark gray (5Y 4/1) and brownish yellow (10YR 6/6) clay; few fine distinct dark greenish gray (5BG 4/1) and few fine distinct dark yellowish brown (10YR 3/4) mottles; massive;

firm, sticky and plastic; few fine volcanic fragments; few fine shell fragments; few fine limestone fragments; water table at depth of 43 inches; strong effervescence; clear smooth boundary.

C3g—50 to 65 inches; 40 percent yellowish brown (10YR 5/4), 20 percent dark gray (5Y 4/1), 15 percent dark bluish gray (5B 4/1), 15 percent bluish gray (5B 5/1), and 10 percent brownish yellow (10YR 6/6) clay; massive; firm, sticky and plastic; few fine volcanic fragments; few fine limestone fragments; violent effervescence.

The solum is 24 to 38 inches thick. If the soil is drained, the depth to the water table ranges from 36 to 60 inches. The Ap horizon has hue of 10YR, value of 3, and chroma of 2 and 3. The B and C horizons are silty clay or clay. The B2 horizon ranges in structure from weak fine to weak coarse subangular blocky. Effervescence ranges from strong to violent throughout the profile.

The Constancia soils are on the same landscape as the San Anton, Cortada, Machuelo, and Cintrona soils. Constancia soils are finer textured and more poorly drained than San Anton and Cortada soils, and they are better drained than the Machuelo and Cintrona soils.

Ct—Constancia silty clay. This is a nearly level soil on alluvial fans along the rivers and streams in the semiarid area. It generally is in areas of about 50 to 200 acres. Slopes are 0 to 2 percent.

Included in mapping are a few small areas of Machuelo clay and San Anton clay loam and a few spots of soils that have coarse textured material below a depth of 2 feet.

Runoff is slow; this soil is not subject to erosion. If it is properly drained and irrigated, it can be cropped intensively without soil loss. It is subject to flooding in some years, generally from August to October. Because of slow permeability, this soil may be saturated after heavy rains. Occasionally there are long periods of drought.

Workability of this soil is poor. Land leveling and smoothing are costly and difficult because the clay is sticky and plastic. Tillage should be done and machinery should be used at the optimum moisture content. Crops respond well to fertilizer.

If properly drained and irrigated, this soil can be planted to sugarcane and rice.

Capability units IIw–1, irrigated, and IIIc–2 nonirrigated; not in a woodland suitability group.

Consumo series

The Consumo series consists of well drained, very steep soils on side slopes and narrow ridges of the strongly dissected humid uplands. Slope ranges from 40 to 60 percent. These soils formed in fine textured residuum of basic volcanic rock. The annual rainfall ranges from 80 to 90 inches, and the temperature ranges from 74° to 76° F.

In a representative profile, the surface layer is reddish brown clay about 7 inches thick. The subsoil is about 13 inches thick. In the upper 7 inches it is red, firm clay, and in the lower 6 inches it is yellowish red, red, and brownish yellow, friable silty clay. The substratum, between depths of 20 and 60 inches, is red, yellow, brown, and light gray friable silty clay saprolite.

These soils are moderately permeable. They have a high available water capacity and low natural fertility. Runoff is very rapid, and the soils are highly susceptible to erosion. These soils are difficult to work. Crops respond well to fertilizer.

Consumo soils have been planted to a number of crops for many years. They are suited to use as woodland and native pasture. Many acres are in native pasture and brush.

Representative profile of Consumo clay, 40 to 60 percent slopes, eroded, 300 meters north of kilometer marker 7 on Highway 526:

Ap—0 to 7 inches; reddish brown (5YR 4/4) clay; weak fine subangular blocky structure; firm, slightly sticky and plastic; many fine roots; very strongly acid; clear smooth boundary.

B2t—7 to 14 inches; red (2.5YR 4/6) clay; moderate medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; thin patchy clay films; very strongly acid; clear wavy boundary.

B3—14 to 20 inches; 40 percent yellowish red (5YR 4/6), 30 percent red (2.5YR 4/6), and 30 percent brownish yellow (10YR 6/6) silty clay; weak fine subangular blocky structure; friable, slightly sticky and plastic; few fine roots; 50 percent of horizon is saprolite; very strongly acid; clear wavy boundary.

C—20 to 60 inches; red, yellow, brown, and light gray silty clay saprolite; massive; friable, slightly sticky and plastic; very strongly acid; original rock structure is visible.

The solum is 14 to 24 inches thick. The Ap horizon has hue of 5YR and 2.5YR, value of 4, and chroma of 4 and higher. The B2t horizon has hue of 5YR and 2.5YR, value of 4, and chroma of 6 and higher. The C horizon is silty clay or clay.

Saprolite makes up 40 to 60 percent of the B3 horizon. The B2t horizon ranges in structure from weak to moderate and fine to medium subangular blocky.

Consumo soils are on the same landscape as Daguey, Humatas, Alonso, and Morado soils. They have a thinner B2t horizon than that of Daguey, Humatas, and Alonso soils, and they are deeper to rock than Morado soils.

CuF2—Consumo clay, 40 to 60 percent slopes, eroded. This is a very steep soil on side slopes and narrow ridgetops of the humid uplands. It generally is in areas of more than 500 acres.

Included in mapping are some areas of Humatas clay, 40 to 60 percent slopes, eroded. Also included are areas of Consumo soils that have slopes of 20 to 40 percent and areas of severely eroded soils on ridges where the substratum is exposed at the surface.

Runoff is very rapid because of the steep slopes.

Erosion is a hazard. Slippage is a hazard on roadbanks and in ditches and drainageways. Because of the steep slopes, applying lime and fertilizer is difficult and costly. Diversion ditches are difficult to lay out, construct, and maintain. This soil has a deep root zone.

In some areas this soil is used for shade-grown coffee, bananas, and oranges. Yields generally are low. A large acreage is in brushy trees and brushy pasture. Some areas are in native pasture of low carrying capacity.

This soil is suitable only for use as woodland and native pasture because of the steep slopes, very rapid runoff, and the erosion hazard.

Capability unit VIIe–1; woodland suitability group 3c1.

Cortada series

The Cortada series consists of well drained, calcareous, nearly level soils on flood plains in the semiarid area. Slope ranges from 0 to 2 percent. These soils formed in medium textured and moderately fine textured sediment of mixed origin that washed from volcanic and limestone hills. The annual rainfall ranges from 25 to 40 inches, and the temperature ranges from 78° to 80° F.

In a representative profile, the surface layer is very dark grayish brown silty clay loam about 10 inches thick. The subsoil is dark brown, firm silty clay loam about 18 inches thick. The substratum, between depths of 28 and 60 inches, is brown silt loam and silty clay loam that is friable.

Cortada soils are moderately permeable. They have a moderate available water capacity, high natural fertility, and high organic matter content. They are easy to work. Runoff is slow, and these soils are not susceptible to erosion.

Cortada soils are suitable for and have been planted to sugarcane for many years. Recently, some areas have been planted to tomatoes and peppers.

Representative profile of Cortada silty clay loam, 75 meters west of kilometer marker 0.8 on Highway 536:

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam; weak fine granular structure; firm, slightly sticky and plastic; many fine roots; few shell fragments; slight effervescence; abrupt smooth boundary.

B2—10 to 18 inches; dark brown (10YR 3/3) silty clay loam; weak medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; few shell fragments; slight effervescence; clear smooth boundary.

B3—18 to 28 inches; dark brown (10YR 3/3) silty clay loam; weak fine and medium subangular blocky structure; firm, slightly sticky and plastic; few fine roots; few shell fragments; strong effervescence; abrupt smooth boundary.

C1—28 to 38 inches; brown (10YR 4/3) silt loam; massive; friable, slightly sticky and slightly plastic; few fine roots; strong effervescence; clear wavy boundary.

C2—38 to 48 inches; brown (10YR 4/3) silty clay loam; massive; friable, slightly sticky and plastic; few fine roots; violent effervescence; abrupt smooth boundary.

C3—48 to 68 inches; brown (10YR 4/3) silt loam; massive; friable, slightly sticky and plastic; few fine roots; strong effervescence.

The solum is 24 to 34 inches thick. The Ap, B2, and B3 horizons have hue of 10YR, value of 2 or 3, and chroma of 3. The C horizon has hue of 10YR, value of 3 or 4, and chroma of 3 and 4.

The C horizon is silt loam or silty clay loam. Effervescence in the solum is slight to strong, and in the C horizon it is strong to violent.

Cortada soils are on the same landscape as San Anton, Constancia, Machuelo, and Cintrona soils. Unlike San Anton soils, Cortada soils are calcareous, and they are better drained and coarser textured than Constancia, Machuelo, and Cintrona soils.

Cx—Cortada silty clay loam. This nearly level soil is on alluvial fans in the semiarid area. It generally is in areas of 50 to 200 acres. Slopes are 0 to 2 percent.

Included in mapping are small areas of the noncalcareous San Anton and Cuyon soils and small spots of the somewhat poorly drained Constancia soils.

Runoff is slow. This soil is not subject to erosion. It can be cropped intensively without loss of soil material. It is subject to flooding in some years, generally from August to October. The root zone is deep.

This soil has a plow layer that is easy to till, and land smoothing and leveling are feasible. This soil needs to be irrigated because rainfall is low and is poorly distributed. Long periods of drought are common in most years. This soil has a moderate available water capacity. It is fertile, and crops respond well to fertilizer. It can be used safely with only ordinary management practices to maintain productivity and good tilth. The use of machinery is feasible.

This soil has been planted to sugarcane and vegetables, and it is suited to a wide range of plants if irrigated.

Capability units I–3, irrigated, and IIc–1, nonirrigated; not in a woodland suitability group.

Cuyon series

The Cuyon series consists of excessively drained, nearly level to gently sloping soils that are close to riverbanks in the semiarid area. The slope ranges from 0 to 5 percent. These soils are shallow over sand and gravel. They formed in recent medium-textured over coarse-textured sediment of mixed origin. The annual rainfall ranges from 25 to 45 inches, and the temperature ranges from 78° to 80° F.

In a representative profile the surface layer is dark brown loam about 11 inches thick. The substratum, to a depth of 60 inches, is dark brown, gravelly coarse sand that is less than 10 percent silt.

These soils have rapid permeability and a low available water capacity. Natural fertility is high in the surface layer. The root zone is restricted by sand and

gravel at a depth of 8 to 12 inches. These soils are easy to work. Runoff is slow.

Cuyon soils are well suited to native pasture. Most of the areas have been in guineagrass and Angletongrass for many years.

Representative profile of Cuyon loam, 0 to 5 percent slopes, 40 meters east of kilometer marker 39.05 on Highway 14:

Ap—0 to 11 inches; dark brown (10YR 3/3) loam; weak fine granular structure; friable, slightly sticky and slightly plastic; many fine roots; few rounded rock fragments, 1 to 2 inches in diameter; neutral; clear irregular boundary.

C1—11 to 17 inches; 70 percent medium and coarse gravel, 25 percent coarse sand, and 5 percent silt, by volume.

C2—17 to 60 inches; dark brown (10YR 3/3) gravelly coarse sand that has less than 10 percent silt.

Thickness of the Ap horizon and depth to the coarse material range from 8 to 12 inches. The Ap horizon has hue of 10YR, value of 2 and 3, and chroma of 3. The Ap horizon is neutral to mildly alkaline. The substratum is 50 to 80 percent gravel.

Cuyon soils are on the same landscape as Jacaguas, San Anton, and Cortada soils. Cuyon soils are shallower and coarser textured than Jacaguas, San Anton, and Cortada soils, and unlike Cortada soils, they are noncalcareous and are neutral to mildly alkaline.

CyB—Cuyon loam, 0 to 5 percent slopes. This is a nearly level soil on small alluvial fans close to rivers and drainageways in the semiarid area. It generally is in areas of 20 to 50 acres.

Included in mapping are a few small areas of Riverwash and small areas that have rocks and boulders on the surface.

Runoff is slow, and this soil is not subject to erosion. It is subject to frequent flooding, generally in August to November. Because rainfall is low and is unevenly distributed throughout the year, there are few adapted kinds of grasses. Furrow irrigation is not feasible because of shallowness to sand and gravel. This soil has a loam layer that can be easily tilled throughout a wide range of moisture content without big clods forming. The available water capacity in the substratum is very low.

The root zone is limited because of a lack of moisture. Land leveling or smoothing is not feasible because coarse textured material is near the surface; however, shallow plowing is feasible. Unlike the underlying layer, which does not have plant nutrients, the surface layer of this soil is fertile.

This soil has mainly been in native pasture grasses such as pangolagrass and Angletongrass. Because rainfall is low and furrow irrigation is impractical, the use of this soil is restricted mainly to pasture. Some areas can be planted to vegetables if sprinkler irrigation is used.

Capability unit VIs–1; not in a woodland suitability group.

Daguey series

The Daguey series consists of well drained, moderately steep soils on the more stable side slopes, ridgetops, and foot slopes of the humid volcanic uplands. The soils formed in fine textured residuum of highly weathered, basic volcanic rock. The slope ranges from 12 to 20 percent. The annual rainfall ranges from 70 to 80 inches, and the temperature ranges from 76° to 78° F.

In a representative profile, the surface layer is dark reddish brown clay about 8 inches thick. The subsoil is about 33 inches thick. In the upper 8 inches, it is reddish brown, firm clay; in the 17 inches below that, it is yellowish red firm clay; and in the lowermost 8 inches, it is red and strong brown, friable clay. The substratum, between depths of 41 and 60 inches, is red, dark red, very pale brown, and yellowish brown clay saprolite.

These soils are moderately permeable. They have moderate to high available water capacity, moderate natural fertility, and moderate organic matter content. They are difficult to work. Runoff is medium, and the soils are somewhat susceptible to erosion. Crops respond well to fertilizer.

Daguey soils have been used mainly for food crops such as yams, plantains, bananas, and tanniers (fig. 3). Some areas are in shade coffee, native pasture, and pangolagrass, and some are suitable for sun-grown coffee.

Representative profile of Daguey clay, 12 to 20 percent slopes, 250 meters south of kilometer marker 7.6 on Highway 526:

Ap—0 to 8 inches; dark reddish brown (5YR 3/4) clay; weak medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; strongly acid; clear smooth boundary.

B21t—8 to 16 inches; reddish brown (5YR 4/4) clay; moderate fine and medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; thin discontinuous clay films; strongly acid; clear wavy boundary.

B22t—16 to 24 inches; yellowish red (5YR 4/6) clay; moderate fine and medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; patchy clay films; strongly acid; clear wavy boundary.

B23t—24 to 33 inches; yellowish red (5YR 4/6) clay; weak medium subangular blocky structure; firm, slightly sticky and plastic; few fine roots; patchy clay films; very strongly acid; clear wavy boundary.

B3—33 to 41 inches; red (2.5YR 4/6) and strong brown (7.5YR 5/8) clay; weak medium subangular blocky structure; friable, slightly sticky and plastic; 50 percent of horizon is saprolite; very strongly acid; clear wavy boundary.

C—41 to 60 inches; variegated colors of the saprolite as red (2.5YR 4/6), dark red (2.5YR 3/6), very pale brown (10YR 7/4), and yellowish brown (10YR 5/8) clay; massive; friable, nonsticky and slightly plastic; very strongly acid.

The solum is 30 to 50 inches thick. The B2t horizon is 19 to 30 inches thick. The Ap horizon has hue of 7.5YR and 5YR, value of 3 and 4, and chroma of 4 and

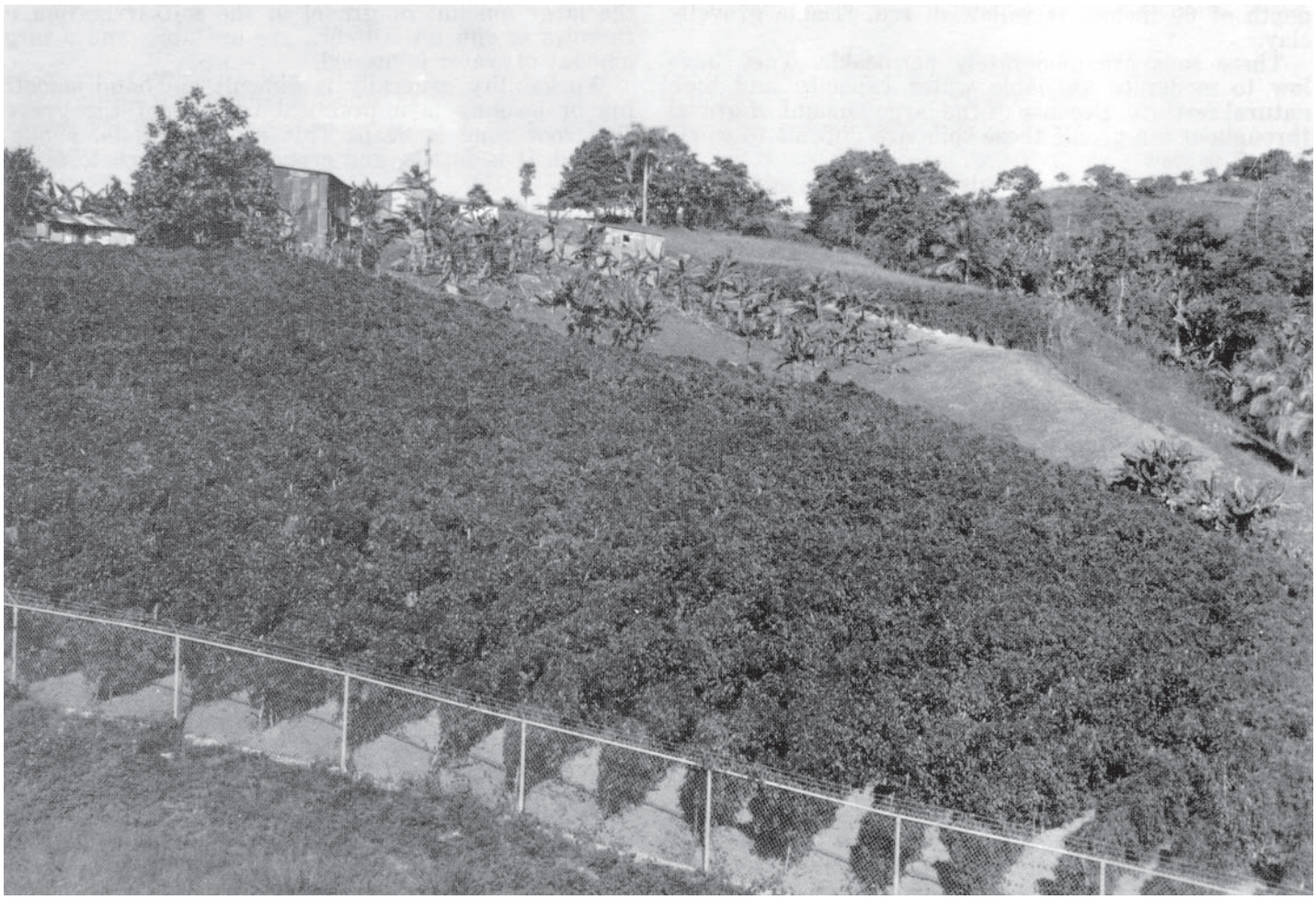

Figure 3.—**Yams and bananas, in the background, grow well on Daguey clay, 12 to 20 percent slopes.**

higher. Clay films in the B2t horizon range from patchy to discontinuous. Structure of the B2t horizon ranges from weak to moderate and from medium to coarse subangular blocky. The B3 horizon is 30 to 60 percent saprolite.

Daguey soils are on the same landscape as Humatas, Consumo, and Alonso soils. Daguey soils are on the more stable ridges, side slopes, and foot slopes; the Humatas soils are on the steeper slopes. Daguey soils are more highly weathered than Humatas soils, have a thicker B horizon than Consumo soils, and have a higher chroma in the B2t horizon than Alonso soils.

DaD—Daguey clay, 12 to 20 percent slopes. This is a moderately steep soil on stable side slopes, ridgetops, and foot slopes on the humid volcanic uplands. It generally is in areas of about 20 to 100 acres.

Included in mapping are small areas of Humatas soils, soils on a few rounded hilltops, and soils on some foot slopes where the slope is less than 12 percent.

Runoff on this soil is medium, and erosion is a hazard. This soil has a plow layer that is difficult to work because of its high content of clay. It should be tilled at optimum moisture content. The root zone is deep. This soil generally is deficient in major plant nutrients. Crops respond well to lime and fertilizer.

This soil has been used for a wide variety of food crops such as tanniers, bananas, plantains, and yams. Some areas are planted to shade-grown coffee. Other areas are in native pasture and brushy forest. This soil is suited to all the crops and pasture plants commonly grown in the area. Because of slope, runoff, and the hazard of erosion, measures to control erosion are needed if cultivated crops are grown. Pangolagrass and stargrass grow well on this soil. Merkergrass can be planted as green chop.

Capability unit IIIe–1; woodland suitability group 2c2.

Ensenada series

The Ensenada series consists of well drained, calcareous, gently sloping to strongly sloping gravelly soils. These soils formed in a mixture of transported clay and limestone gravel. They are on a truncated remnant of a fluvial deposit adjacent to the limestone hills in the semiarid area. Slope ranges from 2 to 12 percent. The annual rainfall ranges from 20 to 30 inches, and the temperature ranges from 78° to 80° F.

In a representative profile, the surface layer is dark reddish brown gravelly clay about 5 inches thick. The upper part of the subsoil is dark reddish brown, firm gravelly clay about 6 inches thick; the lower part, to a

depth of 60 inches, is yellowish red, friable gravelly clay.

These soils are moderately permeable. They have low to moderate available water capacity and high natural fertility. Because of the large amount of gravel throughout the profile these soils are difficult to work. Runoff is slow.

If irrigated, Ensenada soils are suited to sugarcane. They have been planted to this crop for many years. Nonirrigated areas are in native pasture and low brush.

Representative profile of Ensenada gravelly clay, 2 to 12 percent slopes, 30 meters west of kilometer marker 3.75 on Highway 335:

Ap—0 to 5 inches; dark reddish brown (5YR 3/3) gravelly clay; moderate fine granular structure; firm, sticky, and plastic; many fine roots; few cobbles and rock on the surface; 40 percent, by volume, of horizon is limestone gravel; effervescence on small limestone fragments; clear smooth boundary.

B2t—5 to 11 inches; dark reddish brown (5YR 3/4) gravelly clay; moderate fine subangular blocky structure; firm, sticky and plastic; common fine roots; thin patchy clay films; 40 percent, by volume, of horizon is limestone gravel; effervescence on limestone fragments; clear smooth boundary.

B3—11 to 60 inches, yellowish red (5YR 5/8) gravelly clay; weak fine subangular blocky structure; friable, sticky and plastic; 60 percent, by volume, of horizon is rounded and subrounded limestone gravel with clay and calcium carbonate; violent effervescence throughout the soil mass.

The solum is more than 60 inches thick. The content of limestone gravel in the solum ranges from 35 to 60 percent. The Ap horizon has hue of 7.5YR and 5YR, value of 3, and chroma of 2 and 3. The B2t horizon has hue of 5YR and 2.5YR, value of 3 to 5, and chroma of 4 and higher. The B2t horizon ranges in structure from weak medium to moderate fine and medium subangular blocky.

Ensenada soils are in the same area as Aguilita and Tuque soils. They are redder and finer textured than Aguilita soils. Unlike Tuque soils, which are underlain by indurated caliche, Ensenada soils are underlain by gravelly clay.

EnC—Ensenada gravelly clay, 2 to 12 percent slopes. This is a gently sloping to strongly sloping soil on fluvial deposits adjacent to the limestone hills in the semiarid area. It generally is in areas of about 5 to 50 acres. Some stones and rock outcrops are common on the surface.

Included in mapping are some areas where the soil is free of gravel in the surface layer and some small areas where the soil is free of gravel in both the surface layer and the subsoil.

Runoff is slow, and erosion is a hazard if cultivated crops are grown. Rainfall is low and poorly distributed throughout the year. Irrigation is necessary on this soil. Long periods of drought are common. Because of the large amount of gravel in the soil, irrigation by furrows is difficult. Ditches are unstable, and a large amount of water is needed.

Workability generally is difficult and land smoothing or leveling is impractical because of the gravel. The root zone is deep. This soil should be shallow plowed. It is fertile, and crops respond well to fertilizer.

This soil has been used mainly for sugarcane under irrigation management. Large amounts of water are needed because of the gravelly layers. Some small areas where irrigation is not possible are planted to other food crops. Some measures for controlling erosion are needed if cultivated crops are grown. Few species of grass are adapted to this soil because rainfall is low and poorly distributed throughout the year.

Capability unit IIIs–1, irrigated, and IVc–5, nonirrigated; not in a woodland suitability group.

Fe series

The Fe series consists of somewhat poorly drained, calcareous, saline, nearly level soils on alluvial fans slightly above flood plains in the semiarid area. Slopes are 0 to 2 percent. These soils formed in fine textured sediment that was derived from volcanic and limestone rock. Annual rainfall is 20 to 30 inches, and the temperature is 78° to 80° F.

In a representative profile, the surface layer is very dark grayish brown firm clay about 8 inches thick. The subsurface layer, between depths of 8 and 14 inches, is very dark grayish brown and dark grayish brown clay. The substratum, between depths of 14 and 60 inches, is brown, firm clay that has grayish brown, very dark grayish brown, yellowish brown, dark yellowish brown, and light gray mottles.

Permeability is slow and the available water capacity is high. The content of salts is high. These soils are difficult to work. Runoff is slow.

In most areas these soils are in native grasses, and in some small areas they are in sugarcane. In many spots they are barren.

Representative profile of Fe clay, 2 kilometers north of kilometer marker 113.1 on Highway 1:

A1—0 to 8 inches; very dark grayish brown (10YR 3/2) clay; massive; firm, sticky and plastic; many fine roots; pressure faces; first two inches have very weak fine granular structure; violent effervescence; clear smooth boundary.

AC—8 to 14 inches; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) clay; massive; firm, sticky and plastic; many fine roots; pressure faces; violent effervescence; clear smooth boundary.

C1—14 to 21 inches; brown (7.5YR 5/4) clay; common fine distinct very dark grayish brown (10YR 3/2) mottles; massive; firm, sticky and plastic; common fine roots; pressure faces; violent effervescence; clear wavy boundary.

C2—21 to 29 inches; brown (7.5YR 5/4) clay; few fine distinct very dark grayish brown (10YR 3/2) mottles; massive;

firm, sticky and plastic; few fine roots; pressure faces and slickensides; violent effervescence; clear wavy boundary.

C3—29 to 38 inches; brown (7.5YR 5/4) clay; common fine distinct very dark grayish brown (10YR 3/2) and common fine faint grayish brown (10YR 5/2) mottles; massive; firm, sticky and plastic; pressure faces and slickensides; violent effervescence; clear wavy boundary.

C4—38 to 47 inches; brown (7.5YR 5/4) clay; common fine distinct very dark grayish brown (10YR 3/2), yellowish brown (10YR 5/6), and few fine distinct light gray (10YR 6/1) mottles; massive; firm, sticky and plastic; pressure faces and slickensides; lenses of fine sand; violent effervescence; gradual wavy boundary.

C5—47 to 60 inches; brown (7.5YR 5/4) clay; common fine distinct light gray (10YR 6/1) and dark yellowish brown (10YR 4/4) mottles; massive; firm, sticky and plastic; pressure faces and slickensides; violent effervescence.

The A1 horizon is 6 to 10 inches thick. It has hue of 7.5YR and 10YR, value of 3, and chroma of 2 and 3. The C horizon has hue of 7.5YR, value of 4 and 5, and chroma of 4 and 6. Effervescence is strong to violent throughout.

Fe soils are on the same landscape as the Fraternidad, Cintrona, Serrano, and Teresa soils. Unlike Fraternidad and Cintrona soils, Fe soils are saline throughout. They are finer textured than Serrano soils. Fe soils are lighter colored below a depth of 15 inches than Teresa soils, and they have pressure faces and slickensides that Teresa soils do not have.

Fe—Fe clay. This is a nearly level soil on alluvial fans that are slightly above the flood plains in the semiarid area. Slopes are 0 to 2 percent. The areas generally are about 50 to 100 acres in size.

Included in mapping are small areas of Fraternidad clay and Teresa clay.

Runoff is slow. The available water capacity is high. This soil is not subject to erosion. It needs to be drained.

The large amount of harmful salts throughout this soil limits the use of this soil for crops. Because rainfall is low and poorly distributed, this soil needs to be irrigated. Land leveling or smoothing is difficult because of the poor workability of this soil. This soil should be tilled at the optimum moisture content. The use of machinery is feasible.

Most areas of this soil are barren because of the high salt content. A few areas are in sugarcane, and yields are low. Some areas are in salt-tolerant weeds.

This soil has severe limitations for crops or pasture because the content of soluble salts is high. The cost of reclaiming this soil is high.

Capability unit VIs–2; not in a woodland suitability group.

Fraternidad series

The Fraternidad series consists of moderately well drained, gently sloping to strongly sloping soils on the coastal plain in the semiarid area. Slopes are 2 to 12 percent. These soils are at a slightly higher elevation than the soils on flood plains. They formed in fine textured sediment derived from volcanic and limestone rock. Annual rainfall is 30 to 45 inches, and the temperature is 78° to 80° F.

In a representative profile, the surface layer is very dark grayish brown clay about 8 inches thick. The subsurface layer is about 32 inches thick. In the upper 6 inches, it is very dark grayish brown, very firm clay; in the 8 inches below that, it is dark brown and very dark brown, very firm clay; in the 8 inches below that, it is dark yellowish brown, very firm clay; and in the lowermost 10 inches, it is dark brown, very firm clay. The substratum, between depths of 40 and 60 inches, is dark brown, firm silty clay.

Permeability is slow, and the available water capacity is high. Natural fertility is high. These soils are very difficult to work.

If they are irrigated, the Fraternidad soils are well suited to sugarcane. In some areas where water for irrigation is not available these soils are in native pasture.

Representative profile of Fraternidad clay, 2 to 5 percent slopes, 400 meters west of kilometer marker 7.5 on Highway 149:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) clay; weak fine and medium subangular blocky structure; firm, sticky and plastic; many fine roots; 1 inch of self-mulch; neutral; abrupt smooth boundary.

A12—8 to 14 inches; very dark grayish brown (10YR 3/2) clay; massive; very firm, sticky and plastic; many fine roots; many pressure faces; many fine volcanic rock fragments; mildly alkaline; clear wavy boundary.

A13—14 to 22 inches; 70 percent dark brown (7.5YR 3/2) and 30 percent very dark brown (10YR 2/2) clay; massive; very firm, sticky and plastic; few fine roots; many pressure faces; many intersecting slickensides; many fine volcanic rock fragments; mildly alkaline; clear wavy boundary.

A14—22 to 30 inches; dark yellowish brown (10YR 3/4) clay; massive; very firm, sticky and plastic; few fine roots; many pressure faces; many intersecting slickensides; neutral; gradual wavy boundary.

A15—30 to 40 inches; dark brown (10YR 3/3) clay; massive; very firm, sticky and plastic; decayed roots; few lime splotches; many pressure faces; slight effervescence; mildly alkaline; gradual wavy boundary.

AC—40 to 60 inches; dark brown (10YR 4/3) silty clay; massive; firm, sticky and plastic; few lime splotches; very few fine limestone fragments; mildly alkaline.

The Ap horizon is 7 to 10 inches thick. It has hue of 10YR and value and chroma of 2 and 3. The AC horizon has hue of 10YR and 7.5YR, value of 4, and

chroma of 3 and 4. It is clay or silty clay. The Ap horizon ranges from neutral to moderately alkaline.

Fraternidad soils are on the same landscape as Paso Seco, Serrano, Fe, and Teresa soils. Unlike Paso Seco soils, Fraternidad soils do not have gravelly clay layers. They are finer textured than Serrano soils. Unlike Fe, Teresa, and Serrano soils, they are nonsaline.

FtB—Fraternidad clay, 2 to 5 percent slopes. This is a gently sloping soil on the coastal plain in the semiarid area. This soil is on terraces that are slightly higher than the river flood plain. The areas generally are about 50 to 100 acres in size. This is the soil described as representative of the series.

Included in mapping are areas of Paso Seco clay, areas where the surface layer is calcareous, and areas where the surface layer is lighter colored.

Runoff is slow. Permeability is slow, and the available water capacity is high. The root zone is deep. This soil is not subject to erosion and can be cropped intensively.

Because rainfall is low and poorly distributed, this soil needs to be irrigated if crops are grown. Land leveling or smoothing is difficult because of the poor workability of this soil. This soil has hard clods when it is dry, and it is sticky and plastic when wet. It should be tilled at the optimum moisture content because the clay is sticky and plastic. This soil is fertile, and crops respond well to fertilizer.

In most areas this soil has been planted to sugarcane. A few areas are used as native pasture. Adapted species of grasses are few because rainfall is low. If properly managed and irrigated, this soil is best suited to sugarcane and rice.

Capability units IIs–1, irrigated, and IIIc–1, nonirrigated; not in a woodland suitability group.

FtC2—Fraternidad clay, 5 to 12 percent slopes, eroded. This is a strongly sloping soil on the coastal plain in the semiarid area. This soil is on terraces and foot slopes that are slightly higher than the flood plain. The areas are about 50 to 100 acres in size. This soil is similar to the one described as representative of the series, except it has a slightly thinner surface layer.

Included in mapping are some areas where this soil is underlain by soft limestone at a depth of 30 to 40 inches. Also included are areas where this soil is reddish brown throughout and areas where the surface layer is calcareous.

Runoff is slow to medium. Permeability is slow, and the available water capacity is high. The root zone is deep. Erosion is a hazard, and it needs to be controlled if cultivated crops are grown.

Because rainfall is low and poorly distributed this soil needs to be irrigated. It is suited to sprinkler irrigation. Land leveling or smoothing is very difficult because of slope and poor workability. This soil has hard clods when it is dry, and it is plastic when wet. It should be tilled at the optimum moisture content. This soil is fertile, and crops respond well to fertilizer.

A large acreage is planted to sugarcane, and the rest is in native pasture. Adapted species of grasses are few because rainfall is low. If properly managed and irrigated, this soil is best suited to sugarcane.

Capability units IIIe–2, irrigated, and IVc–1, nonirrigated; not in a woodland suitability group.

Guanabano series

The Guanabano series consists of well drained, calcareous, very steep soils on side slopes and rounded hilltops on the semiarid, volcanic uplands. Slopes are 40 to 60 percent. These soils formed in moderately fine textured and fine textured residuum that was derived from calcareous volcanic rock.

In a representative profile, the surface layer is dark reddish brown clay about 6 inches thick. The subsoil is about 14 inches thick. In the upper 5 inches, it is dark reddish brown, firm clay; and in the lower 9 inches it is reddish brown, firm silty clay loam. The substratum, between 20 and 50 inches, is reddish brown, firm silty clay loam, and between depths of 50 and 60 inches, it is reddish gray, firm gravelly silty clay loam.

Permeability is moderate, and the available water capacity is high. Natural fertility is high. These soils are somewhat difficult to work. Runoff is rapid, and the soils are susceptible to erosion.

Guanabano soils have been in native pasture for many years, and a few acres are in brush. These soils are suited to guineagrass and Angletongrass.

Representative profile of Guanabano clay, 40 to 60 percent slopes, 100 meters south of Ubarris farm silo, southwest of kilometer marker 18.15 on Highway 14:

Ap—0 to 6 inches; dark reddish brown (5YR 3/2) clay; moderate medium granular structure; firm, slightly sticky and plastic; many fine roots; many very fine volcanic rock and limestone angular fragments; 15 percent, by volume, volcanic and limestone cobbles on the surface; strong effervescence; clear smooth boundary.

B2t—6 to 11 inches; dark reddish brown (5YR 3/2) clay; moderate medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; few patchy clay films; many very fine volcanic rock and limestone fragments; few medium volcanic rock fragments; strong effervescence; clear smooth boundary.

B3ca—11 to 20 inches; reddish brown (5YR 4/3) silty clay loam; weak medium and coarse subangular blocky structure; firm, slightly sticky and plastic; common fine roots; accumulations of fine soft calcium carbonate in spheres, coatings, and mycelia shapes on faces of peds; many very fine volcanic rock fragments; violent effervescence; clear wavy boundary.

C1—20 to 50 inches; reddish brown (5YR 5/3) silty clay loam; massive; firm, slightly sticky and plastic; violent effervescence; clear wavy boundary.

C2—50 to 60 inches; reddish gray (5YR 5/2) gravelly silty clay loam; massive; firm, slightly sticky and plastic; 50 percent, by volume, subrounded and angular volcanic rock and limestone fragments; violent effervescence.

The solum is 16 to 28 inches thick. The surface is 10 to 20 percent, by volume, volcanic and limestone

cobbles. The Ap horizon has hue of 5YR and value and chroma of 2 and 3. Calcium carbonate accumulations are between depths of 9 and 16 inches. Semiconsolidated, calcareous volcanic rock is between depths of 60 and 80 inches.

Guanabano soils are on the same landscape as Aguilita, Juana Diaz, and Callabo soils. They are redder than those soils. Unlike Aguilita soils, Guanabano soils do not have a thick layer of soft limestone. They are thicker than Juana Diaz soils, and, unlike Juana Diaz soils, they are calcareous throughout.

GoF—Guanabano clay, 40 to 60 percent slopes. This is a very steep soil on short side slopes and ridgetops on the semiarid, volcanic uplands. The areas generally are about 50 to 100 acres in size.

Included in mapping are small areas of Aguilita gravelly clay and Callabo silty clay loam. Also included are ridgetops that have a large percentage of rocks on the surface and a few areas on the lower part of slopes where the slope is less than 40 percent.

Runoff is very rapid. Permeability and the available water capacity are moderate. This soil is very susceptible to erosion.

This soil has severe limitations for cultivated crops because of slope and the erosion hazard. A permanent vegetative cover needs to be maintained. Because rainfall is low and droughty periods are frequent and long, special pasture management and deferred grazing are needed to avoid overgrazing. Few adapted species of grasses are in this area. This soil is fertile and somewhat difficult to work.

Most of the acreage is in native pasture grasses, including mainly guineagrass and Angletongrass. Some small areas are in brush. This soil generally is not suitable for cultivation because of slope, very rapid runoff, and susceptibility to erosion. It is suited to use as range if deferred grazing is used to control erosion.

Capability unit VIIe–3; not in a woodland suitability group.

Humatas series

The Humatas series consists of well drained, steep and very steep soils on side slopes and hilltops on strongly dissected, humid uplands. These soils formed in fine textured residuum derived from basic volcanic rock. Slopes are 20 to 60 percent. The annual rainfall is 70 to 90 inches, and the temperature is 76° to 78° F.

In a representative profile, the surface layer is dark brown clay about 5 inches thick. The subsoil is about 35 inches thick. In the upper 6 inches it is yellowish red, red, and dark brown firm clay, and in the lower 29 inches it is red, firm clay. The substratum, between depths of 40 and 60 inches, is red, yellowish brown, dark red, and very pale brown friable clay.

Permeability is moderate, and the available water capacity is moderate to high. Natural fertility is medium. These soils are difficult to work. Runoff is rapid or very rapid, and these soils are susceptible to erosion. Crops respond well to lime and fertilizer.

For many years, Humatas soils have been planted to a wide variety of food crops. A large acreage is in shade-grown coffee and brush. Other areas are in native pasture and pangolagrass. These soils are suited to sun-grown and shade-grown coffee and clean-tilled crops such as plantains, yams, and tanniers. They are also suited to pangolagrass, stargrass, and guineagrass.

Representative profile of Humatas clay, 20 to 40 percent slopes, eroded, 450 meters north of kilometer marker 72.5 on Highway 135:

Ap—0 to 5 inches; dark brown (7.5YR 4/4) clay; weak fine and medium subangular blocky structure; firm, slightly sticky and slightly plastic; many fine roots; very strongly acid; clear smooth boundary.

B21t—5 to 11 inches; 40 percent yellowish red (5YR 4/6), 40 percent red (2.5YR 4/8), and 20 percent dark brown (7.5YR 4/4) clay; moderate medium subangular blocky structure; firm, slightly sticky and plastic; common fine roots; many thin patchy clay films; very strongly acid; clear smooth boundary.

B22t—11 to 20 inches; red (2.5YR 4/8) clay; moderate medium subangular blocky structure; firm, slightly sticky and plastic; common fine roots; many thin patchy clay films; very strongly acid; clear wavy boundary.

B23t—20 to 28 inches; red (2.5YR 4/8) clay; weak fine and medium subangular blocky structure; firm, slightly sticky and plastic; few fine roots; common thin patchy clay films; very strongly acid; clear wavy boundary.

B3—28 to 40 inches; rubbed color red (2.5YR 4/8) clay; weak fine and medium subangular blocky structure; firm, slightly sticky and plastic; few fine roots; few patchy clay films; 25 percent saprolite; very strongly acid; clear wavy boundary.

C—40 to 60 inches; variegated colors of saprolite; red (2.5YR 4/8, 4/6), yellowish brown (10YR 5/8), dark red (2.5YR 3/6), and very pale brown (10YR 7/4) clay; massive; friable, slightly sticky and slightly plastic; very strongly acid.

The solum is 30 to 52 inches thick. The B2t horizon is 18 to 30 inches thick. The Ap horizon has hue of 7.5YR and 5YR, value of 3 and 4, and chroma of 4 and 6. The B2t horizon has hue of 2.5YR, 5YR, and 7.5YR, value of 4, and chroma of 6 to 8. The B3 horizon is 20 to 40 percent saprolite.

In some areas, the Humatas soils are in a complex with gravelly soils that are too variable to classify.

Humatas soils are on the same landscape as Daguey, Consumo, and Alonso soils. Humatas soils are not so highly weathered as Daguey soils, and, unlike Daguey soils, they are on the steeper side slopes and on narrow hilltops. Humatas soils have a thicker B horizon than Consumo soils. They have a higher value and chroma in the A and B horizons than Alonso soils.

HmE2—Humatas clay, 20 to 40 percent slopes, eroded. This is a steep soil on side slopes and ridgetops on strongly dissected, humid uplands. The areas generally are more than 200 acres in size. This is the soil described as representative of the series.

Included in mapping are areas of narrow foot slopes

where the slope is less than 20 percent, areas of Consumo clay, and a few areas of Daguey clay on hilltops.

Runoff is rapid. Erosion is a hazard. Slippage is common on roadbanks and in ditches and drainageways. This soil is difficult to work because the slopes are steep and the clay is sticky and plastic. Hillside ditches and diversions are difficult to lay out, construct, and maintain. The root zone is deep. Fertility is medium, and crops respond well to heavy and periodical applications of lime and fertilizer.

This soil has been used for shade-grown coffee, plantains, tanniers, yams, bananas, and oranges. Some areas have been used as native pasture. Other areas are in improved pasture, and a large acreage is in brush. Most of the coffee farms have been abandoned and are brushy.

This soil can be planted periodically to all the crops adapted to the humid uplands if erosion is controlled and large amounts of lime and fertilizer are applied. Pangolagrass and stargrass grow well on this soil. Deferred grazing can help to avoid overgrazing and control erosion.

Capability unit IVe–1; woodland suitability group 2c1.

HmF2—Humatas clay, 40 to 60 percent slopes, eroded. This is a very steep soil on side slopes and narrow ridges on humid uplands. The areas generally are more than 200 acres in size. This soil is similar to the one described as representative of the series, except it has a slightly thinner surface layer.

Included in mapping are a few areas that have rocks and boulders on the surface and some severely eroded soils on ridges where the substratum is exposed. Also included are areas of Consumo clay and small areas of Humatas clay that has slopes of less than 40 percent.

Runoff is very rapid. The root zone is deep. This soil is very susceptible to erosion. Slippage is common on roadbanks and in ditches and drainageways. This soil generally is not suitable for cultivation. A permanent vegetative cover needs to be maintained to control erosion. Hillside ditches and diversions are very difficult to lay out, construct, and maintain because of the steep slopes. Liming and fertilizing are difficult and costly.

A large acreage is in shade-grown coffee. Other areas are used as brush pasture and native pasture that has a low carrying capacity. Most of the coffee farms have been abandoned and are in brush forest.

This soil should be kept in permanent vegetation, woodland, or pasture because of the steep slopes, rapid runoff, and the erosion hazard. Deferred grazing can be used in pastures.

Capability unit VIe–1; woodland suitability group 3c1.

HxF—Humatas complex, 20 to 60 percent slopes. This map unit is about 30 percent Humatas soil and 70 percent gravelly soils that are too variable to classify. The soils in this complex are steep to very steep; slopes are 20 to 60 percent. The surface layer is clay. The Humatas soil is similar to the one described as representative of the series. The other soils, to a depth of more than 5 feet, are 70 to 80 percent red, yellow, and light gray, medium hard volcanic gravel; the gravel is angular and subangular in structure. These soils are 20 to 30 percent reddish brown to red, very strongly acid, and slightly sticky and plastic clay. The soils in this complex are so intermingled that it was not practical to separate them in mapping at the scale used.

Included in mapping are small areas where the soils have rocks and boulders on the surface.

Most areas of this map unit are in abandoned coffee trees and brush. A few areas are in shade-grown coffee and brushy pasture.

These soils have severe limitations for cultivated crops and for residential, commercial, industrial, or recreational uses because of slope, rapid runoff, the erosion hazard, and the large content of gravel. These soils are suitable for use as native pasture and woodland and for wildlife food and cover.

Capability unit VIIe–1; woodland suitability group 3c1.

Hydraquents

Hy—Hydraquents. This map unit is in lagoonlike areas and in depressions on the flood plains of streams and rivers. The areas generally are about 5 to 20 acres in size. The water table is at or near the surface most of the year.

The high water table severely limits these soils for cultivation. Artificial drainage is not feasible because these soils do not have outlets for drainage. These soils are best suited to wildlife food and cover.

These soils have severe limitations for residential, commercial, industrial, or recreational uses.

Capability unit VIIIw–1; not in a woodland suitability group.

Hydraquents, saline

Hz—Hydraquents, saline. This map unit is in lagoonlike areas and in depressions on river flood plains in the semiarid area. The areas generally are about 50 to 100 acres in size.

These soils are saline. The water table is at or near the surface most of the year. These soils vary in color and texture throughout the profile. Organic material from decayed mangrove trees is scattered throughout the profile, and other material, such as shells, coral, and marl, can also be found.

These soils have very severe limitations for cultivation because the water table and the content of harmful salts are high. Reclamation is expensive. These soils have been mainly in mangrove trees, and they are suitable as habitat for wildlife such as birds, oysters, and crabs.

These soils generally have very severe limitations for nonfarm uses. Capability unit VIIIs–1; not in a woodland suitability group.

Jacaguas series

The Jacaguas series consists of well drained, nearly level soils on flood plains in the semiarid area very near streams, rivers, and drainageways. These soils formed in moderately fine textured over coarse textured sediment that washed from volcanic and limestone hills. Slopes are 0 to 2 percent. The annual rainfall is 25 to 40 inches, and the temperature is 78° to 80° F.

In a representative profile, the surface layer is very

dark grayish brown silty clay loam about 7 inches thick. The subsoil is very dark grayish brown, firm silty clay loam about 7 inches thick. The substratum, between depths of 14 and 60 inches, is a mixture of fine sand, gravel, and cobbles.

Permeability is moderate in the surface layer and subsoil, and it is rapid in the substratum. The available water capacity is moderate in the surface layer and subsoil. The root zone is restricted by the coarse material in the substratum. Natural fertility is high. These soils are easy to work. Runoff is slow, and these soils are not susceptible to erosion.

Jacaguas soils have been planted to sugarcane and native pasture grasses for many years. Guineagrass, Angletongrass, and buffelgrass are the most common grasses. If irrigated, these soils can be used for vegetables.

Representative profile of Jacaguas silty clay loam, 1.9 kilometers west of kilometer marker 3.05 on Highway 510:

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate fine granular structure; firm, slightly sticky and slightly plastic; many fine roots; neutral; clear smooth boundary.

B2—7 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam; weak fine and medium subangular blocky structure parting to granular; firm, slightly sticky and slightly plastic; many fine roots; neutral; abrupt smooth boundary.

IIC—14 to 60 inches; mixture of fine sand, gravel, and cobbles.

Thickness of the solum and depth to the coarse material in the substratum range from 12 to 20 inches. The Ap horizon has hue of 10YR and value and chroma of 2 and 3. The B2 horizon ranges from silty clay loam to loam. Structure of the B2 horizon ranges from weak fine to weak medium subangular blocky. The soil material is neutral throughout.

Jacaguas soils are on the same landscape as Cuyon, San Anton, Cortada, Machuelo, and Constancia soils. Jacaguas soils have a thicker profile than Cuyon soils. Unlike San Anton and Cortada soils, Jacaguas soils have coarse material at a depth of 20 inches or less. Unlike Machuelo and Constancia soils, Jacaguas soils are noncalcareous, somewhat excessively drained, and have coarse material at a depth of 20 inches or less.

Jg—Jacaguas silty clay loam. This is a nearly level soil on alluvial fans and terraces along rivers and streams in the semiarid area. Slopes are 0 to 2 percent. The areas of this soil generally are about 5 to 50 acres in size.

Included in mapping are small areas of Cuyon loam and small areas that have a large number of rocks and boulders on the surface. Also included are a few areas of Riverwash.

Runoff is slow. This soil is not subject to erosion. If irrigated, this soil can be cropped intensively without loss of soil material. In some years it is subject to flooding from August to October. The root zone is deep, but it is restricted by the low available water capacity of the substratum. This soil needs to be irrigated because rainfall is low and poorly distributed throughout the year. Furrows have poor stability; irrigation on furrows is difficult and requires a large amount of water because permeability is rapid in the substratum. Sprinkler irrigation can be used. Land leveling or smoothing exposes coarse material at the surface. Adapted species of grasses are few because rainfall is low. This soil can be easily worked with machinery.

This soil has been planted to sugarcane and food crops, and a large acreage is in native pasture. If this soil is irrigated it is suited to sugarcane and to the vegetables and food crops commonly grown in the survey area.

Capability units IIIs–1, irrigated, and IVc–4, nonirrigated; not in a woodland suitability group.

Jacana series

The Jacana series consists of well drained, strongly sloping soils on foot slopes and low rolling hills in the semiarid area. These soils are moderately deep to volcanic rock. They formed in fine textured sediment and fine textured residuum that was derived from basic volcanic rock. Slopes are 5 to 12 percent. The annual rainfall is 20 to 40 inches, and the temperature is 78° to 80° F.

In a representative profile, the combined surface layer and subsurface layer are very dark brown clay about 13 inches thick. The subsoil is dark brown, very firm clay about 14 inches thick. Highly weathered volcanic rock that can be penetrated using a spade is at a depth of 27 inches.

Permeability is moderately slow, and the available water capacity is moderate. Natural fertility is high. These soils are somewhat difficult to work. The content of organic matter is high. Runoff is medium.

Jacana soils have been in pasture for many years. In some areas they have been used for corn, tobacco, and pigeonpeas. The most common grasses are guineagrass, Angletongrass, and buffelgrass. The use of the soils for food crops and cut grasses is restricted because irrigation water is not available.

Representative profile of Jacana clay, 5 to 12 percent slopes, 12 meters east of kilometer marker 2.0 on Highway 545:

Ap—0 to 7 inches; very dark brown (10YR 2/2) clay; weak medium subangular blocky parting to granular structure; firm, sticky and plastic; many fine roots; few fine and medium volcanic rock fragments; mildly alkaline; clear smooth boundary.

A12—7 to 13 inches; very dark brown (10YR 2/2) clay; weak coarse subangular blocky structure; firm, sticky and plastic; many fine roots; pressure faces; few fine volcanic rock fragments; mildly alkaline; clear wavy boundary.

B2—13 to 21 inches; dark brown (10YR 3/3) clay; weak coarse subangular blocky structure; very firm, sticky and plastic; few fine roots; pressure faces; few fine volcanic rock fragments; cracks to a depth of 21 inches; mildly alkaline; gradual wavy boundary.

B3—21 to 27 inches; dark brown (10YR 3/3) clay; weak coarse subangular blocky structure; firm, sticky and plastic; few fine roots; 30 percent, by volume, sapro-

lite; mildly alkaline; gradual wavy boundary.

C—27 inches; weathered volcanic rock.

The solum is 18 to 32 inches thick. Depth to the semiconsolidated rock is 20 to 40 inches. The Ap and A12 horizons have hue of 10YR and value and chroma of 2 and 3. The B2 horizon has hue of 10YR and 7.5YR, value of 3, and chroma of 3 or more. The B2 horizon is weak medium or weak coarse subangular blocky in structure. The Ap horizon is mildly alkaline to slightly acid.

Jacana soils are on the same landscape as Callabo, Juana Diaz, and Llanos soils. Jacana soils are finer textured and deeper to rock than Callabo and Juana Diaz soils, and they are shallower than Llanos soils. Jacana soils are underlain by semiconsolidated volcanic rock, unlike Llanos soils.

JnC—Jacana clay, 5 to 12 percent slopes. This is a strongly sloping soil on foot slopes and low rolling hills in the semiarid area. The areas of this soil generally are about 20 to 50 acres in size.

Included in mapping are small areas where this soil has slopes of less than 5 percent. Also included are some areas on hilltops where this soil has been intensively cultivated and is so eroded that material from the substratum is included in the surface layer.

Runoff is medium. If cultivated, this soil is subject to erosion. Cultivated crops can only be grown in the wet months because rainfall is low and is poorly distributed throughout the year. Furrow irrigation is difficult because of slope. Sprinkler irrigation can be used. Land leveling or smoothing is difficult because of slope and shallowness to rock. This soil is somewhat difficult to work because the clay is sticky. The root zone is deep. Adapted species of grasses are few because rainfall is low. Erosion needs to be controlled if cultivated crops are grown. If this soil is used as pasture, deferred grazing can help to avoid overgrazing.

In most areas, this soil has been used as native pasture. The main grasses are Angletongrass and guineagrass, and a few areas are in buffelgrass. Some areas have been in corn, pigeonpeas, and pumpkins, and a very small acreage has been in sugarcane. These crops are grown during the rainy season.

Capability units IIIe–3, irrigated, and IVc–1, nonirrigated; woodland suitability group 2d1.

Juana Diaz series

The Juana Diaz series consists of well drained, moderately steep and steep soils on side slopes, foot slopes, and hilltops on semiarid uplands. These soils formed in moderately fine textured and medium textured residuum that was derived from sandstone. Slopes are 12 to 40 percent. The annual rainfall is 25 to 40 inches, and the temperature is 78° to 80° F.

In a representative profile, the surface layer is dark yellowish brown and dark brown clay loam about 6 inches thick. The subsoil is about 12 inches thick. In the upper 6 inches, it is dark yellowish brown, firm clay loam, and in the lower 6 inches it is yellowish brown, friable silt loam. Semiconsolidated sandstone that can be easily penetrated using a spade is at a depth of about 18 inches.

Permeability is moderate, and the available water capacity is low. Natural fertility is medium. These soils are easy to work. Runoff is medium to rapid, and these soils are highly susceptible to erosion.

Juana Diaz soils have been in native pasture for many years. The most common grasses are guineagrass and Angletongrass. A few acres are in brush.

Representative profile of Juana Diaz clay loam, 20 to 40 percent slopes, 24 meters south of kilometer marker 15.75 on Highway 14:

Ap—0 to 6 inches; 80 percent dark yellowish brown (10YR 3/4), 20 percent dark brown (10YR 4/3) clay loam; moderate fine and medium granular structure; firm, slightly sticky and plastic; many fine roots; neutral; abrupt smooth boundary.

B2—6 to 12 inches; dark yellowish brown (10YR 4/4) clay loam; weak medium and coarse subangular blocky structure; firm, slightly sticky and plastic; common fine roots; neutral; clear smooth boundary.

B3—12 to 18 inches; yellowish brown (10YR 5/6) silt loam; weak medium subangular blocky structure; friable, slightly sticky and slightly plastic; few fine roots; 15 percent, by volume, saprolite; mildly alkaline; clear smooth boundary.

R—18 inches; semiconsolidated sandstone that is easily penetrated using a spade.

Thickness of the solum and depth to sandstone ranges from 14 to 20 inches. The Ap horizon has hue of 10YR and value and chroma of 3 and 4. The B2 horizon has hue of 10YR, value of 4 and 5, and chroma of 4 and 6. The B2 horizon ranges from clay loam to loam. The B2 horizon ranges from weak fine to coarse subangular blocky in structure.

Juana Diaz soils are on the same landscape as Callabo, Jacana, and Guanabano soils. Juana Diaz soils are coarser textured than Callabo soils, are shallower to rock and coarser textured than the Jacana soils, and are coarser textured and shallower to rock than Guanabano soils. Unlike Guanabano soils, they are noncalcareous.

JzD—Juana Diaz clay loam, 12 to 20 percent slopes. This is a moderately steep soil on foot slopes, on the upper part of side slopes, and on hilltops on semiarid uplands. The areas generally are about 20 to 50 acres in size. This soil is similar to the one described as representative of the series except it has a slightly thicker surface layer.

Included in mapping are a few small areas of Callabo silty clay loam and areas where semiconsolidated sandstone is at a depth of less than 14 inches.

Runoff is medium. Erosion is a hazard. This soil generally is not suitable for cultivation and should be maintained in permanent vegetation. Because rainfall is low and poorly distributed, only a few adapted species of grasses are suitable. The root zone is not restricted by the semiconsolidated sandstone. This soil is easy to fill.

This soil has mainly been used as native pasture. Angletongrass and guineagrass are the main grasses. In some areas this soil is in brush and in a few areas it is in pigeonpeas. Because rainfall is low and because of slope and shallowness to sandstone, this soil is best

suited to use as range. Deferred grazing helps to avoid overgrazing and to control erosion.

Capability unit VIe–4; woodland suitability group 3d1.

JzE—Juana Diaz clay loam, 20 to 40 percent slopes. This is a steep soil on side slopes and hilltops on semiarid uplands. The areas generally are about 20 to 100 acres in size. This is the soil described as representative of the series.

Included in mapping are a few small areas of Callabo silty clay loam and a few areas, especially on hilltops, where the soils are severely eroded.

Runoff is rapid. Erosion is a hazard. This soil is not suited to cultivation and should be maintained in permanent vegetation to control erosion. Rainfall is low and poorly distributed throughout the year. There are few adapted species of grasses. The root zone is not restricted by the semiconsolidated sandstone. The plow layer is easy to till.

This soil has been mostly in native pasture grasses, mainly guineagrass and Angletongrass. A few areas are in pigeonpeas, and some areas are in brush. Because of low rainfall, the erosion hazard, and shallowness to the semiconsolidated sandstone, this soil is best suited to use as range. A controlled stocking rate helps to avoid overgrazing.

Capability unit VIIe–3; woodland suitability group 3d1.

Lares series

The Lares series consists of moderately well drained, strongly sloping soils. These soils are on terraces below the red and brown soils on the humid uplands. They formed in fine textured material. The slope ranges from 5 to 12 percent. The annual rainfall ranges from 60 to 70 inches, and the temperature ranges from 76° to 78° F.

In a representative profile, the surface layer is dark brown and dark yellowish brown clay about 10 inches thick. The subsoil is about 30 inches thick. In the upper 13 inches, it is strong brown, yellowish red, and red, firm clay; in the 10 inches below that, it is strong brown and yellowish red firm clay that has light gray mottles; and in the lower 7 inches, it is dark brown, strong brown, and light gray, firm clay. The substratum, between depths of 40 and 60 inches, is strong brown, firm clay.

Lares soils are moderately permeable. They have moderate available water capacity and medium natural fertility and are somewhat difficult to work. Crops respond well to fertilizer. The content of organic matter is moderate, and runoff is medium.

Lares soils have been planted to a large variety of food crops for many years. In some areas they are planted to sugarcane and pasture grasses. Plantains, yams, and tanniers are among the food crops grown. Pangolagrass, stargrass, and guineagrass are among the grasses that grow well on these soils.

Representative profile of Lares clay, 5 to 12 percent slopes, 200 meters east of kilometer marker 0.6 on Highway 514:

Ap—0 to 10 inches; 80 percent dark brown (10YR 3/3), 20 percent dark yellowish brown (10YR 4/4) clay, rubbed color dark brown (10YR 4/3); moderate fine and medium granular structure; firm, slightly sticky and plastic; many fine roots; 15 percent fine and medium volcanic rock fragments; few fine black concretions; strongly acid; clear smooth boundary.

B21t—10 to 15 inches; 60 percent strong brown (7.5YR 5/6), 30 percent yellowish red (5YR 5/6), and 10 percent red (2.5YR 4/8) clay, rubbed color yellowish red (5YR 5/6); moderate medium subangular blocky structure; firm, slightly sticky and plastic; thin discontinuous clay films; few fine roots; few fine black concretions; black stains because of root decay; strongly acid; clear smooth boundary.

B22t—15 to 23 inches; 70 percent strong brown (7.5YR 5/8), 20 percent yellowish red (5YR 4/6), and 10 percent red (2.5YR 4/8) clay, rubbed color strong brown (7.5YR 5/6); weak medium subangular blocky structure; firm, slightly sticky and plastic; thin discontinuous clay films; few fine roots; few fine black concretions; black stains because of root decay; strongly acid; clear smooth boundary.

B23t—23 to 33 inches; 85 percent strong brown (7.5YR 5/6), 10 percent yellowish red (5YR 6/6), and 5 percent mottles of light gray (10YR 7/1) clay, rubbed color strong brown (7.5YR 5/8); weak medium subangular blocky structure; firm, slightly sticky and plastic; thin patchy clay films; few fine roots; few fine black concretions; black stains because of root decay; strongly acid; gradual wavy boundary.

B3—33 to 40 inches; 80 percent dark brown (7.5YR 4/4), 10 percent strong brown (7.5YR 5/6), and 10 percent light gray (10YR 7/1) clay, rubbed color brown (7.5YR 5/4); weak medium subangular blocky structure; firm, slightly sticky and plastic; few patchy clay films; few fine black concretions; strongly acid; gradual wavy boundary.

C—40 to 60 inches; rubbed color strong brown (7.5YR 5/8) clay; massive; firm, slightly sticky and plastic; strongly acid.

The solum is 30 to 50 inches thick. The B2t horizon is 18 to 30 inches thick. The Ap horizon has hue of 10YR and 7.5YR, value of 3 and 4, and chroma of 3 and higher. The B2t horizon is weak to moderate and fine to medium subangular blocky in structure. It has clay films that are thin patchy to thin discontinuous.

Lares soils are on the same landscape as Daguey, Humatas, and Mucara soils. Unlike Daguey and Humatas soils, Lares soils are moderately well drained. Lares soils have a thicker profile and are redder and more acid than Mucara soils.

LeC—Lares clay, 5 to 12 percent slopes. This is a strongly sloping soil on terraces and foot slopes below

the red and brown soils of the humid uplands. It generally is in areas of about 20 to 50 acres.

Included in mapping are small areas of soils that have stones and boulders on the surface and a few areas where the slope is less than 5 percent.

Runoff is medium. Erosion is a hazard. Some measures for controlling erosion are needed if cultivated crops are grown. This soil has a plow layer that is difficult to work because of the high clay content and stickiness and plasticity. This soil should be tilled at the optimum moisture content to prevent large clods from forming. The root zone is deep. Fertility is medium, and crops respond well to heavy applications of fertilizers. The use of machinery is feasible.

This soil has been used mainly for sugarcane. In some areas it is in native pasture and food crops. This soil has some limitations, but it can be used safely for clean cultivation if some management practices are used to control erosion. It is suited to all crops commonly grown in the area such as plantains, yams, tanniers, and coffee. Pangolagrass and stargrass grow well on this soil. Merkergrass can be grown for green chop.

Capability unit IIIe–1; woodland suitability group 2c2.

Lirios series

The Lirios series consists of well drained, very steep soils on side slopes and narrow hilltops on the strongly dissected, humid uplands. These soils formed in fine textured and moderately fine textured residuum that weathered from plutonic rocks. The slope ranges from 40 to 60 percent. The annual rainfall ranges from 80 to 90 inches, and the temperature ranges from 77° to 80° F.

In a representative profile, the surface layer is dark reddish brown clay loam about 5 inches thick. The subsoil is about 23 inches thick. In the upper 14 inches, it is red, firm clay, and in the lower 9 inches, it is red, firm silty clay. The substratum, between depths of 28 and 60 inches, is clay loam that has variegated colors of red, strong brown, and reddish brown.

These soils are moderately permeable. They have moderate available water capacity and medium natural fertility, and they are easy to work. Runoff is very rapid, and the soils are highly susceptible to erosion. Crops respond well to fertilizer.

Lirios soils have been used for shade-grown coffee and as native pasture. Small areas were planted to sugarcane. Pangolagrass, guineagrass, and stargrass grow well on these soils.

Representative profile of Lirios clay loam, 40 to 60 percent slopes, eroded, 1.5 kilometers north of kilometer marker 3.8 on Highway 524:

Ap—0 to 5 inches; dark reddish brown (5YR 3/4) clay loam; moderate fine granular structure; firm, slightly sticky and plastic; many fine roots; many fine quartz grains; very strongly acid; clear smooth boundary.

B21t—5 to 12 inches; red (2.5YR 4/6) clay with coatings of reddish brown (2.5YR 4/4) moderate medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; many patchy clay films; many fine quartz grains; very strongly acid; clear smooth boundary.

B22t—12 to 19 inches; red (2.5YR 4/6) clay; moderate fine and medium subangular blocky structure; firm, slightly sticky and plastic; common fine roots; common patchy clay films; many fine quartz grains; very strongly acid; clear smooth boundary.

B3—19 to 28 inches; red (2.5YR 4/8) silty clay; weak fine and medium subangular blocky structure; firm, slightly sticky and plastic; few fine roots; few fine thin patchy clay films; 25 percent of horizon is saprolite; many fine quartz grains; very strongly acid; gradual wavy boundary.

C—28 to 60 inches; variegated colors of the saprolite of red, strong brown, and reddish brown clay loam; massive; friable, slightly sticky and slightly plastic; many fine quartz grains; very strongly acid.

The solum is 20 to 32 inches thick. The B2t horizon is 16 to 26 inches thick. The Ap horizon has hue of 7.5YR and 5YR, value of 4, and chroma of 3 and 4. The B2t horizon has hue of 5YR and 2.5YR, value of 4, and chroma of 4 to 8. The B21t horizon is clay to silty clay. The C horizon is clay loam to silty clay loam.

Lirios soils are on the same landscape as Pellejas soils. They have a thicker B horizon and are redder and finer textured than Pellejas soils.

LmF2—Lirios clay loam, 40 to 60 percent slopes, eroded. This is a very steep soil on side slopes and narrow ridges on the humid uplands. It generally is in areas of about 50 to 100 acres.

Included in mapping are areas of Humatas and Consumo clay and a few small areas of Pellajas clay loam. Also included are a few areas where this soil has slopes of less than 40 percent.

Runoff is very rapid. Erosion is a hazard if this soil is not properly managed. Deep gullies are common in drainageways. Slips are common on roadbanks and in ditches and drainageways. Diversion ditches are difficult to lay out, construct, and maintain. Liming and fertilizing are difficult and costly. The root zone is deep. Fertility is medium.

This soil has been mainly in native pasture, shade-grown coffee, bananas, oranges, and pangolagrass. In some areas it is in brushy woods. Because of steepness of slope and the hazard of erosion, this soil has very severe limitations for cultivated crops. It should be maintained in permanent vegetation such as trees or pasture grasses. Pastures should have a controlled stocking rate to avoid overgrazing.

Capability unit VIIe–1; woodland suitability group 3c1.

Llanos series

The Llanos series consists of well drained, gently sloping to strongly sloping soils on foot slopes, alluvial fans, and stream terraces in the semiarid area. These soils formed in fine textured and moderately fine textured sediment that derived from basic volcanic rock. The slope ranges from 2 to 12 percent. The annual

rainfall ranges from 25 to 45 inches, and the temperature ranges from 78° to 80° F.

In a representative profile, the surface layer is very dark brown clay about 5 inches thick. The subsurface layer is black clay about 5 inches thick. The subsoil is 19 inches thick. In the upper 5 inches, it is very dark brown and black firm clay; and in the lower 14 inches, it is dark brown, firm clay. The substratum, between depths of 29 and 38 inches, is dark brown, firm clay loam; between depths of 38 and 50 inches, it is dark brown, friable sandy clay loam; between depths of 50 and 60 inches it is dark brown, friable sandy loam.

Llanos soils have moderately slow permeability. The substratum is more permeable than the other layers. These soils have a high available water capacity and high natural fertility, and they are difficult to work. The content of organic matter is high, and runoff is slow to medium.

Most of these soils have been in pasture for many years. Guineagrass, Angletongrass, and buffelgrass are the best adapted grasses. Small areas have been planted to sorghum for silage. If irrigated, the Llanos soils can be used for many food crops.

Representative profile of Llanos clay, 5 to 12 percent slopes, eroded, 250 meters south of kilometer marker 15.8 on Highway 150:

A11—0 to 5 inches; very dark brown (10YR 2/2) clay; moderate fine and medium granular structure; firm, slightly sticky and plastic; many fine roots; neutral; clear smooth boundary.

A12—5 to 10 inches; black (10YR 2/1) clay; weak medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; neutral; clear smooth boundary.

B1—10 to 15 inches; very dark brown (10YR 2/2) and black (10YR 2/1) clay; weak coarse subangular blocky structure; very firm, sticky and plastic; few fine roots; many pressure faces; 10 percent, by volume, fine and very fine volcanic rock fragments; neutral; clear smooth boundary.

B2—15 to 23 inches; dark brown (10YR 4/3) clay; moderate coarse subangular blocky structure; very firm, sticky and plastic; few fine roots; many pressure faces; 5 percent, by volume, very fine volcanic rock fragments; neutral; clear wavy boundary.

B3—23 to 29 inches; dark brown (10YR 4/3) clay; weak medium subangular blocky structure; firm, slightly sticky and plastic; few fine roots; 10 percent, by volume, fine pebbles; neutral; cracks to a depth of 29 inches; clear wavy boundary.

C1—29 to 38 inches; dark brown (10YR 4/3) clay loam; massive; firm, slightly sticky and plastic; 10 percent, by volume, fine pebbles; mildly alkaline; gradual wavy boundary.

C2—38 to 50 inches; dark brown (10YR 4/3) sandy clay loam; massive; friable, nonsticky and slightly plastic; 10 percent, by volume, fine pebbles; mildly alkaline; gradual wavy boundary.

IIC3—50 to 60 inches; dark brown (10YR 4/3) sandy loam; single grained; friable; nonsticky and nonplastic; mildly alkaline.

The solum is 23 to 36 inches thick. The A horizon has hue of 10YR, value of 2 and 3, and chroma of 1 to 3. The upper part of the C horizon ranges from clay loam to sandy clay loam; the lower part of the C horizon ranges from sandy loam to loamy sand.

Llanos soils are on the same landscape as Jacana and Callabo soils. They have a thicker profile than Jacana and Callabo soils, and they do not have the semiconsolidated rock that Jacana and Callabo soils have.

LnB—Llanos clay, 2 to 5 percent slopes. This is a gently sloping soil on foot slopes, alluvial fans, and terraces in the semiarid area. It generally is in areas of about 50 to 100 acres. This soil is similar to the one described as representative of the series, except it has a slightly thicker surface layer.

Included in mapping are areas of Jacana clay, small areas of narrow strips along drainageways where the slope is slightly more than 5 percent, and some small areas of soils that have calcareous material at a depth below 2 feet.

Runoff is slow, but in heavy rains erosion is a hazard if the soil is cultivated. This soil can be used safely for cultivated crops, but some measures for controlling erosion are needed. Heavy showers are common in favorable years. Because of the low and poorly distributed rainfall, food crops are restricted to the rainy season. Long droughty periods are common.

This soil has a plow layer that is difficult to work because of stickiness and plasticity. This soil should be tilled at the optimum moisture content to help prevent large clods. Land leveling or smoothing is difficult because of the poor workability of the soil. The root zone is deep. This soil has only a few adapted kinds of grasses because of low rainfall. The use of machinery is feasible. This soil is fertile, and crops respond well to fertilizer.

Because there is no irrigation, most of the acreage of this soil has been in pasture grasses, mainly Angletongrass and guineagrass. Some small areas are in buffelgrass. Crops such as corn, pumpkins, and pigeonpeas are grown in the rainy season. Scarcity of irrigation water is a limitation on this soil. If irrigated, this soil is suited to sugarcane. Merker and sorghum grasses can be grown as green chop in irrigated areas.

Capability units IIs–3, irrigated, and IIIc–1, nonirrigated; not in a woodland suitability group.

LnC2—Llanos clay, 5 to 12 percent slopes, eroded. This is a strongly sloping soil mainly on foot slopes and stream terraces in the semiarid area. It generally is in areas of about 50 to 100 acres. This is the soil described as representative of the series. Gullies are common.

Included in mapping are a few small areas of soils that are calcareous at a depth below 24 inches. Also included are some small areas of soils that are close to gullies where the underlying coarse material is closer to the surface.

Runoff is medium. Erosion is a hazard. If this soil is used for cultivated crops, some measures will be needed to control erosion, especially in gullies. Heavy

showers are common in favorable years. Long droughty periods are common. Food crops are mainly grown in the rainy season.

The plow layer is difficult to work because the clay is sticky and plastic. Land leveling or smoothing is not recommended because of the poor workability of the soil and strong slopes. The root zone is deep. Because of low, poorly distributed rainfall, food crops are grown only in the rainy season. The use of machinery is feasible. This soil is fertile, and crops respond well to fertilizer.

In most areas this soil has been in pasture grasses, mainly guineagrass and Angletongrass. A few areas are in buffelgrass. Food crops such as corn, pumpkins, and pigeonpeas grow well during the rainy season. Lack of water for irrigation is a limitation on this soil. Furrow irrigation is not practical because of the slope. Sprinkler irrigation is practical. If irrigated, this soil is suited to sugarcane and a wide variety of food crops. Merkergrass and sorghum can be grown as green chop in irrigated areas.

Capability units IIIe–5, irrigated, and IVc–1, nonirrigated; not in a woodland suitability group.

Los Guineos series

The Los Guineos series consists of deep, moderately well drained soils that are steep and very steep and have slopes of 20 to 60 percent. These soils formed in fine-textured residuum derived from basic volcanic rocks. They are on side slopes and hilltops in areas of high altitude and high rainfall. The average annual soil temperature at a depth of 20 inches is below 72° F. The annual rainfall ranges from 90 to 100 inches, and the temperature ranges from 69° to 72° F.

In a representative profile, the surface layer is dark yellowish brown and yellowish brown clay about 7 inches thick. The subsoil is about 41 inches thick. In the upper 6 inches it is yellowish brown firm clay, and in the lower 35 inches it is mainly yellowish red, yellowish brown, and red firm clay. The substratum is red, yellowish brown, and yellowish red friable clay that extends to a depth of 72 inches.

The Los Guineos soils are moderately permeable. They have moderate to high available water capacity and low natural fertility and are difficult to work. Surface runoff is rapid to very rapid.

These soils have been used for food crops such as yams, plantains, and tanniers. Some areas are in shade-grown coffee trees and brush, and others are in native pasture.

Representative profile of Los Guineos clay, 20 to 40 percent slopes, 50 meters east of kilometer marker 5.1 on Highway 522:

Ap—0 to 7 inches, 60 percent dark yellowish brown (10YR 4/4) and 40 percent yellowish brown (10YR 5/8) clay; moderate medium granular structure; firm, slightly sticky and plastic; many fine roots; few worm casts; rust due to root decay; very strongly acid; clear smooth boundary.

B21t—7 to 13 inches, yellowish brown (10YR 5/8) clay; strong, medium and coarse, subangular blocky structure; firm, slightly sticky and plastic; discontinuous clay films; many fine roots; very strongly acid; clear smooth boundary.

B22t—13 to 20 inches, 65 percent yellowish red (5YR 4/8), 20 percent yellowish brown (10YR 5/8), and 15 percent red (2.5YR 4/6) clay, yellowish red (5YR 5/6) rubbed; strong medium subangular blocky structure; firm, slightly sticky and plastic; common fine roots; discontinuous clay films; very strongly acid; clear smooth boundary.

B23t—20 to 30 inches, 70 percent red (2.5YR 4/6), 20 percent yellowish brown (10YR 5/8), and 10 percent red (2.5YR 4/8) clay, red (2.5YR 5/8) rubbed; moderate, fine and medium, subangular blocky structure; firm, slightly sticky and plastic; few fine roots; discontinuous clay films; very strongly acid; gradual wavy boundary.

B31—30 to 39 inches, 80 percent yellowish red (5YR 4/6), 10 percent yellowish brown (10YR 5/8), and 10 percent red (2.5YR 5/8) clay, yellowish red (5YR 5/8) rubbed; weak medium subangular blocky structure; firm, slightly sticky and plastic; 20 percent of horizon is saprolite; very strongly acid; gradual wavy boundary.

B32—39 to 48 inches, 60 percent yellowish red (5YR 4/8), 20 percent red (2.5YR 5/8), and 20 percent yellowish brown (10YR 5/8) clay; weak, fine and medium, subangular blocky structure; firm, slightly sticky and plastic; few patchy clay films; 40 percent of horizon is saprolite; very strongly acid; gradual wavy boundary.

C—48 to 72 inches, red (2.5YR 4/6 and 4/8), yellowish brown (10YR 5/8), and yellowish red (5YR 4/8) clay saprolite; massive; friable, slightly sticky and slightly plastic; very strongly acid.

The solum ranges from 38 to 56 inches in thickness. The Ap horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 or higher. The B2t horizon ranges in structure from moderate to strong and fine to coarse, subangular blocky. The B3 horizon is 20 to 50 percent saprolite.

The Los Guineos soils are on the same landscape as the Maricao soils. They have a thicker profile and are deeper to saprolite than the Maricao soils.

LuE—Los Guineos clay, 20 to 40 percent slopes. This soil is on side slopes and ridges in the humid uplands, generally in areas of about 100 to 500 acres. It has the profile described as representative of the series.

Included with this soil in mapping are some rounded hilltops and narrow foot slopes where slopes are less than 20 percent and some narrow areas along drainageways where slopes are more than 40 percent.

Runoff is rapid on this soil, and some measures for controlling erosion are needed if cultivated crops are grown. The root zone is deep, but the plow layer is difficult to work because of the sticky and plastic clay. Ditches are difficult to lay out, establish, and maintain

because of the steep slopes. Slippage is common in road cuts, ditches, and drainageways.

Because of the steep slopes, the hazard of erosion, high altitude, and high rainfall, this soil has severe limitations for cultivated crops. Its use is limited largely to pasture and forest, but because of the high altitude and high rainfall, few species of trees suitable for commercial purposes can be grown.

This soil has mainly been in native pasture of low carrying capacity. Some areas are in shade-grown coffee trees, and a large acreage is in brush. Very few acres are in food crops.

Capability unit VIe–1; woodland suitability group 2c1.

LuF—Los Guineos clay, 40 to 60 percent slopes. This is a very steep soil on side slopes and narrow ridges in the humid uplands. It generally is in areas of more than 500 acres.

Included with this soil in mapping are some hilltops that have a large amount of rocks and boulders on the surface and some ridgetops where slopes are more than 60 percent.

Runoff is very rapid on this soil, and erosion is a hazard. The root zone is deep, but the soil is difficult to work because of the slope and the stickiness and plasticity of the clay. The use of lime and fertilizer is not practical. Ditches are very difficult to lay out, establish, and maintain, and slippage is very common in road cuts and drainageways.

Because of the slope, the hazard of erosion, high altitude, and high rainfall, this soil has very severe limitations for cultivated crops. Because of the high altitude and high rainfall, only a few species of trees suitable for commercial purposes can be grown. This soil should be maintained in permanent vegetation.

A large acreage of this soil is in brush, and some areas are in brushy pasture of low carrying capacity.

Capability unit VIIe–1; woodland suitability group 2c3.

LyFX—Los Guineos-Maricao association, steep. This map unit is on side slopes and ridges in the humid uplands. Slopes are 20 to 60 percent. The soils occur in such an intricate pattern that it was not practical to separate them at the scale used in mapping. Los Guineos soils make up about 60 percent of the association, and Maricao soils make up about 40 percent. These soils are clayey throughout.

Included with this association in mapping are some areas where slopes are more than 60 percent and a few areas that have stones and boulders on the surface.

Because of slope, rapid runoff, and the hazard of erosion, the soils of this map unit generally are not suitable for cultivation. They are better suited to forest and wildlife food and cover than to most other uses. Clearing the soils for pasture is very difficult and costly. These soils have severe limitations for nonfarm uses in general.

Most of the acreage of this map unit is in hardwood trees, sierra palms, and tree ferns. Very few areas are in brushy pasture.

Capability unit VIIe–1; woodland suitability group 2c3.

LzFX—Los Guineos-Maricao-Stony rock land association, steep. This map unit is on side slopes and ridges in the humid uplands. Slopes are 30 to 60 percent. The soils occur in such an intricate pattern that it was not practical to separate them at the scale used in mapping. Los Guineos and Maricao soils each make up about 40 percent of the association, and the remaining 20 percent consists of Stony rock land and patches of soils that are not classified. The soils are clayey throughout.

Included in mapping are some high peaks where slopes are more than 60 percent.

Because of the slope, rapid runoff, the hazard of erosion, and the presence of rocks and boulders, the soils of this map unit generally are not suitable for cultivation. They are better suited to forest and wildlife food and cover than to most other uses. Clearing these soils for pasture is very difficult and costly. These soils have severe limitations for nonfarm uses in general.

Most of the acreage of this map unit is in brush. Very few areas are in brushy pasture.

Capability unit VIIs–5; woodland suitability group 3x2.

Machuelo series

The Machuelo series consists of poorly drained, calcareous, nearly level soils in the lower lying flood plains in the semiarid area. These soils formed in fine textured sediment that weathered from volcanic and limestone rocks. The slope ranges from 0 to 2 percent. The annual rainfall ranges from 25 to 40 inches, and the temperature ranges from 78° to 80° F.

In a representative profile, the surface layer is dark grayish brown, mottled clay about 8 inches thick. The substratum, to a depth of 21 inches, is mottled, dark gray, firm clay; between depths of 21 and 29 inches it is mottled, greenish gray, firm clay; between depths of 29 and 37 inches it is light olive brown, greenish gray, and dark bluish gray, firm clay; and between depths of 37 and 60 inches it is olive, dark greenish gray, gray, and light olive brown clay.

Machuelo soils are slowly permeable. They have a high available water capacity and high natural fertility. They are difficult to work. Runoff is slow. These soils have a restricted root zone because of a fluctuating water table.

If irrigated, Machuelo soils are suited to sugarcane. Many acres are planted to this crop. Areas where water for irrigation is not available are in native pasture grasses, mostly Angletongrass.

Representative profile of Machuelo clay, 2.5 kilometers south of kilometer marker 123.75 on Highway 1:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) clay; few fine distinct yellowish brown (10YR 5/6), strong brown (7.5YR 5/8), and gray (10YR 6/1) mottles; moderate fine and medium granular structure; firm, slightly sticky and plastic; many fine roots; common fine volcanic rock fragments; strong effervescence; abrupt smooth boundary.

C1g—8 to 16 inches; dark gray (10YR 4/1) clay; few fine distinct light gray (10YR 7/1) and few fine distinct yellowish brown (10YR 5/6) mottles; weak medium and

coarse subangular blocky structure; firm, slightly sticky and plastic; many fine roots; common fine volcanic rock fragments; common fine limestone fragments; few shell fragments; strong effervescence; abrupt smooth boundary.

C2g—16 to 21 inches; dark gray (5Y 4/1) clay; common fine distinct olive yellow (2.5Y 6/6), a few fine faint gray (5Y 5/1), and a few fine distinct dark grayish brown (10YR 4/2) mottles; weak medium subangular blocky structure; firm, slightly sticky and plastic; common fine roots; common fine volcanic rock fragments; few fine limestone fragments; strong effervescence; clear smooth boundary.

C3g—21 to 29 inches; greenish gray (5GY 5/1) clay; many fine prominent yellowish brown (10YR 5/4), common fine prominent olive yellow (2.5Y 6/6), few fine distinct bluish gray (5B 5/1), and few fine distinct dark bluish gray (5B 4/1) mottles; massive; firm, slightly sticky and plastic; few fine roots; few fine volcanic rock fragments; few fine limestone fragments; few fine shell fragments; slight effervescence; clear wavy boundary.

C4g—29 to 37 inches; light olive brown (2.5Y 5/6), greenish gray (5BG 5/1), and dark bluish gray (5B 4/1) clay; rubbed color is gray (5Y 5/1); massive; firm, sticky and plastic; common fine volcanic rock fragments; few fine limestone fragments; few shell fragments; water table at a depth of 32 inches; strong effervescence; clear wavy boundary.

C5g—37 to 60 inches; olive (5Y 5/4), dark greenish gray (5BG 4/1), gray (5Y 5/1), light olive brown (2.5Y 5/4) clay; rubbed color is dark greenish gray (5GY 4/1); massive; firm, sticky and plastic; few fine volcanic rock fragments; few fine limestone fragments; few lime splotches; strong effervescence.

In irrigated areas, the water table is at a depth of 18 to 36 inches. The A horizon has hue of 10YR and 2.5Y, value of 3 and 4, and chroma of 2 or 3; it has gray and brown mottles. The C horizon has hue of 10YR, 5Y, 5GY, 2.5Y, 5B, and 5BG, value of 4 and 5, and chroma of 1 to 6.

Machuelo soils are on the same landscape as Cintrona, Constancia, Cortada, and San Anton soils. Machuelo soils have a lighter colored surface than that of Cintrona soils. Unlike Constancia soils, which are somewhat poorly drained, and Cortada and San Anton soils, which are well drained, Machuelo soils are poorly drained. Cortada and San Anton soils are coarser textured than Machuelo soils.

Ma—Machuelo clay. This is a nearly level soil in depressions on the flood plains in the semiarid area. It generally is in areas of about 50 to 200 acres. The slope is 0 to 2 percent.

Included in mapping are a few saline spots that have little or no vegetation and a few areas of somewhat poorly drained Constancia silty clay.

Runoff is slow. This soil is not subject to erosion. If properly drained and irrigated, it can be intensively cropped without loss of soil material. It is subject to flooding in some years, generally from August to October. Because permeability is slow, this soil can become saturated during heavy rains. Long droughty periods are common.

Workability is poor. Land leveling and smoothing are difficult due to a high clay content, stickiness, and plasticity. Machinery can only be used in the dry months. Earth movement should be done at optimum moisture content. The root zone is restricted by a high water table. This soil is fertile, and crops respond well to fertilizer.

Most of the acreage has been in sugarcane for many years. If properly managed, this soil is suitable for sugarcane and rice.

Capability units IIIw–1, irrigated, and IVc–2, nonirrigated; not in a woodland suitability group.

Maraguez series

The Maraguez series consists of well drained, very steep soils on side slopes and narrow hilltops on the strongly dissected, humid uplands. These soils formed in moderately fine textured and medium textured residuum that derived from volcanic rock. The slope ranges from 40 to 60 percent. The annual rainfall ranges from 55 to 70 inches, and the temperature ranges from 76° to 78° F.

In a representative profile, the surface layer is dark brown silty clay loam about 6 inches thick. The subsoil is about 15 inches thick. In the upper 6 inches it is brown and dark brown, firm, slightly sticky and slightly plastic clay loam, and in the lower 9 inches it is dark yellowish brown, friable, slightly sticky and slightly plastic loam. The substratum, between depths of 21 and 60 inches, is yellowish brown, friable, slightly sticky and slightly plastic loam.

Maraguez soils are moderately permeable. They have a moderate available water capacity and high natural fertility, and they are easy to work. Runoff is very rapid, and susceptibility to erosion is high.

Maraguez soils have been used for shade-grown coffee and native pasture. Some acres are in brush. These soils are best suited to use as native pasture and woodland.

Representative profile of Maraguez silty clay loam, 40 to 60 percent slopes, eroded, 15 meters east of kilometer marker 16.1 on Highway 139:

Ap—0 to 6 inches; dark brown (10YR 3/3) silty clay loam; moderate fine and medium subangular blocky structure; firm, slightly sticky and slightly plastic; many fine and medium roots; few worm holes; few fine and medium pebbles; slightly acid; clear wavy boundary.

B2—6 to 12 inches; 60 percent brown (10YR 4/3), and 40 percent dark brown (10YR 3/3) clay loam; weak fine and medium subangular blocky structure; firm, slightly sticky and slightly plastic; few fine and medium roots; few worm holes;

many fine volcanic rock fragments; slightly acid; clear wavy boundary.

B3—12 to 21 inches; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; friable, slightly sticky and slightly plastic; few fine and medium roots; common fine subangular volcanic rock fragments; common fine quartz grains; slightly acid; clear wavy boundary.

C—21 to 60 inches; yellowish brown (10YR 5/4) loam; massive; friable, slightly sticky and slightly plastic; few fine and medium roots; common fine and medium volcanic rock fragments; many fine quartz grains; medium acid.

The solum is 16 to 24 inches thick. The Ap horizon has hue of 10YR, value of 3, and chroma of 2 and 3. The B2 horizon has hue of 10YR, value of 3 and 4, and chroma of 3. The B2 horizon is clay loam to loam, and the B3 horizon is loam or silt loam.

Maraguez soils are on the same landscape as Caguabo, Morado, Múcara, and Quebrada soils. They are deeper to rock than Caguabo soils and have coarser textured B and C horizons than those of Morado, Múcara, and Quebrada soils.

MeF2—Maraguez silty clay loam, 40 to 60 percent slopes, eroded. This is a very steep soil on side slopes and narrow ridges on the humid uplands. It generally is in areas of about 100 to 200 acres.

Included in mapping are small areas of soils that have a coarser textured surface layer and calcareous substrata and areas of soils that have slopes of less than 40 percent.

Runoff is very rapid and erosion is a hazard. Deep gullies are common in drainageways. Generally, this soil is not suitable for cultivation. Slips are common in road cuts, ditches, and drainageways. The layout, construction, and maintenance of ditches is very difficult and costly. Fertilizing pastures is not practical. The root zone is deep. This soil is fertile.

Most of the acreage has been in native pasture of low carrying capacity. Some areas are in shade-grown coffee and brush. This soil has very severe limitations for cultivation because of steep slope, very rapid runoff, and the erosion hazard. It should be maintained in permanent vegetation. It is suitable for use as native pasture and woodland. Deferred grazing is helpful in avoiding overgrazing.

Capability unit VIIe–2; woodland suitability group 3r1.

Maricao series

The Maricao series consists of well drained, steep and very steep soils on side slopes and narrow hilltops on the strongly dissected uplands. These soils formed in fine textured residuum that was derived from basic volcanic rock. The slope ranges from 20 to 60 percent. These soils are in areas where rainfall and altitude are high and the mean annual soil temperature at a depth of 20 inches is lower than 72° F. The annual rainfall in these areas ranges from 90 to 100 inches, and the temperature ranges from 72° to 74° F.

In a representative profile, the surface layer is reddish brown and red clay about 5 inches thick. The subsoil is about 13 inches thick. In the upper 7 inches it is red, firm, slightly sticky and plastic clay; and in the lower 6 inches it is red and yellowish red, friable, slightly sticky and plastic clay. The substratum, between depths of 18 and 60 inches, is red, yellowish red, reddish brown, and reddish gray, friable, slightly sticky and slightly plastic clay. This layer is mainly saprolite.

Maricao soils are moderately permeable. They have a high available water capacity and low natural fertility. They are difficult to work. Runoff is rapid to very rapid. These soils are highly susceptible to erosion.

Most of these soils have been in native pasture for many years. There are small patches of shade-grown coffee and subsistence crops. Some areas are in abandoned coffee trees and brush. These soils are suitable for pangolagrass.

Representative profile of Maricao clay, 20 to 60 percent slopes, eroded, 40 meters south of kilometer marker 3.4 on Highway 143:

Ap—0 to 5 inches; 70 percent reddish brown (5YR 4/4) and 30 percent red (2.5YR 5/8) clay; moderate fine and medium granular structure; firm, slightly sticky and plastic; many fine roots; 15 percent, by volume, is fine angular gravel; very strongly acid; clear smooth boundary.

B2t—5 to 12 inches; red (2.5YR 5/8) clay; weak medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; patchy clay films on ped surfaces; 10 percent of horizon is saprolite; 5 percent, by volume, is fine angular gravel; very strongly acid; clear wavy boundary.

B3—12 to 18 inches; red (2.5YR 5/8 and 10R 4/8) and yellowish red (5YR 5/8), rubbed color is yellowish red (5YR 4/6) clay; weak fine subangular blocky structure; friable, slightly sticky and plastic; few fine roots; few patchy clay films; 35 percent, by volume, of horizon is saprolite; very strongly acid; clear wavy boundary.

C—18 to 60 inches; variegated colors of the saprolite are red, yellowish red, reddish brown, and reddish gray clay; rubbed color is red (2.5YR 5/6); friable, slightly sticky and slightly plastic; very strongly acid.

The solum is 15 to 22 inches thick. The Ap horizon has hue of 5YR and 2.5YR, value of 4 and 5, and chroma of 4 and higher. The B2t horizon has hue of 2.5YR and 10R, value of 4 and 5, and chroma of 6 and 8. The B2t horizon ranges from weak medium to moderate fine and medium subangular blocky in structure.

Maricao soils are on the same landscape as Los Guineos soils. They have a thinner profile and are shallower to saprolite than Los Guineos soils.

MkF2—Maricao clay, 20 to 60 percent slopes, eroded. This is a steep and very steep soil on side slopes and narrow ridges in areas of high altitude and high rainfall. It is in areas of more than 500 acres.

Included in mapping are some areas of soils, especially on ridges, that are severely eroded and other areas of soils that are along drainageways that have more than 60 percent slopes.

Runoff is rapid to very rapid; erosion is a hazard. Deep gullies are common in drainageways. Slips are common in road cuts, ditches, and drainageways. Layout, construction, and maintenance of ditches are difficult and costly. Liming and fertilizing are not practical. The root zone is deep. Because of the high altitude and the high rainfall, there are only a few adapted kinds of trees that have commercial value.

Most of the acreage of this soil is brushy woodland and pasture. Some areas are in native pasture of low carrying capacity. This soil has severe limitations for cultivation because of slope, rapid to very rapid runoff, and the erosion hazard. Clearing the brush land for pasture is costly. This soil should be maintained in permanent vegetation to control erosion.

Capability unit VIIe–1; woodland suitability group 2c3.

Meros series

The Meros series consists of excessively drained, nearly level soils on benches along the coast at an elevation slightly above sea level. These soils formed in coarse textured sediment that was derived from volcanic rock, sea shells, and coral. The slope ranges from 0 to 2 percent. The annual rainfall ranges from 25 to 40 inches, and the temperature ranges from 78° to 80° F.

In a representative profile, the surface layer is very dark grayish brown fine sand about 16 inches thick. The substratum, between depths of 16 and 60 inches, is fine sand. In the upper 8 inches it is dark brown; in the next 6 inches it is very dark grayish brown; and in the lowermost 30 inches it is very dark gray.

Meros soils are very rapidly permeable. They have very low available water capacity and natural fertility. These soils generally are in coconuts and weeds.

Representative profile of Meros sand, 3 kilometers south of kilometer marker 125.1 on Highway 1:

A1—0 to 16 inches; very dark grayish brown (10YR 3/2) moist, dark grayish brown (10YR 4/2) dry, fine sand; single grain; loose, nonsticky and nonplastic; many fine roots; common very fine volcanic gravel; neutral; clear smooth boundary.

C1—16 to 24 inches; dark brown (10YR 3/3) moist, grayish brown (10YR 5/2) dry, fine sand; single grain; loose, nonsticky and nonplastic; few fine roots; neutral; clear smooth boundary.

C2—24 to 30 inches; very dark grayish brown (2.5Y 3/2) moist, olive gray (5Y 4/2) dry, fine sand; single grain; loose, nonsticky and nonplastic; few fine roots; mildly alkaline; clear smooth boundary.

C3—30 to 44 inches; very dark gray (5Y 3/1) moist and olive gray (5Y 5/2) dry, fine sand; single grain; loose, nonsticky and nonplastic; few fine roots; moderately alkaline; clear smooth boundary.

C4—44 to 60 inches; very dark gray (5Y 3/1) moist and olive gray (5Y 5/2) dry, fine sand; single grain; loose, nonsticky and nonplastic; many shell fragments; strong effervescence.

The A1 horizon is 10 to 20 inches thick. The calcareous horizon is at a depth between 30 and 54 inches. The A1 horizon has hue of 10YR, value of 3, and chroma of 2 and 3.

Meros soils are on the same landscape as Serrano soils, Hydraquents, and Hydraquents, saline. Unlike Serrano soils and Hydraquents, saline, Meros soils are nonsaline, and unlike Hydraquents, they are excessively drained and are not saturated with water.

Mr—Meros sand. This is a nearly level soil on benches along the coast. It generally is in areas of about 20 to 50 acres. The slope is 0 to 2 percent.

Included in mapping are few narrow strips of beach sand that has been reworked by waves, and small areas of soils that have a calcareous surface layer.

Runoff is slow. This soil is not subject to erosion. It has very low available water capacity and natural fertility. Occasionally there are long periods of drought.

Irrigation is not feasible because permeability is very rapid. Fertilizing is not practical. No kinds of grasses can adapt to this soil.

This soil has been mainly in coconuts for many years. Some areas are in brush, and other areas have no vegetation. This soil has a severe limitation for cultivation because of very rapid permeability and very low available water capacity. Coconuts grow well on this soil.

Capability unit VIIs–1; not in a woodland suitability group.

Montegrande series

The Montegrande series consists of moderately well drained, gently sloping to strongly sloping soils on alluvial fans and foot slopes on the volcanic uplands. These soils formed in fine textured and gravelly textured sediment that was derived from volcanic rock. The slope ranges from 2 to 12 percent. The annual rainfall ranges from 65 to 80 inches, and the temperature ranges from 76° to 78° F.

In a representative profile, the surface layer is very dark grayish brown clay about 7 inches thick. The subsoil is about 18 inches thick. In the upper 6 inches it is brown, dark yellowish brown, and very dark grayish brown firm clay; and in the lowermost 5 inches it is dark yellowish brown firm clay that has splotches of very dark grayish brown. The substratum, between depths of 25 and 60 inches, is dark yellowish brown, firm gravelly clay that has dark gray mottles.

Montegrande soils have moderately slow permeability. They have high available water capacity and natural fertility, and they are difficult to work. Runoff is slow to medium.

Most of the acreage of these soils is in sugarcane. Some small areas are used as native pasture and for food crops. These soils are well suited to paragrass, pangolagrass, stargrass, and Merkergrass.

Representative profile of Montegrande clay, 2 to 12 percent slopes, 500 meters north of kilometer marker 11.2 on Highway 132:

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) clay; weak coarse subangular blocky structure; very firm, sticky and plastic; many fine roots; many fine subangular volcanic rock fragments; apparently compacted by machinery; pressure faces; medium acid; clear smooth boundary.

B1—7 to 13 inches; 60 percent dark brown (10YR 3/3) and 40 percent brown (10YR 4/3) clay; weak coarse subangular blocky structure; very firm, sticky and plastic; common fine roots; many fine subangular volcanic rock fragments; pressure faces; slightly acid; clear smooth boundary.

B2—13 to 20 inches; 60 percent brown (10YR 4/3), 25 percent dark yellowish brown (10YR 4/4), and 15 percent very dark grayish brown (10YR 3/2) clay; massive; firm, sticky and plastic; few fine roots; common fine subangular volcanic rock fragments; cracks to a depth of 20 inches; pressure faces and slickensides; neutral; clear smooth boundary.

B3—20 to 25 inches; dark yellowish brown (10YR 4/4) clay; splotches of very dark grayish brown (10YR 3/2) and a few fine dark gray (10YR 4/1) mottles; massive; firm, sticky and plastic; pressure faces and slickensides; mildly alkaline; clear smooth boundary.

IIC—25 to 60 inches; dark yellowish brown (10YR 4/4) gravelly clay; common fine dark gray (10YR 4/1) mottles; massive; firm, slightly sticky and slightly plastic; fine and medium subangular volcanic rock fragments make up more than 40 percent of the horizon; mildly alkaline.

Thickness of the solum and depth to the gravelly clay layer range from 20 to 34 inches. The Ap horizon has hue of 10YR, value of 3 and 4, and chroma of 2, 3, or 4. The B2 horizon is weak medium to coarse subangular blocky or massive. The C horizon is 40 to 60 percent volcanic rock fragments.

Montegrande soils are on the same landscape as Lares, Mucara, and Quebrada soils. Montegrande soils are browner and less acidic than Lares soils. Unlike Mucara and Quebrada soils, they are moderately well drained and have gravelly clay layers in the substratum.

MsC—Montegrande clay, 2 to 12 percent slopes. This is a gently sloping to strongly sloping soil on alluvial fans and foot slopes on volcanic hills. It generally is in areas of about 20 to 50 acres.

Included in mapping are small areas of soils that are free of gravel throughout the profile and other areas of soils that have the gravelly layer closer to the surface.

Runoff is slow to medium. Erosion is a hazard. Some measures for controlling erosion are needed if cultivated crops are grown. Because permeability is moderately slow in the upper part of the profile, this soil needs to be drained. It has a plow layer that is difficult to work because of the high clay content and the plasticity and stickiness of the clay.

Tillage should be done at the optimum moisture content. Land leveling and smoothing are difficult because of poor workability, slope, and the gravelly layers in the substratum. The root zone is deep. This soil is fertile, and crops respond well to fertilizer. The use of machinery is feasible.

In some areas this soil is in sugarcane and food crops. A large acreage is in native pasture. This soil has some limitations for cultivated crops because of the erosion hazard and the need for drainage. If properly managed and drained, it can be used for a wide range of food crops and as pasture. Paragrass, pangolagrass, and stargrass grow well on this soil, and merker grass can be used as green chop.

Capability unit IIw–2; not in a woodland suitability group.

Morado series

The Morado series consists of well drained, steep and very steep soils on side slopes, foot slopes, and hilltops on the strongly dissected, humid uplands. These soils are moderately deep to volcanic rock. They formed in moderately fine textured residuum that was derived from pinkish volcanic rock. The slope ranges from 20 to 60 percent. The annual rainfall ranges from 65 to 88 inches, and the temperature ranges from 76° to 78° F.

In a representative profile, the surface layer is dark reddish gray clay loam about 6 inches thick. The subsoil is about 18 inches thick. In the upper 10 inches it is reddish gray, friable clay loam; and in the lower 8 inches it is dark reddish gray, friable clay loam. The substratum, between depths of 24 and 30 inches, is dark brown, dark reddish gray, and dark gray, friable clay loam saprolite. Reddish gray semiconsolidated volcanic rock is at a depth of 30 inches.

Morado soils are moderately permeable. They have a moderate available water capacity and high natural fertility, and they are easy to work. Runoff is rapid to very rapid.

These soils have been used for food crops and shade-grown coffee and as pasture. Some areas were formerly used for coffee and brushy woodland.

Representative profile of Morado clay loam, 20 to 40 percent slopes, eroded, 500 meters west of kilometer marker 15.0 on Highway 139:

Ap—0 to 6 inches; dark reddish gray (10R 4/1) moist, dark gray (5YR 4/1) dry, clay loam; moderate fine and medium granular structure; friable, slightly sticky and plastic; many fine roots; 15 percent by volume is fine volcanic rock fragments; medium acid; clear smooth boundary.

B2—6 to 16 inches; reddish gray (5YR 5/2) clay loam; weak fine and medium subangular blocky structure; friable, slightly sticky and plastic; many fine roots; 10 percent by volume is saprolite; slightly acid; gradual smooth boundary.

B3—16 to 24 inches; dark reddish gray (5YR 4/2) clay loam; weak fine subangular blocky structure parting to fine granu-

lar; friable, slightly sticky and plastic; few fine roots; 50 percent by volume is saprolite; slightly acid; clear wavy boundary.

C—24 to 30 inches; variegated colors of the clay loam saprolite are dark brown (7.5YR 4/2), dark reddish gray (5YR 4/2), and dark gray (5YR 4/1); massive; friable, slightly sticky and slightly plastic; slightly acid.

R—30 inches; reddish gray semiconsolidated volcanic rock.

The solum is 16 to 30 inches thick. The Ap horizon has hue of 10R and 2.5YR, value of 4 and 5, and chroma of 1 and 2. The B2 horizon has hue of 2.5YR and 5YR, value of 4 and 5, and chroma of 1 and 2. The B2 horizon is weak fine to weak medium subangular blocky in structure. Depth to the semiconsolidated rock ranges from 20 to 36 inches.

Morado soils are on the same landscape as Mucara, Caguabo, Maraguez, and Quebrada soils. Unlike those soils, Morado soils have a dark reddish gray surface layer. Morado soils have a thicker profile than Caguabo soils, Morado soils are shallower to rock than Maraguez and Quebrada soils.

MtE2—Morado clay loam, 20 to 40 percent slopes, eroded. This is a steep soil on side slopes and hilltops on the humid uplands. It generally is in areas of about 50 to 100 acres. This is the soil described as representative of the series.

Included in mapping are some areas of soils on foot slopes where the slope is 20 percent and a few areas of soils on hilltops where rocks and boulders are on the surface.

Runoff is rapid. Erosion is a hazard. Deep gullies are common in drainageways. This soil generally is not suited to cultivation. The layout, construction, and maintenance of ditches are difficult and costly. This soil is easy to work. The root zone is moderately deep. This soil is fertile, and crops respond well to fertilizer.

Most of the acreage of this soil is in native pasture of low carrying capacity. Some areas are in brushy woodland, brushy pasture, and shade-grown coffee. Occasionally food crops are planted.

This soil has a severe limitation for cultivated crops because of slope, rapid runoff, and the hazard of erosion. It should be maintained in permanent vegetation. It is well suited to pangolagrass, stargrass, and guineagrass. Deferred grazing is helpful in maintaining good pasture and controlling erosion. This soil is suited to use as woodland.

Capability unit VIe–3; woodland suitability group 3d2.

MtF2—Morado clay loam, 40 to 60 percent slopes, eroded. This is a very steep soil on side slopes and ridges on the humid uplands. It generally is in areas of about 100 to 500 acres. This soil has a thinner profile than the one described as representative of the series.

Runoff is very rapid. This soil is very erosive. Very deep gullies are common in drainageways. This soil is not suited to cultivation. The layout, construction, and maintenance of ditches and the application of fertilizer are very difficult and costly. The root zone is moderately deep.

Most of the acreage of this soil is in brushy woodland and brushy pasture. Some small cleared areas are in native pasture of low carrying capacity. A few areas are in shade-grown coffee.

Because of very steep slopes, very rapid runoff, and the hazard of erosion, this soil has very severe limitations for cultivation. It should be under permanent vegetation such as trees or pasture grasses.

Capability unit VIIe–2; woodland suitability group 3d3.

Mucara series

The Mucara series consists of well drained, moderately steep to very steep soils on foot slopes, side slopes, and rounded hilltops on the strongly dissected, volcanic uplands. These soils are moderately deep to volcanic rock. They formed in fine textured residuum that was derived from weathered volcanic rock. The slope ranges from 12 to 60 percent. The annual rainfall ranges from 60 to 80 inches, and the temperature ranges from 76° to 78° F.

In a representative profile, the surface layer is very dark grayish brown silty clay about 5 inches thick. The subsoil is about 14 inches thick. In the upper 8 inches it is dark brown, firm silty clay; and in the lower 6 inches it is dark yellowish brown, yellowish brown, and dark brown, friable silty clay. The substratum, between depths of 19 and 30 inches, is friable, highly weathered volcanic rock. Semiconsolidated rock is at a depth of 30 inches.

Mucara soils are moderately permeable. They have moderate available water capacity and high natural fertility. They are difficult to work. The organic matter content is moderate.

These soils have been planted to a variety of crops. Some areas are in native pasture, shade-grown coffee, and pangolagrass. A large acreage is in brushy pasture and brushy woodland.

Representative profile of Múcara silty clay, 40 to 60 percent slopes, eroded, 700 meters south of kilometer marker 6.3 on Highway 143:

Ap—0 to 5 inches; very dark grayish brown (10YR 3/2) silty clay; weak fine and medium granular structure; friable, slightly sticky and plastic; many fine roots; 10 percent, by volume, is fine and medium volcanic rock fragments; medium acid; clear smooth boundary.

B2—5 to 13 inches; dark brown (10YR 4/3) silty clay; weak medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; 5 percent, by volume, fine and medium volcanic rock fragments; medium acid; clear wavy boundary.

B3—13 to 19 inches; dark yellowish brown (10YR 4/4), yellowish brown (10YR 5/4), and dark brown (10YR 4/3) silty clay; weak medium subangular blocky structure; friable, slightly sticky and slightly plastic; few fine roots; 30 percent of horizon is saprolite; slightly acid; clear wavy boundary.

C—19 to 30 inches; friable, neutral, highly weathered volcanic rock.

R—30 inches; semiconsolidated volcanic rock.

The solum is 14 to 20 inches thick. The Ap horizon has hue of 10YR, value of 3, and chroma of 2 or 3. The B2 horizon has hue of 10YR, value of 4, and chroma of 3 or 4. The B2 horizon is silty clay or clay. The B2 horizon is weak fine or weak medium subangular blocky in structure. Depth to the semiconsolidated volcanic rock ranges from 20 to 36 inches.

Mucara soils are on the same landscape as Morado, Quebrada, Maraguez, and Caguabo soils. Unlike Morado soils, which have a dark reddish gray, moderately fine textured surface layer, Mucara soils have a very dark grayish brown, fine textured surface layer. Mucara soils are shallower to the semiconsolidated volcanic rock than Quebrada and Maraguez soils. Mucara soils are deeper to volcanic rock than Caguabo soils.

MuD2—Mucara silty clay, 12 to 20 percent slopes, eroded. This is a moderately steep soil on foot slopes, side slopes, and rounded hilltops on the humid uplands. It generally is in areas of about 20 to 50 acres. This soil is similar to the one described as representative of the series, except it has a thicker surface layer, is on less steep slopes, and has been less affected by erosion.

Included in mapping are soils on a few narrow foot slopes where the slope is less than 12 percent. These soils have a thicker surface layer than this Mucara soil.

Runoff is medium. Erosion is a hazard. Gullies are common in drainageways. Some measures for controlling erosion are needed if cultivated crops are grown. This soil has a plow layer that is somewhat difficult to work because of the stickiness and plasticity of the clay. The root zone is moderately deep. This soil is fertile, and crops respond well to fertilizer.

Most of the acreage of this soil has been in native pasture. Some areas are in shade-grown coffee, and a few areas are in food crops. If used for cultivated crops, this soil has limitations because of slope, runoff, and the hazard of erosion. Intensive cropping on this soil is not feasible. This soil is suited to most of the food crops grown in the area. Stripcropping and crop rotation are helpful in controlling erosion. Native pasture grasses, pangolagrass, and stargrass grow well on this soil and provide a good cover. Deferred grazing is helpful in avoiding overgrazing. This soil is suitable for use as woodland.

Capability unit IVe–2; woodland suitability group 3d2.

MuE2—Mucara silty clay, 20 to 40 percent slopes, eroded. This is a steep soil on side slopes and ridges on the humid uplands. It generally is in areas of about 50 to 200 acres. This soil is similar to the one described as representative of the series, except it has a slightly thicker surface layer.

Included in mapping are many narrow strips of soils along drainageways that have more than 40 percent slopes. Also included are a few areas of soils on foot slopes that have less than 20 percent slopes and areas on some hilltops that have many rocks and boulders on the surface.

Runoff is rapid. Erosion is a hazard. This soil is not suited to cultivated crops. Gullies are common in drainageways. The layout, construction, and maintenance of ditches are difficult and costly. The root zone is moderately deep. This soil is fertile, and crops respond well to fertilizer.

Most of the acreage of this soil is in native pasture and brushy woodland. Some small areas are planted to food crops, and some areas are in shade-grown coffee.

Because of slope, runoff, and the hazard of erosion, this soil is not suitable for cultivation. It should be maintained in permanent vegetation. Pangolagrass and stargrass grow well on this soil. Deferred grazing is necessary to avoid overgrazing. This soil is suitable for use as woodland.

Capability unit VIe–3; woodland suitability group 3d2.

MuF2—Mucara silty clay, 40 to 60 percent slopes, eroded. This is a very steep soil on side slopes and narrow ridges on the humid uplands. The areas generally are more than 500 acres in size. This is the soil described as representative of the series.

Included in mapping are many very small areas of soils that have many rocks and boulders on the surface and many areas of severely eroded soils that have substratum material in the surface layer.

Runoff is very rapid. This soil is very erodible. It is not suitable for cultivation. Large gullies are common in drainageways. Slips are common in road cuts and ditches. The layout, construction, and maintenance of ditches and the application of fertilizer are very difficult and costly. Establishing a good species of grass is difficult and costly.

This soil has mainly been in brushy woodland and brushy pasture. Some small areas are in native pasture of low carrying capacity. Occasionally, food crops are grown in some small areas.

This soil is not suitable for cultivation because of slope, runoff, and the erosion hazard. It should be maintained in permanent vegetation to control erosion.

Capability unit VIIe–2; woodland suitability group 3d3.

Paso Seco series

The Paso Seco series consists of moderately well drained, gently sloping soils on alluvial fans and terraces that are slightly higher than the flood plain. These soils formed in fine textured sediment of mixed origin over gravelly fine textured sediment. The slope ranges from 2 to 5 percent. The annual rainfall ranges from 25 to 40 inches, and the temperature ranges from 78° to 80° F.

In a representative profile, the surface layer is very dark grayish brown clay about 10 inches thick. The subsurface layer is dark yellowish brown and very dark grayish brown, firm clay about 5 inches thick. The next layer, between depths of 15 to 25 inches, is dark yellowish brown, firm clay. The substratum, between depths of 25 and 32 inches, is dark yellowish brown, friable gravelly clay, and between depths of 32 to 60 inches it is friable sand, gravel, and silt that has very little clay.

Paso Seco soils are slowly permeable. They have high available water capacity and natural fertility. They are

difficult to work. Runoff is slow. The content of organic matter is high.

These soils are suited to sugarcane and have been planted to this crop for many years where irrigation water is available. If they are not irrigated, these soils are used for native pasture grasses, mainly Angletongrass and guineagrass.

Representative profile of Paso Seco clay, 2 to 5 percent slopes, 100 meters west of kilometer marker 2.6 on Highway 543:

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) clay; weak medium and coarse subangular blocky structure; firm, sticky and plastic; many fine roots; many fine volcanic rock fragments; pressure faces; 1 inch of self-mulch soil; mildly alkaline; clear smooth boundary.

A12—10 to 15 inches; 60 percent dark yellowish brown (10YR 4/4) and 40 percent very dark grayish brown (10YR 3/2) clay; rubbed color is dark yellowish brown (10YR 3/4); massive; firm, sticky and plastic; many fine roots; many fine volcanic rock fragments; pressure faces; cracks 3 to 5 inches wide to a depth of 15 inches; mildly alkaline; abrupt smooth boundary.

AC—15 to 25 inches; dark yellowish brown (10YR 4/4) clay; massive; firm, sticky and plastic; few fine roots; few medium pebbles; many very fine pebbles; pressure faces; mildly alkaline; clear smooth boundary.

IIC1—25 to 32 inches; dark yellowish brown (10YR 4/4) gravelly clay; massive; friable; slightly sticky and plastic; few fine roots; mildly alkaline; abrupt smooth boundary.

IIIC2—32 to 60 inches; friable, nonsticky and nonplastic; moderately alkaline sand, gravel, and silt with very little clay.

The Ap horizon is 6 to 12 inches thick. The gravelly layer is at a depth between 20 and 32 inches. The Ap horizon has hue of 10YR, value of 3, and chroma of 2 or 3.

Paso Seco soils are on the same landscape as Fe, Fraternidad, Serrano, and Teresa soils. Unlike Fe, Serrano, and Teresa soils, Paso Seco soils are nonsaline. Unlike Fe and Fraternidad soils, Paso Seco soils have gravel in the substratum.

PaB—Paso Seco clay, 2 to 5 percent slopes. This is a gently sloping soil on alluvial fans and terraces on the coastal plain in the semiarid area. It generally is in areas of about 50 to 200 acres.

Included in mapping are some areas of soils that have calcareous gravelly layers below a depth of 20 inches. Also included are small areas of soils that are dark reddish brown in the surface and subsurface layers and some areas of soils that are deeper to the gravelly layers than this Paso Seco soil.

Runoff is slow. If properly managed, this soil can be used for intensive cropping without loss of soil material. Because of low, poorly distributed rainfall, this soil needs to be irrigated. Shallow furrows are helpful in avoiding the more permeable layers. Workability is poor because the clay is sticky and plastic. This soil has hard clods when it is dry, and tillage should be done at the optimum moisture content. Land leveling is not helpful because of the gravelly layers below a depth of 20 inches. Land smoothing is difficult because of poor workability. The root zone is deep. This soil is fertile, and crops respond well to fertilizer.

Most of the acreage of this soil has been planted to sugarcane under irrigation management for many years. Sugarcane is the best adapted crop. Those areas that are not under irrigation are in guineagrass and Angletongrass.

Capability units IIs–2, irrigated, and IIIc–1, nonirrigated; not in a woodland suitability group.

Pellejas series

The Pellejas series consists of somewhat excessively drained, very steep soils on short side slopes and narrow ridges on the strongly dissected, humid uplands. These soils formed in moderately fine textured over coarse textured and moderately coarse textured residuum that weathered from plutonic rocks. The slope ranges from 40 to 60 percent. The annual rainfall ranges from 70 to 90 inches, and the temperature ranges from 76° to 78° F.

In a representative profile, the surface layer is dark grayish brown clay loam about 5 inches thick. The subsoil is about 10 inches thick. In the upper 6 inches it is dark brown, firm clay loam, and in the lower 4 inches it is pale brown and dark yellowish brown, friable sandy loam. The substratum, between depths of 15 and 60 inches, is light brownish gray, very friable loamy sand.

Pellejas soils have moderately rapid permeability. They have a moderate available water capacity and low natural fertility. They are easy to work. Runoff is very rapid. These soils are highly susceptible to erosion.

These soils have been used as native pasture and for shade-grown coffee and food crops. In a few areas they are in brush.

Representative profile of Pellejas clay loam, 40 to 60 percent slopes, eroded, 100 meters north of kilometer marker 44.5 on Highway 10:

Ap—0 to 5 inches; dark grayish brown (10YR 4/2) clay loam; moderate fine granular structure; firm, slightly sticky and slightly plastic; many fine roots; many fine quartz grains; strongly acid; clear smooth boundary.

B2—5 to 11 inches; dark brown (10YR 4/3) clay loam; weak medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; common fine and few medium quartz grains; strongly acid; clear wavy boundary.

B3—11 to 15 inches; 80 percent pale brown (10YR 6/3) and 20 percent dark yellowish brown (10YR 4/4) sandy loam, rubbed color is light brownish gray (2.5Y 6/2); weak fine and medium subangular blocky structure; friable, nonsticky and slightly plastic; common fine roots; many fine quartz grains; many

fine white and black specks; strongly acid; clear wavy boundary.

C—15 to 60 inches; light brownish gray (2.5Y 6/2) loamy sand; single grain; very friable, nonsticky and nonplastic; strongly acid.

The solum is 11 to 20 inches thick. The Ap horizon has hue of 10YR, value of 4, and chroma of 2 or 3. The B2 horizon has hue of 10YR, value of 4, and chroma of 3 or 4. The B2 horizon is clay loam to loam. The B3 horizon is sandy loam to loamy sand.

Pellejas soils are on the same landscape as Lirios soils. Pellejas soils are shallower to saprolite and are coarser textured throughout the profile than Lirios soils. Unlike Lirios soils, they have a brown B horizon.

PeF2—Pellejas clay loam, 40 to 60 percent slopes, eroded. This is a very steep soil on side slopes and very narrow ridges on the humid uplands. The areas generally are more than 100 acres in size.

Included in mapping are many small areas of soils that have less than 40 percent slopes and many small areas of soils that are severely eroded.

Runoff is very rapid. This soil is very erodible. Rills are common, and deep gullies are common in drainageways. Slips are common in road cuts, ditches, and drainageways. This soil is not suitable for cultivation. The layout, construction, and maintenance of ditches and the application of lime and fertilizer are difficult and costly. Establishing a good species of grass is costly. The root zone is deep. This soil has low natural fertility. Frequently, the pasture grasses and crops suffer because of the lack of moisture in this soil.

Most of the acreage is in native pasture. A few small areas are planted to pangolagrass, and some areas are in shade-grown coffee.

Because of slope, runoff, and the erosion hazard, this soil is not suitable for cultivation. It should be maintained in permanent vegetation such as pasture grasses or trees.

Capability unit VIIe–5; woodland suitability group 3r1.

Quebrada series

The Quebrada series consists of well drained, moderately steep to very steep soils on foot slopes, side slopes, and hilltops on the strongly dissected, humid uplands. These soils formed in moderately fine textured and fine textured residuum that was derived from volcanic rock. The slope ranges from 12 to 60 percent. The annual rainfall ranges from 70 to 80 inches, and the temperature ranges from 76° to 78° F.

In a representative profile, the surface layer is dark brown silty clay loam about 7 inches thick. The subsoil is dark yellowish brown, firm silty clay about 7 inches thick. The substratum, between depths of 14 and 60 inches, is very dark brown, gray, and greenish gray, friable, slightly sticky and nonplastic silty clay loam saprolite.

Quebrada soils are moderately permeable. They have moderate to high available water capacity and high natural fertility. They are easy to work. Runoff is medium to very rapid.

These soils have been planted to food crops, shade-grown coffee, and pasture grasses. A large acreage is in native pasture of low carrying capacity. Some areas are in brushy woodland or brushy pasture.

Representative profile of Quebrada silty clay loam, 20 to 40 percent slopes, eroded, 10 meters east of dirt road, 1.7 kilometers from kilometer marker 5.9 on Highway 151:

Ap—0 to 7 inches; dark brown (10YR 3/3) silty clay loam; moderate fine and medium granular structure; hard, firm, slightly sticky and plastic; many fine roots; common fine black concretions; 10 percent, by volume, is subangular volcanic rock fragments; slightly acid; clear smooth boundary.

B—7 to 14 inches; dark yellowish brown (10YR 4/4) silty clay; weak medium subangular blocky structure; firm, slightly sticky and plastic; common fine roots; neutral; gradual wavy boundary.

C—14 to 60 inches; weathered material with variegated colors of very dark brown, gray, and greenish gray; silty clay loam; massive; friable, slightly sticky, nonplastic; neutral.

The solum is 12 to 18 inches thick. The Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 3. The B horizon has hue of 10YR, value of 4 or 5, and chroma of 4 and higher. The B horizon is silty clay or clay. The B horizon is weak fine or weak medium subangular blocky in structure.

Quebrada soils are on the same landscape as Mucara, Caguabo, Morado, and Maraguez soils. They are deeper to rock than Mucara, Caguabo, and Morado soils. They have finer textured B and C horizons than Maraguez soils.

QeD2—Quebrada silty clay loam, 12 to 20 percent slopes, eroded. This is a moderately steep soil on side slopes and rounded hilltops on the humid uplands. The areas generally are about 50 to 100 acres in size. This soil is similar to the one described as representative of the series, except it has a thicker surface layer and subsoil and has been less affected by erosion.

Included in mapping are soils on some narrow foot slopes where the slope is less than 12 percent. These soils have a much thicker surface layer than this Quebrada soil.

Runoff is medium. Erosion is a hazard. Rills are common. There are some deep gullies in drainageways. Erosion needs to be controlled if cultivated crops are grown. This soil is easy to work. The root zone is deep. This soil is fertile, and crops respond well to fertilizer.

This soil has been used for food crops, mainly corn and pigeonpeas. Some areas are in pasture grasses, mainly pangolagrass. Some areas are in shade-grown coffee and native pasture.

This soil is suitable for cultivation if properly managed using a good crop rotation and other practices to control erosion. It is suited to a wide range of crops. Pangolagrass, guineagrass, and stargrass are well adapted to this soil.

Capability unit IVe–2; woodland suitability group 2c4.

QeE2—Quebrada silty clay loam, 20 to 40 percent slopes, eroded. This is a steep soil on side slopes and hilltops on the humid uplands. It generally is in areas

of about 50 to 200 acres. This is the soil described as representative of the series.

Included in mapping are narrow strips of soils along drainageways where the slope is more than 40 percent. Also included are some areas of severely eroded soils on ridges where substratum material is in the surface layer and some areas of Mucara silty clay.

Runoff is rapid. Erosion is a hazard. Rills are common. Deep gullies are common in drainageways. This soil generally is not suitable for cultivation. Slips are common in road cuts, ditches, and drainageways. The layout, construction, and maintenance of ditches are difficult and costly. The root zone is deep. This soil is fertile, and crops respond well to fertilizer.

A large acreage is in native pasture of low carrying capacity. Some areas are in brushy pasture and brushy woodland. Other areas are planted periodically to food crops, mainly pigeonpeas.

Because of slope, runoff, and the hazard of erosion, this soil is not suitable for clean cultivation. It should be maintained in permanent vegetation of pasture grasses or trees. Pangolagrass, stargrass and guineagrass adapt well to this soil. Deferred grazing is necessary to avoid overgrazing and to control erosion.

Capability unit VIe–3; woodland suitability group 2c4.

QeF2—Quebrada silty clay loam, 40 to 60 percent slopes, eroded. This is a very steep soil on side slopes, narrow ridges, and along drainageways on the humid uplands. It generally is in areas of more than 500 acres. This soil is similar to the one described as representative of the series, except it has a thinner surface layer and subsoil.

Included in mapping are a few ridges where the soils have a large amount of rocks and boulders on the surface. Also included are some areas of Mucara silty clay loam and areas of eroded soils that have substratum material in the surface layer.

Runoff is very rapid. This soil is very erodible. Very deep gullies are common in drainageways. Slips in road cuts and ditches are common. This soil is not suitable for cultivation. The layout, construction, and maintenance of ditches, the application of fertilizer, and the establishment of a good species of grass are very difficult and costly.

Most of the acreage has been in brushy pasture and brushy woodland. Some areas are occasionally planted to food crops, mainly pigeonpeas. Some areas are in cleared native pasture.

Because of slope, runoff, and the erosion hazard, this soil should be maintained in permanent vegetation such as pasture grasses or trees.

Capability unit VIIe–2; woodland suitability group 3r1.

Reilly series

The Reilly series consists of excessively drained, nearly level soils adjacent to the rivers and streams on the humid flood plains. These soils are underlain by stratified layers of sand and gravel. They formed in medium textured and coarse textured sediment of mixed origin. Slopes are 0 to 2 percent. The annual rainfall is 60 to 80 inches, and the temperature is 76° to 78° F.

In a representative profile, the surface layer is very dark grayish brown gravelly loam about 8 inches thick. The substratum, between depths of 8 and 60 inches, is coarse sand and fine and coarse gravel.

Reilly soils are rapidly permeable. They have a low available water capacity and are easy to work. Runoff is slow.

These soils have been used mainly as pasture. Small areas adjacent to the deeper soils are planted to sugarcane, and a very small acreage has been used for food crops.

Representative profile of Reilly gravelly loam, 500 meters south of kilometer marker 1.2 on Highway 150:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) gravelly loam; weak fine granular structure; friable, slightly sticky and slightly plastic; many fine roots; medium acid; abrupt smooth boundary.

C1—8 to 16 inches; dark grayish brown (10YR 4/2) gravelly sand; 50 percent, by volume, fine gravel; single grain; slightly acid; abrupt smooth boundary.

C2—16 to 60 inches; 30 percent coarse sand and 70 percent fine and coarse gravel.

The Ap horizon is 6 to 14 inches thick. It has hue of 10YR, value of 3, and chroma of 2 or 3.

Reilly soils are on the same landscape as Toa soils. They are coarser textured and shallower than Toa soils.

Re—Reilly gravelly loam. This is a nearly level soil in narrow strips adjacent to rivers and streams on the humid flood plains. It generally is in areas of about 5 to 20 acres. In some areas this soil has stones and cobbles on the surface. Slopes are 0 to 2 percent.

Included in mapping are some small areas of Riverwash.

Runoff is slow. Erosion is not a hazard. Flooding is frequent in most years, generally from June to October. Because of the rapid permeability and low available water capacity of this soil, plants suffer from a lack of moisture in most years from December to April. Furrow irrigation is not feasible because the stability of ditchbanks is poor.

The plow layer is easy to till. Shallow plowing is needed to avoid turning the coarser material to the surface. The root zone is limited by low fertility and by the lack of moisture in the coarse textured layers below the surface layer. Fertility generally is low. The use of machinery on this soil is feasible.

Most of the acreage is in native pasture, a few areas are in pangolagrass and stargrass, and a very few acres are in food crops.

Because of frequent flooding and the low available water capacity, the use of this soil for cultivation is mainly restricted to such shallow-rooted crops as vegetables.

In most years supplementary irrigation by sprinklers is necessary. The duration and frequency of irrigation depend on the kind of vegetables grown. Pangolagrass and stargrass grow well on this soil. Merkergrass is well suited as green chop.

Capability unit IVs–1; not in a woodland suitability group.

Riverwash

Rw—Riverwash. This map unit consists of nearly level areas close to rivers and streams. It is in narrow strips and in river channels. In places, stones and boulders are numerous on the surface. Other areas consist of a mixture of sand, gravel, and cobbles.

Most areas of this map unit have no vegetation. Riverwash has no agricultural value. In general, it has severe limitations for nonfarm uses because of very frequent flooding and the large amount of coarse material on the surface.

Machinery has been set up close to the river channels to grind and separate the coarse material by sizes. This material is used in the construction of buildings and highways.

Capability unit VIIIs–2; not in a woodland suitability group.

San Anton series

The San Anton series consists of well drained, nearly level soils on flood plains in the semiarid area. These soils formed in medium textured and moderately fine textured sediment that was derived from limestone and volcanic rock. The slope ranges from 0 to 2 percent. The annual rainfall ranges from 25 to 40 inches, and the temperature ranges from 78° to 80° F.

In a representative profile, the surface layer is very dark brown clay loam about 9 inches thick. The subsurface layer is about 18 inches thick. In the upper 13 inches it is very dark brown, firm clay loam, and in the lower 5 inches it is dark brown, friable loam. The subsoil, between depths of 27 and 34 inches, is dark yellowish brown, firm silty clay loam. The substratum, between depths of 34 to 40 inches, is dark yellowish brown, friable loam; between depths of 40 and 46 inches, it is dark brown, friable loam; between depths of 46 and 52 inches, it is dark yellowish brown, friable silt loam; and between depths of 52 and 60 inches, it is dark yellowish brown, friable clay loam.

San Anton soils have moderate permeability. They have moderate to high available water capacity and high natural fertility. They are easy to work. Runoff is slow. The organic matter content is high.

For many years these soils have been planted to sugarcane under irrigation management (fig. 4). Small areas where irrigation is not feasible are used as pasture. Some areas are planted to vegetables.

Representative profile of San Anton clay loam, 9 meters west of kilometer marker 2.35 on Highway 506:

Ap—0 to 9 inches; very dark brown (10YR 2/2) clay loam; weak fine granular structure; friable, slightly sticky and slightly plastic; many fine roots; many fine rounded volcanic pebbles; moderately alkaline; abrupt smooth boundary.

A11—9 to 22 inches; very dark brown (10YR 2/2) clay loam; weak fine subangular blocky structure; firm, slightly sticky and slightly plastic; common fine roots; many fine rounded volcanic pebbles; neutral; abrupt smooth boundary.

A12—22 to 27 inches; dark brown (10YR 3/3) loam; weak fine subangular blocky

Figure 4.—**If properly managed, the San Anton soils are well suited to sugarcane. Steep and shallow Callabo soils are in the background.**

structure; friable, slightly sticky and slightly plastic; few fine roots; neutral; clear wavy boundary.

B—27 to 34 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak fine subangular blocky structure; firm, slightly sticky and slightly plastic; few fine roots; neutral; clear wavy boundary.

IIC1—34 to 40 inches; dark yellowish brown (10YR 4/4) silt loam; massive; friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary.

IIC2—40 to 46 inches; dark brown (10YR 3/3) loam; massive; friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary.

IIC3—46 to 52 inches; dark yellowish brown (10YR 4/4) silt loam; massive; friable, slightly sticky and slightly plastic; mildly alkaline; abrupt smooth boundary.

IIIC4—52 to 60 inches; dark yellowish brown (10YR 4/4) clay loam; massive; friable, slightly sticky and slightly plastic; mildly alkaline.

The solum is 28 to 42 inches thick. The A horizon has hue of 10YR, value of 2 and 3, and chroma of 2 and 3. The B horizon has hue of 10YR, value of 4, and chroma of 4 and higher. The B horizon is silt loam, clay loam, or silty clay loam. It is weak fine or weak medium subangular blocky in structure. The C horizon is clay loam, silt loam, or loam. The B and C horizons are neutral to mildly alkaline.

San Anton soils are on the same landscape as Cortada, Machuelo, Cintrona, and Constancia soils. Unlike Cortada soils, San Anton soils are noncalcareous. Unlike Machuelo and Cintrona soils, which are poorly drained and fine textured, San Anton soils are well drained and are medium textured and moderately fine textured. San Anton soils are better drained than Constancia soils.

Sa—San Anton clay loam. This is a nearly level soil on alluvial fans in the semiarid area. It is in areas of about 50 to 200 acres. Slopes are 0 to 2 percent.

Included in mapping are some areas of soils that have a silty clay loam surface layer and some small areas of the calcareous Cortada soils.

Runoff is slow. This soil is not subject to erosion. It can be used for intensive cropping without loss of soil material. It is subject to flooding in some years, generally from August to October. This soil is easy to till. Because rainfall is low and poorly distributed throughout the year, this soil needs to be irrigated. Long periods of drought are common in most years.

Land leveling or smoothing is feasible. The root zone is deep. This soil is fertile, and crops respond well to fertilizer.

This soil has mainly been used for sugarcane under irrigation management. Small areas that are not irrigated are in pasture. Some areas are in vegetables, mainly tomatoes. If irrigated, this soil is suited to sugarcane and to a wide range of vegetables and food crops.

Capability units I–2, irrigated, and IIc–1, nonirrigated; not in a woodland suitability group.

Serrano series

The Serrano series consists of poorly drained, saline, nearly level soils on the coastal plain adjacent to the beach in the semiarid area. These soils formed in coarse textured to moderately fine textured sediment over coarse textured sediment. The slope ranges from 0 to 2 percent. The annual rainfall ranges from 20 to 30 inches, and the temperature ranges from 78° to 80° F.

In a representative profile, the surface layer is very dark grayish brown sand about 4 inches thick. The subsurface layer is very dark grayish brown, friable sandy loam about 5 inches thick. The subsoil, between depths of 9 and 14 inches, is dark grayish brown, firm sandy clay loam. The substratum, between depths of 14 and 21 inches, is very dark grayish brown, friable loamy sand, and between depths of 21 and 60 inches, it is very dark gray, friable sand.

Serrano soils are rapidly permeable. They have low available water capacity and very low natural fertility. They are easy to work. Runoff is slow.

These soils have been in salt-tolerant weeds, and in some areas they are barren of vegetation.

Representative profile of Serrano sand, 3.6 kilometers south of kilometer marker 123.75, on Highway 1:

A11—0 to 4 inches; very dark grayish brown (2.5Y 3/2) sand; few fine faint dark grayish brown (10YR 4/2) mottles; single grain; very friable, nonsticky, nonplastic, many fine roots; very strongly alkaline; clear smooth boundary.

A12—4 to 9 inches; very dark grayish brown (2.5Y 3/2) sandy loam; common fine faint dark grayish brown (10YR 4/2) and many fine distinct black (N 2/) mottles; single grain; friable, nonsticky and nonplastic; common fine roots; 10 percent by volume is fine volcanic rock fragments; very strongly alkaline; clear smooth boundary.

Bg—9 to 14 inches; dark grayish brown (10YR 4/2), dark greenish gray (5GY 4/1), and brown (10YR 4/3) sandy clay loam; weak fine and medium subangular blocky structure; firm, slightly sticky and plastic; 10 percent by volume is fine volcanic rock fragments; very strongly alkaline; clear smooth boundary.

C1—14 to 21 inches; very dark grayish brown (2.5Y 3/2) loamy sand; many medium distinct brown (10YR 4/3) and many fine distinct very dark gray (5Y 3/1) mottles; single grain; friable, nonsticky and nonplastic; 10 percent by volume is strongly alkaline; clear smooth boundary.

C2—21 to 60 inches; very dark gray (5Y 3/1) sand; few fine faint dark olive gray (5Y 3/2) mottles; single grain; friable, nonsticky and nonplastic; 10 percent by volume is fine volcanic rock fragments;

water table is at 40 inches; very strongly alkaline.

The solum is 11 to 20 inches thick. The A11 horizon has hue of 10YR and 2.5Y, value of 3, and chroma of 2 or 3. The B horizon is sandy clay loam to sandy loam. Depth to the water table ranges from 30 to 42 inches. The content of fine volcanic rock fragments is 5 to 15 percent throughout the profile.

Serrano soils are on the same landscape as Teresa, Machuelo, and Meros soils. Serrano soils are coarser textured than Teresa soils. Serrano soils are coarser textured throughout the profile than Machuelo soils. Unlike Machuelo and Meros soils, Serrano soils are saline.

Se—Serrano sand. This is a nearly level soil on the coastal plains near the beach in the semiarid area. It generally is in areas of about 20 to 50 acres. This soil is saline throughout. It has 0 to 2 percent slopes.

Included in mapping are a few narrow strips of beach sands that are reworked by the waves and a few areas of nonsaline Meros soils.

Runoff is slow. Erosion is not a hazard. A large amount of harmful salts throughout the profile makes this soil not suitable for crops. The cost of reclamation is high. Drainage is needed on this soil.

In most areas this soil is barren of vegetation, and attempts to grow sugarcane have failed.

Capability unit VIIs–4; not in a woodland suitability group.

Teresa series

The Teresa series consists of somewhat poorly drained, saline, nearly level soils on coastal plains near the beach in the semiarid area. These soils formed in moderately fine, medium, and fine textured sediment of mixed origin. Slopes are 0 to 2 percent. The annual rainfall ranges from 20 to 30 inches, and the temperature ranges from 78° to 80° F.

In a representative profile, the surface layer is dark grayish brown clay about 6 inches thick. The subsurface layer, between depths of 6 and 15 inches, is very dark grayish brown, firm clay. The subsoil, between depths of 15 and 23 inches, is brown, firm silty clay loam that has gray, dark gray, and black mottles. The substratum, between depths of 23 and 34 inches, is dark gray, firm silty clay loam that has yellowish brown, black, and gray mottles; between depths of 34 and 44 inches, it is dark gray and black, firm clay that has gray and yellowish brown mottles; between depths of 44 and 50 inches, it is dark gray, firm clay that has yellowish brown, gray, and black mottles; and between depths of 50 and 60 inches, it is dark gray, friable sandy loam that has yellowish brown and black mottles.

Permeability is moderate, and the available water capacity is moderate to high. Natural fertility is very low. The concentration of salts throughout the profile is high. Runoff is very slow.

These soils have little or no agricultural value. Attempts to grow sugarcane on these soils have failed. If these soils are used for agricultural purposes, a major reclamation project is needed.

Representative profile of Teresa clay, 1 kilometer south of kilometer marker 116.3 on Highway 1:

A11—0 to 6 inches; dark grayish brown (10YR 4/2) clay; weak fine subangular blocky structure; firm, slightly sticky and plastic; many fine roots; very strongly alkaline; clear smooth boundary.

A12—6 to 15 inches; very dark grayish brown (10YR 3/2) clay; moderate fine and medium subangular blocky structure; firm, slightly sticky and plastic; common fine roots; very strongly alkaline; clear smooth boundary.

B—15 to 23 inches; brown (10YR 4/3) silty clay loam; few fine distinct dark gray (10YR 4/1), light gray (10YR 7/2), and black (10YR 2/1) mottles; weak fine and medium subangular blocky structure; firm, slightly sticky and plastic; 5 percent, by volume, is fine limestone fragments; very strongly alkaline; clear smooth boundary.

C1—23 to 34 inches; dark gray (10YR 4/1) silty clay loam; common fine distinct yellowish brown (10YR 5/6) few fine distinct black (10YR 2/1), and few fine faint gray (10YR 6/1, 5/1) mottles; massive; firm, slightly sticky and plastic; 10 percent, by volume, is fine limestone fragments; very strongly alkaline; clear smooth boundary.

C2—34 to 44 inches; dark gray (5Y 4/1) and black (10YR 2/1) clay; few fine distinct gray (10YR 6/1), and yellowish brown (10YR 5/6) mottles; massive; firm, sticky and plastic; very strongly alkaline; gradual wavy boundary.

C3—44 to 50 inches; dark gray (5Y 4/1) clay; common fine prominent yellowish brown (10YR 5/6); few fine distinct gray (10YR 6/1) and few fine prominent black (10YR 2/1) mottles; rubbed color is very dark grayish brown (2.5Y 3/2); massive; firm, slightly sticky and slightly plastic; very strongly alkaline; gradual, wavy boundary.

C4—50 to 60 inches; dark gray (5Y 4/1) sandy loam; few fine prominent yellowish brown (10YR 5/6) and black (10YR 2/1) mottles; single grain; friable, nonsticky and nonplastic; very strongly alkaline.

The solum is 16 to 30 inches thick. Salinity in the A and B horizons ranges from 12 to 22 millimhos per centimeter. The A11 horizon has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. The B horizon has hue of 10YR, value of 3 or 4, and chroma of 3. The B horizon is silty clay loam to clay in texture. It is weak medium to moderate fine and medium subangular blocky in structure. Depth to the water table ranges from 30 to 40 inches. Soil reaction ranges from pH 10.0 in the upper horizons to pH 9.0 in the lower part of the C horizon.

Teresa soils are on the same landscape as Serrano and Machuelo soils. Unlike Serrano soils, which are coarse textured and poorly drained, Teresa soils are

fine textured and somewhat poorly drained. Unlike Machuelo soils, Teresa soils are saline.

Te—Teresa clay. This is a nearly level soil on the coastal plain in the semiarid area. It is adjacent to the beach in areas of about 100 to 200 acres. It is saline throughout. Slopes are 0 to 2 percent.

Included in mapping are a few areas of Serrano sand and Tidal flats and a very few areas of the nonsaline Meros sand.

Runoff is very slow. Erosion is not a hazard. Because of the high content of salt throughout the profile, this soil is not suited to crops or pasture. Reclamation is costly, and drainage is necessary.

This soil is mostly barren of vegetation. In a few areas it is in salt-tolerant weeds. Attempts to plant this soil to sugarcane have failed. This soil has no agricultural value.

Capability unit VIs–2; not in a woodland suitability group.

Tidal flats

Tf—Tidal flats. Tidal flats are on the coastal plains in the semiarid area. They are barren, sandy areas that are periodically covered by tidal water. Some of these areas are covered permanently by saltwater; others are covered only during unusually high tides. When these areas are dry, a few inches of mud covers the surface in places, salt accumulations are common on the surface, and in places there are thin layers of fine-textured soil material that was deposited by nearby streams.

This miscellaneous area has no value for farming because of the high salt content and high water table. Reclamation is not practical. Tidal flats have severe limitations for nonfarm uses that are extremely difficult to overcome.

Capability unit VIIIs–1; not in a woodland suitability group.

Toa series

The Toa series consists of well drained, nearly level soils adjacent to rivers and streams in the humid area. These soils formed in moderately fine textured sediment of mixed origin. Slopes are 0 to 2 percent. The annual rainfall is 60 to 80 inches, and the temperature is 76° to 78° F.

In a representative profile, the surface layer is very dark grayish brown silty clay loam about 10 inches thick. The subsoil, between depths of 10 and 20 inches, is dark brown, firm clay loam, and between depths of 20 and 30 inches it is dark grayish brown, firm silty clay loam that has gray mottles. The substratum, between depths of 30 and 42 inches, is dark grayish brown and dark brown, firm silty clay loam that has gray mottles, and between depths of 42 and 60 inches it is friable clay loam that has rust and gray mottles.

Permeability is moderate, and the available water capacity is moderate to high. Natural fertility is high. These soils are easy to work. Runoff is slow.

In most areas these soils have been in sugarcane for many years. In some small areas they are planted to food crops, and in a few areas they are used as pasture.

Representative profile of Toa silty clay loam, 50 meters east of kilometer marker 2.0 on Highway 391:

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate fine granular structure; firm, slightly sticky and plastic; many fine roots; many fine volcanic rock fragments; slightly acid; clear smooth boundary.

B2—10 to 20 inches; dark brown (10YR 3/3) clay loam; weak medium subangular blocky structure; firm, slightly sticky and plastic; many fine roots; many fine volcanic rock fragments; slightly acid; clear smooth boundary.

B3—20 to 30 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine faint gray (10YR 6/1) mottles; weak fine subangular blocky structure; firm, slightly sticky and plastic; common fine roots; few fine volcanic rock fragments; slightly acid; clear smooth boundary.

C1—30 to 42 inches; 80 percent dark grayish brown (10YR 4/2), 20 percent dark brown (10YR 4/3) silty clay loam; few fine faint gray (10YR 6/1) mottles; massive; firm, slightly sticky and slightly plastic; few fine roots; slightly acid; clear smooth boundary.

C2—42 to 60 inches; dark brown (10YR 4/3) clay loam; few yellowish red (5YR 5/8) and few fine faint gray (10YR 6/1) mottles; massive; friable, slightly sticky and slightly plastic; slightly acid.

The solum is 22 to 36 inches thick. The Ap horizon has hue of 10YR, value of 3, and chroma of 2 or 3. The B2 horizon has hue of 10YR, value of 4, and chroma of 2 or 3. The B2 horizon ranges from clay loam to silty clay loam. It is weak fine or medium subangular blocky in structure.

Toa soils are on the same landscape as Reilly soils, but they have a thicker profile than Reilly soils and are finer textured throughout.

To—Toa silty clay loam. This is a nearly level soil on flood plains in the humid area. This soil generally is in narrow strips that are about 20 to 50 acres in size. Slopes are 0 to 2 percent.

Included in mapping are a few areas where this soil is closer to riverbanks that have sand and gravel between depths of 20 and 40 inches.

Runoff is slow, and erosion is not a hazard. This soil can be intensively cropped without loss of soil material. It is subject to flooding in most years, mainly from June to October. This soil is easy to till. The root zone is deep. Machinery can be used on this soil. This soil is fertile, and crops respond well to fertilizer.

This soil is used mainly for sugarcane. In some areas it is in native pasture and pangolagrass. A small acreage is planted to food crops.

This soil can be used for cultivated crops if it is managed to maintain productivity and good tilth. It is suited to sugarcane and to many food crops and vegetables. Pangolagrass and stargrass grow well on this soil. This soil is suited to merkergrass that is planted as green chop.

Capability unit I–1; not in a woodland suitability group.

Tuque series

The Tuque series consists of well drained, calcareous, moderately steep to very steep stony soils on side slopes, foot slopes, and hilltops on the semiarid uplands. These soils are shallow and very shallow to indurated caliche. They formed in fine textured residuum over gravelly, partly indurated limestone. Slopes are 12 to 60 percent. The annual rainfall is 20 to 30 inches, and the temperature is 78° to 80° F.

In a representative profile, the surface layer is dark reddish brown stony clay loam about 5 inches thick. The subsoil, between depths of 5 and 11 inches, is dark red, firm gravelly clay. The substratum, between depths of 11 and 19 inches, is very pale brown indurated caliche; between depths of 19 and 24 inches, it is strong brown, firm gravelly clay; and between depths of 24 and 60 inches, it is gravelly limestone that can be penetrated using a spade.

Permeability is very slow, and the available water capacity is low. Natural fertility is low. These soils are very difficult to work. The root zone is restricted. Runoff is rapid to very rapid.

In most areas these soils have been in brush for many years, and in some areas they are used as brushy pasture.

Representative profile of Tuque stony clay loam, 12 to 60 percent slopes, 500 meters north of kilometer marker 254.8 on Highway 2:

A1—0 to 5 inches; dark reddish brown (2.5YR 3/4) stony clay loam; weak fine granular structure; friable, slightly sticky and plastic; many fine and medium roots; many shell fragments; violent effervescence; clear broken boundary.

B2—5 to 11 inches; dark red (2.5YR 3/6) gravelly clay; weak fine and medium subangular blocky parting to weak fine granular structure; firm, slightly sticky and plastic; violent effervescence; clear broken boundary.

C1cam—11 to 19 inches; very pale brown (10YR 8/3) indurated caliche; laminar, with brownish horizontal bands; gradual broken boundary.

C2—19 to 24 inches; strong brown (7.5YR 5/6) gravelly clay; massive; firm, slightly sticky and plastic; violent effervescence; gradual wavy boundary.

C3—24 to 60 inches; gravelly limestone that can be penetrated using a spade or an auger.

Thickness of the solum and depth to caliche range from 8 to 14 inches. The caliche horizon is 4 to 8 inches thick. Gravelly limestone is at a depth between 16 and 30 inches. The soil material is 35 to 50 percent limestone fragments throughout. The surface is 25 to 40 percent rocks.

Tuque soils are on the same landscape as Aguilita soils. Unlike Aguilita soils, Tuque soils have a caliche horizon. Tuque soils are redder than Aguilita soils.

TuF—Tuque stony clay loam, 12 to 60 percent slopes. This is a moderately steep to very steep soil on foot slopes, side slopes, and hilltops on limestone uplands. The areas generally are more than 500 acres in size. Cobbles and outcrops of hard limestone on the surface are common.

Included in mapping are small areas of Aguilita soils. Also included are strips along drainageways that consist of undifferentiated soils that vary in color and depth and a few areas of soils that do not have stones on the surface.

Runoff is rapid to very rapid. Erosion is a hazard. This soil is not suitable for cultivation because of very steep slopes and the large amount of stones on the surface. The root zone is restricted by the indurated caliche. Workability is poor. Long periods of drought are common in most years. There are very few adapted species of grasses and trees on this soil because of low rainfall and the high content of calcium carbonate. Seeding and fertilizing are not practical. The layout, construction, and maintenance of ditches are difficult and costly.

Most of the acreage is in brush. Clearing this brushy land for use as pasture is costly. In a few areas, however, this soil is used as native pasture.

This soil is not suitable for cultivation because of slope, the erosion hazard, and the large amount of stones on the surface. It should be maintained in permanent vegetation to control erosion.

Capability unit VIIs–2; not in a woodland suitability group.

Yauco series

The Yauco series consists of well drained, calcareous, gently sloping and strongly sloping soils on rounded hills and foot slopes below the limestone hills in the semiarid area. Slope ranges from 2 to 12 percent. These soils formed in transported moderately fine textured sediment that was derived from limestone. The annual rainfall is 25 to 40 inches, and the temperature is 78° to 80° F.

In a representative profile, the surface layer is very dark grayish brown silty clay loam about 11 inches thick. The subsoil, between depths of 11 and 17 inches, is dark brown and very dark grayish brown, firm silty clay loam; and between depths of 17 and 21 inches, it is yellowish brown and light yellowish brown, firm silty clay loam. The substratum, between depths of 21 and 60 inches, is very pale brown soft limestone that can be easily penetrated using a spade or an auger.

Permeability is moderate, and the available water capacity is low to moderate. Natural fertility is high, and the content of organic matter in the surface layer generally is high. The root zone is restricted because of the high content of calcium carbonate.

Yauco soils have been used mainly as native pasture. In some areas, they have been planted to sugarcane.

Representative profile of Yauco silty clay loam, 2 to 5 percent slopes, 2.4 kilometers west of kilometer marker 3.05 on Highway 510:

Ap—0 to 11 inches; very dark grayish brown (10YR 3/2) silty clay loam; strong fine and medium granular structure; firm, slightly sticky and plastic; many fine roots; common fine shell, volcanic rock,

and limestone fragments; strong effervescence; clear smooth boundary.

B2ca—11 to 17 inches; 80 percent dark brown (10YR 4/3), 20 percent very dark grayish brown (10YR 3/2) silty clay loam; moderate fine and medium subangular blocky structure; firm, slightly sticky and plastic; few fine roots; common fine shell fragments; many fine calcium carbonate accumulations in the form of mycelia and pendents; violent effervescence; clear smooth boundary.

B3ca—17 to 21 inches; 50 percent yellowish brown (10YR 5/4) and 50 percent light yellowish brown (10YR 6/4) silty clay loam; weak fine subangular blocky structure; firm, slightly sticky and plastic; violent effervescence; many calcium carbonate accumulations in the form of mycelia and pendents; clear wavy boundary.

C—21 to 60 inches; very pale brown (10YR 7/3) soft limestone that can be easily penetrated using a spade or an auger.

The thickness of the solum and the depth to soft limestone range from 20 to 30 inches. The Ap horizon has hue of 10YR and value and chroma of 3 or less. The upper part of the B horizon has hue of 10YR, value of 3 and 4, and chroma of 2 and 3. The lower part of the B horizon has hue of 10YR and value and chroma of 4 or higher. The B horizon is weak to moderate and fine to medium subangular blocky in structure.

Yauco soils are on the same landscape as Aguilita and Tuque soils. Yauco soils are deeper to soft limestone than Aguilita soils and do not have gravel throughout the profile. Unlike Tuque soils, Yauco soils do not have indurated limestone.

YcB—Yauco silty clay loam, 2 to 5 percent slopes. This is a gently sloping soil on foot slopes in the semiarid area. This soil generally is below the limestone hills, and the areas are about 20 to 50 acres in size. This is the soil described as representative of the series.

Included in mapping are a few areas of soils that have about 10 to 15 percent cobbles on the surface and some narrow strips of soils that are deeper to soft limestone than this Yauco soil.

Runoff is slow. Erosion is a hazard, and it needs to be controlled if cultivated crops are grown. Land leveling or smoothing can expose the soft limestone at the surface. Irrigation is needed on this soil because of low, poorly distributed rainfall. Long periods of drought are common in most years from December to April.

The root zone is somewhat restricted by the high content of carbonates below the surface layer. Few food crops and grasses can adapt to this soil because of low rainfall and the high content of carbonates.

Most of the acreage is used as native pasture because water for irrigation is not available. In areas that are irrigated this soil is in sugarcane, which is the best adapted crop. Guineagrass and Angletongrass are among the best adapted grasses.

Capability units IIIe–4, irrigated, and IVc–3, nonirrigated; woodland suitability group 2o1.

YcC—Yauco silty clay loam, 5 to 12 percent slopes. This is a strongly sloping soil on small rounded hills and foot slopes below the limestone hills. The areas generally are about 20 to 50 acres in size. This soil is similar to the one described as representative of the series, except it has a slightly thinner surface and subsoil.

Included in mapping are many small areas of soils that have soft limestone at or near the surface and other small areas where the surface is 10 to 15 percent limestone cobbles and rocks.

Runoff is medium. Erosion is a hazard. Cultivated crops can be planted periodically, but if they are grown, erosion needs to be controlled. The choice of food crops and pasture grasses is limited because of the low, poorly distributed rainfall and because of the high content of carbonates below the surface layer. Shallow plowing is helpful. The root zone is restricted by carbonates. The use of this soil for food crops is restricted mainly to the rainy months in favorable years.

This soil generally is used as pasture. It can be used for food crops such as corn and pigeonpeas, but its use for crops is restricted to the rainy months from May to October because water is not available at other times. A very few acres are planted to sugarcane under furrow irrigation. Sprinkler irrigation can be used to control erosion if irrigation water is available. Guineagrass and Angletongrass are the best adapted grasses.

Capability units IIIe–4, irrigated, and IVc–3, nonirrigated; woodland suitability group 2o1.

Use and management of the soils

This section explains the system of capability classification used by the Soil Conservation Service and gives the estimated yields of the principal crops and pasture grasses grown in the Ponce Area. It also contains information on the use and management of the soils in the survey area for woodland, for recreation, and for engineering uses.

Crops and pasture

Some principles of management are general enough to apply to all the soils suited to crops and pasture in the survey area, though the individual soils or groups of soils require different kinds of management. These general principles of management are discussed in the following paragraphs. Use and management for each soil are discussed in the section "Description of the soils."

Many soils in this survey area need lime or fertilizer, or both. The amount needed depends on the natural content of lime and plant nutrients, which is determined by laboratory analyses of soil samples; on the needs of the crop; and on the desired level of yields. Only general suggestions for applying lime and fertilizer are given in this publication.

Tillage tends to break down structure, therefore it should be kept to the minimum necessary to prepare the seedbed and control weeds. Maintaining the organic

matter content of the plow layer helps to preserve soil structure. The organic matter content of the plow layer can be maintained by adding manure, by leaving crop residue on the surface, and by growing cover crops and green manure crops.

On wet soils, such as Machuelo clay and Cintrona clay, the yield of sugarcane can be increased by using a drainage system of open ditches and suitable outlets.

All of the gently sloping and steeper soils that are cultivated are subject to erosion. Runoff and erosion occur mostly while a cultivated crop is growing or soon after one has been harvested. On all erodible soils, a cropping system that controls runoff and erosion needs to be combined with other erosion control practices. As used here, cropping system refers to the sequence of crops grown and should be combined with management that includes minimum tillage, using crop residue, growing cover crops, and applying lime and fertilizer. Other erosion control practices are contour cultivation, terracing, contour stripcropping, diversion of runoff, and use of grassed waterways. The effectiveness of a particular combination of these measures differs from one soil to another, but different combinations can be equally effective on the same soil. The local representative of the Soil Conservation Service can assist in planning an effective combination of practices.

Pasture is effective in controlling erosion on all but a few of the soils. A high level of pasture management is needed to provide enough ground cover to keep the soil from eroding, especially on the semiarid uplands that are subject to long periods of drought. A high level of pasture management calls for fertilization, control of grazing, selection of pasture mixtures, controlled rate of stocking, and other practices that help maintain good ground cover and forage plants. Grazing is controlled by rotating the livestock from one pasture to another and resting the pasture after each grazing period to allow for regrowth of the plants. On some soils, pasture mixtures should be selected that require the least amount of renovation to provide good ground cover and forage for grazing.

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 use as range, for forest trees, or for engineering uses.

In the capability system, the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use.

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 contains only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–4 or IIIe–6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation; and the Arabic numeral specifically identifies the capability unit within each subclass.

The eight classes in the capability system and the subclasses and units in the Ponce Area are described in the list that follows.

Class I: Soils have few limitations that restrict their use.

(No subclasses).

Capability unit I–1. Nearly level, deep, well drained, slightly acid, moderately permeable soils that have a silty clay loam surface layer.

Capability unit I–2. Nearly level, deep, well drained, neutral to moderately alkaline, moderately permeable soils that have a clay loam surface layer. In the dry area; under irrigation.

Capability unit I–3. Nearly level, deep, well drained, calcareous, moderately permeable soils that have a silty clay loam surface layer. In the dry area; under irrigation.

Class II: Soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Subclass IIw: Soils moderately limited because of excess water.

Capability unit IIw–1. Nearly level, deep, somewhat poorly drained, calcareous, slowly permeable soils that have a silty clay surface layer. In the dry area; under irrigation.

Capability unit IIw–2. Nearly level to strongly sloping, deep, moderately well drained, medium acid, moderately slow permeable soils that have a clay surface layer.

Subclass IIs: Soils moderately limited because of poor workability.

Capability unit IIs–1. Gently sloping, deep, moderately well drained, neutral to moderately alkaline, slowly permeable soils that have a clay surface layer. In the dry area; under irrigation.

Capability unit IIs–2. Gently sloping, moderately deep to gravel and sand, moderately well drained, neutral, slowly permeable soils that have a clay surface layer. In the dry area; under irrigation.

Capability unit IIs–3. Gently sloping, deep, well drained, neutral, moderately slowly permeable soils that have a clay surface layer. In the dry area; under irrigation.

Subclass IIc: Soils limited by deficiency of moisture due to low rainfall and high evaporation rate.

Capability unit IIc–1. Nearly level, deep, well drained, neutral or calcareous, moderately permeable soils that have a clay loam surface layer. In the dry area; not irrigated.

Class III: Soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Subclass IIIe: Soils subject to severe erosion if they are cultivated and not protected.

Capability unit IIIe–1. Strongly sloping and moderately steep, deep, well drained and moderately well drained, strongly acid, moderately permeable soils that have a clay surface layer.

Capability unit IIIe–2. Strongly sloping, deep, moderately well drained, neutral to moderately alkaline, slowly permeable soils that have a clay surface layer. In the dry area; under irrigation.

Capability unit IIIe–3. Strongly sloping, moderately deep to volcanic rock, well drained, mildly alkaline, moderately slowly permeable soils that have a clay surface layer. In the dry area; under irrigation.

Capability unit IIIe–4. Gently sloping to strongly sloping, moderately deep to soft limestone, well drained, calcareous, moderately permeable soils that have a silty clay loam surface layer. In the dry area; under irrigation.

Capability unit IIIe–5. Strongly sloping, deep, well drained, neutral, moderately slowly permeable soils that have a clay surface layer. In the dry area; under irrigation.

Subclass IIIw: Soils severely limited for cultivation because of excess water.

Capability unit IIIw–1. Nearly level, deep, poorly drained, calcareous, slowly permeable soils that have a clay surface layer. In the dry area; under irrigation.

Subclass IIIs: Soils severely limited for cultivation by droughtiness.

Capability unit IIIs–1. Nearly level, shallow to sand and gravel, somewhat excessively drained, neutral to mildly alkaline, rapidly permeable soils that have a silty clay loam surface layer. In the dry area; under irrigation.

Subclass IIIc: Soils limited by deficiency of moisture which results from low rainfall and a high evaporation rate.

Capability unit IIIc–1. Gently sloping, moderately deep to gravel and sand, moderately well drained, neutral to moderately alkaline, slowly permeable soils that have a clay surface layer. Not irrigated.

Capability unit IIIc–2. Nearly level, deep, somewhat poorly drained, calcareous, slowly permeable soils that have a silty clay surface layer. Not irrigated.

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

Subclass IVe: Soils subject to very severe erosion if they are cultivated and not protected.

Capability unit IVe–1. Steep, deep, well drained, very strongly acid, moderately permeable soils that have a clay surface layer.

Capability unit IVe–2. Moderately steep, deep and moderately deep to volcanic rock, well drained, slightly acid and medium acid, moderately permeable soils that have a surface layer of silty clay or silty clay loam.

Capability unit IVe–3. Moderately steep, moderately deep to volcanic rock, well drained, slightly acid, moderately permeable soils that have a silty clay loam surface layer. In the dry area.

Subclass IVs: Soils very severely limited by droughtiness.

Capability unit IVs–1. Nearly level, very shallow to sand and gravel, excessively drained, medium acid, rapidly permeable soils that have a gravelly loam surface layer.

Subclass IVc: Soils limited by deficiency of moisture which results from low rainfall and a high evaporation rate.

Capability unit IVc–1. Strongly sloping, deep, moderately well drained, neutral to moderately alkaline, slowly permeable soils that have a clay surface layer. Not irrigated.

Capability unit IVc–2. Nearly level, deep, poorly drained, calcareous, slowly permeable soils that have a clay surface layer. Not irrigated.

Capability unit IVc–3. Gently sloping to strongly sloping, moderately deep to soft limestone, well drained, calcareous, moderately permeable soils that have a silty clay loam surface layer. Not irrigated.

Capability unit IVc–4. Nearly level, shallow to sand and gravel, somewhat excessively drained, neutral to mildly alkaline, rapidly permeable soils that have a silty clay loam surface layer. Not irrigated.

Capability unit IVc–5. Gently sloping to strongly sloping, deep, well drained, calcareous, moderately permeable soils that are gravelly clay throughout. Not irrigated.

Class V: Soils are not likely to erode but have other limitations, impractical to remove, that limit their use mainly to pasture, woodland, or wildlife. (None in the Ponce Area.)

Class VI: Soils have severe limitations that make

them generally unsuited to cultivation and limit their use largely to pasture, woodland, or wildlife habitat.

Subclass VIe: Soils severely limited, mainly by risk of erosion, unless protective cover is maintained.

Capability unit VIe–1. Moderately steep to very steep, deep, well drained and moderately well drained, very strongly acid, moderately permeable soils that have a clay surface layer. In the humid area.

Capability unit VIe–2. Moderately steep, shallow to gravelly soft limestone, well drained, calcareous, moderately permeable soils that have a gravelly clay loam surface layer. In the dry area.

Capability unit VIe–3. Steep, deep and moderately deep to volcanic rock, well drained, slightly acid and medium acid, moderately permeable soils that have a surface layer of clay loam, silty clay, or silty clay loam. In the humid area.

Capability unit VIe–4. Moderately steep and steep, moderately deep and shallow to volcanic rock, well drained, slightly acid to neutral, moderately permeable soils that have a surface layer of silty clay loam or clay loam. In the dry area.

Subclass VIs: Soils generally unsuitable for cultivation and limited for other uses by their low available water capacity and high content of salts.

Capability unit VIs–1. Nearly level to gently sloping, shallow to sand and gravel, excessively drained, neutral, rapidly permeable soils that have a loam surface layer. In the dry area.

Capability unit VIs–2. Nearly level, deep, somewhat poorly drained, saline, moderately permeable and slowly permeable soils that have a clay surface layer. In the dry area.

Class VII: Soils have very severe limitations that make them unsuitable for cultivation and restrict their use mainly to grazing, woodland, or wildlife habitat.

Subclass VIIe: Soils very severely limited, mainly by risk of erosion, unless protective cover is maintained.

Capability unit VIIe–1. Steep and very steep, deep, well drained and moderately well drained, very strongly acid, moderately permeable soils that have a clay or clay loam surface layer. In the humid area.

Capability unit VIIe–2. Very steep, deep and moderately deep to volcanic rock, well drained, slightly acid and medium acid, moderately permeable soils that have a clay loam or silty clay loam surface layer. In the humid area.

Capability unit VIIe–3. Steep and very steep, deep, shallow, and moderately deep to volcanic rock; well drained; slightly acid or calcareous; moderately permeable soils that have a surface layer of silty clay loam, clay loam, or clay. In the dry area.

Capability unit VIIe–4. Steep to very steep, shallow to gravelly soft limestone, well drained, calcareous, moderately permeable soils that have a gravelly clay loam surface layer. In the dry area.

Capability unit VIIe–5. Very steep, deep, somewhat excessively drained, strongly acid, moderately rapidly permeable soils that have a clay loam surface layer. In the humid area.

Subclass VIIs: Soils severely limited by droughtiness, stones, shallowness, or other soil features.

Capability unit VIIs–1. Nearly level, deep, excessively drained, neutral, very rapidly permeable sands. In the dry area.

Capability unit VIIs–2. Moderately steep to very steep, shallow to limestone, well drained, calcareous, moderately permeable soils that have a stony clay loam surface layer. In the dry area.

Capability unit VIIs–3. Steep and very steep, shallow and very shallow, well drained, neutral, moderately permeable soils that have a gravelly clay loam surface layer. In the humid area. Some of these soils have rocks on the surface.

Capability unit VIIs–4. Nearly level, deep, poorly drained, saline, rapidly permeable soils that have a sand surface layer. In the dry area.

Capability unit VIIs–5. Steep and very steep, deep and moderately deep, well drained and moderately well drained, very strongly acid, moderately permeable soils that have rocks on the surface. In area of high rainfall.

Class VIII: Soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes.

Subclass VIIIw: Extremely wet marshy land.

Capability unit VIIIw–1. Ponded areas; fresh water is on or near the surface throughout the year.

Subclass VIIIs: Coastal areas and other areas that have little potential for commercial crop production.

Capability unit VIIIs–1. Tidal flats and other saline areas.

Capability unit VIIIs–2. Riverwash.

Estimated yields

Estimated average yields per acre of the principal crops grown in the survey area under two levels of management are given in table 3. The estimated yields of the principal pasture grasses are given in table 4.

In both tables, the estimated yields in the A columns are those that can be expected under management commonly used in the survey area. Under such management, not enough lime or fertilizer is used; erosion control, drainage, and irrigation are inadequate; improved varieties of crops are not used; seedbeds are improperly prepared; weeds, insects, and plant diseases and runoff and erosion are not properly controlled; and pastures are overgrazed.

The estimated yields in the B columns are those that can be expected under high level management. High level management for cultivated crops and pasture is defined as follows:

1. Surface and internal drainage provide optimum growing conditions if natural drainage is restricted.
2. Fertilizer and lime are applied according to crop needs based on soil tests.
3. All crop residue is returned to the soil.

TABLE 3.—*Estimated average yields per acre of*

[Yields in the A columns are those expected under common management; yields in the B columns are those expected under high

arable soils

Soil	Sugarcane						Coffee			
	Fall		Spring		Ratoons		Shade		Sun	
	A	B	A	B	A	B	A	B	A	B
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Cwt*	*Cwt*	*Cwt*	*Cwt*
Alonso clay, 20 to 40 percent slopes, eroded							6	12	8	18
Alonso clay, 40 to 60 percent slopes, eroded							5	10		
Callabo silty clay loam, 12 to 20 percent slopes										
Cintrona clay	50	65	40	55	30	45				
Constancia silty clay	55	70	45	60	35	50				
Consumo clay, 40 to 60 percent slopes, eroded							4	8		
Cortada silty clay loam	60	75	50	65	40	55				
Daguey clay, 12 to 20 percent slopes							8	15	10	20
Ensenada gravelly clay, 2 to 12 percent slopes	30	40	25	35	20	25				
Fraternidad clay, 2 to 5 percent slopes	55	70	45	60	35	50				
Fraternidad clay, 5 to 12 percent slopes, eroded	40	50	30	40	25	30				
Humatas clay, 20 to 40 percent slopes, eroded							6	12	8	18
Humatas clay, 40 to 60 percent slopes, eroded							5	10		
Jacaguas silty clay loam	40	50	30	40	25	30				
Jacana clay, 5 to 12 percent slopes										
Juana Diaz clay loam, 12 to 20 percent slopes										
Lares clay, 5 to 12 percent slopes							8	15	10	20
Lirios clay loam, 40 to 60 percent slopes, eroded							4	8		
Llanos clay, 2 to 5 percent slopes										
Llanos clay, 5 to 12 percent slopes, eroded										
Los Guineos clay, 20 to 40 percent slopes							5	10	8	18
Los Guineos clay, 40 to 60 percent slopes							4	8		
Machuelo clay	50	65	40	55	30	45				
Maraguez silty clay loam, 40 to 60 percent slopes, eroded							4	8		
Maricao clay, 20 to 60 percent slopes, eroded							4	8		
Montegrande clay, 2 to 12 percent slopes	40	50	30	40	25	30				
Morado clay loam, 20 to 40 percent slopes, eroded							5	10	7	15
Morado clay loam, 40 to 60 percent slopes, eroded							4	8		
Mucara silty clay, 12 to 20 percent slopes, eroded							6	12	8	18
Mucara silty clay, 20 to 40 percent slopes, eroded							5	10	7	15
Mucara silty clay, 40 to 60 percent slopes, eroded							4	8		
Paso Seco clay, 2 to 5 percent slopes	55	70	45	60	35	50				
Pellejas clay loam, 40 to 60 percent slopes, eroded							4	8		
Quebrada silty clay loam, 12 to 20 percent slopes, eroded							6	12	8	18
Quebrada silty clay loam, 20 to 40 percent slopes, eroded							5	10	7	15
Quebrada silty clay loam, 40 to 60 percent slopes, eroded							4	8		
San Anton clay loam	60	75	50	65	40	55				
Toa silty clay loam	60	75	50	65	40	55			10	20
Yauco silty clay loam, 2 to 5 percent slopes	40	50	30	40	25	30				

principal crops under two levels of management

level management. Dashes indicate that the soil is not suited to the crop or the crop ordinarily is not grown on that soil. Only are listed]

Plantains		Bananas		Taniers		Pigeonpeas		Yams (Dioscorea)		Corn		Tomatoes		Peppers	
A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Thousands	*Thousands*	*Cwt*	*Cwt*	*Cwt*	*Cwt*	*Cwt*	*Cwt*	*Cwt*	*Cwt*	*Cwt*	*Cwt*	*Cwt*	*Cwt*	*Cwt*	*Cwt*
15	25	20	35	60	120			125	250						
								75	200						
						6	10			6	12				
										10	20	100	250	80	200
15	25	20	35	60	120			125	250						
										10	20	100	250		
										10	20	100	250		
15	25	20	35	60	120			125	250						
								75	200						
										6	12	75	200	80	200
						6	10			8	14	75	200	80	200
						6	10								
15	25	20	35	60	120			125	250	5	10			60	100
										8	16	100	250	80	200
						6	10			8	16	100	250	80	200
								100	200						
						6	10			6	12				
12	20	15	30	50	90	6	10			6	10			40	100
										10	20	100	250		
12	20	15	30	50	90	6	10			6	10			40	100
										10	20	100	250	100	200
15	25	20	35	80	120					10	20			100	200

TABLE 4.—*Estimated average yields per acre of principal pasture grasses under two levels of management*

[Yields in the A columns are those expected under common management; yields in the B columns are those expected under high level management. Dashes indicate that the soil is not suited to the crop or the crop ordinarily is not grown on that soil. Only arable soils are listed]

Soil	Stargrass		Pangolagrass		Guineagrass		Merkergrass	
	A	B	A	B	A	B	A	B
	AUM[1]	*AUM*[1]	*AUM*[1]	*AUM*[1]	*AUM*[1]	*AUM*[1]	*Tons*	*Tons*
Adjuntas clay, 40 to 60 percent slopes, eroded	15	21	15	21			30	45
Aguilita gravelly clay loam, 12 to 20 percent slopes					2	4		
Aguilita gravelly clay loam, 20 to 60 percent slopes					2	4		
Alonso clay, 20 to 40 percent slopes, eroded	15	21	15	21			30	45
Alonso clay, 40 to 60 percent slopes, eroded	15	21	15	21				
Caguabo gravelly clay loam, 20 to 60 percent slopes, eroded	8	12	8	12				
Callabo silty clay loam, 12 to 20 percent slopes					2	4		
Callabo silty clay loam, 20 to 40 percent slopes					2	4		
Callabo silty clay loam, 40 to 60 percent slopes, eroded					2	4		
Consumo clay, 40 to 60 percent slopes, eroded	15	21	15	21				
Cortada silty clay loam							30	60
Cuyon loam, 0 to 5 percent slopes					1	2		
Daguey clay, 12 to 20 percent slopes	15	21	15	21			25	50
Ensenada gravelly clay, 2 to 12 percent slopes					3	6		
Fraternidad clay, 2 to 5 percent slopes					7	14	30	60
Fraternidad clay, 5 to 12 percent slopes, eroded					7	14	30	60
Guanabano clay, 40 to 60 percent slopes					2	4		
Humatas clay, 20 to 40 percent slopes, eroded	14	21	14	21			25	50
Humatas clay, 40 to 60 percent slopes, eroded	14	21	14	21				
Humatas complex, 20 to 60 percent slopes	6	12	6	12				
Jacaguas silty clay loam					2	14	25	50
Jacana clay, 5 to 12 percent slopes					2	6		
Juana Diaz clay loam, 12 to 20 percent slopes					2	5		
Juana Diaz clay loam, 20 to 40 percent slopes					2	4		
Lares clay, 5 to 12 percent slopes	18	24	18	24			25	50
Lirios clay loam, 40 to 60 percent slopes, eroded	14	21	14	21				
Llanos clay, 2 to 5 percent slopes					2	6		
Llanos clay, 5 to 12 percent slopes, eroded					2	6		
Los Guineos clay, 20 to 40 percent slopes	13	19	13	19			25	50
Los Guineos clay, 40 to 60 percent slopes	13	19	13	19				
Maraguez silty clay loam, 40 to 60 percent slopes, eroded	7	12	7	12				
Maricao clay, 20 to 60 percent slopes, eroded	13	19	13	19				
Montegrande clay, 2 to 12 percent slopes	18	24	18	24			30	60
Morado clay loam, 20 to 40 percent slopes, eroded	7	12	7	12			25	50
Morado clay loam, 40 to 60 percent slopes, eroded	7	12	7	12				
Mucara silty clay, 12 to 20 percent slopes, eroded	18	24	18	24			25	50
Mucara silty clay, 20 to 40 percent slopes, eroded	12	18	12	18			25	50
Mucara silty clay, 40 to 60 percent slopes, eroded	7	12	7	12				
Paso Seco clay, 2 to 5 percent slopes					2	14	30	60
Pellejas clay loam, 40 to 60 percent slopes, eroded	7	10	7	10				
Quebrada silty clay loam, 12 to 20 percent slopes, eroded	18	24	18	24			25	50
Quebrada silty clay loam, 20 to 40 percent slopes, eroded	12	18	12	18			25	50
Quebrada silty clay loam, 40 to 60 percent slopes, eroded	7	12	7	12				
Reilly gravelly loam	18	24	18	24			25	50
San Anton clay loam							30	60
Toa silty clay loam	18	24	18	24			30	60
Yauco silty clay loam, 2 to 5 percent slopes					2	6		
Yauco silty clay loam, 5 to 12 percent slopes					2	6		

[1] AUM is animal-unit-months, a term used to express the carrying capacity of pasture. It is the number of months during the year that 1 acre will provide grazing for 1 animal unit (1 cow, 1 horse, 1 mule, 5 hogs, or 7 sheep) without damage to the pasture.

4. If needed, seedbeds are adequately prepared, including leveling and smoothing.
5. Crop variety, seed quality, and plant population are considered for a specific soil or location.
6. Weeds, plant diseases, and insects are adequately controlled.
7. Runoff and erosion are kept within tolerable limits.
8. The irrigation system, amount of water, and frequency of irrigation fit the crop and soil.
9. Stands are reseeded and reestablished regularly.
10. Grazing is deferred and rotated as needed.
11. The stocking rate is controlled.
12. Harvesting is timed for the highest, most economical yields.

Woodland management and productivity

Forests completely covered Puerto Rico in the early 1500's when it was colonized. By 1880, most of the forests had been cleared. Because some areas were not suitable for permanent cultivation, they were abandoned and later were invaded by inferior volunteer trees.

In many places in the survey area, woodland is an excellent use of the soils. The trees help conserve soil and water, minimize flooding, reduce the amount of soil that is lost as sediment in the rivers, and impede runoff until a time of dry weather. To use the soil as woodland some noncommercial forests should be converted to commercial forests, other noncommercial forests should be protected in their natural state, and unforested areas should be planted to trees.

In table 5, the average yearly growth per acre of trees that are important for wood crops is expressed in board feet. The trees are Honduras pine, Honduras mahogany, teak, kadam, and eucalyptus. Available data are not yet adequate to establish an accurate indication of potential productivity for each wood crop.

The rate of growth varies according to soil characteristics and location. For example, a soil that is favorable for mahogany is deep, well drained, and neutral to mildly acid. It is at an elevation of less than 1,500 feet and is protected from wind. Such a soil could be expected to produce 500 board feet per acre per year; a shallow but otherwise favorable soil, 450 board feet a year; and a shallow and slightly acid but otherwise favorable soil, 400 board feet a year. Establishing priorities for species within woodland groups is difficult because the annual growth rate and the market value differ. The annual growth rate of teak and mahogany, for example, is considerably less than that of pine and kadam, both of which grow well in Puerto Rico.

Some choices are clear in considering priority within a group. For example, for mahogany, an elevation of less than 1,500 feet and protection from the wind are necessary, but depth is not critical. For teak, an elevation of less than 1,500 feet and a well drained soil are required. For pine, a well drained, acid, moist sandy or light clay soil is required, but fertility is not critical. For kadam, a deep, moist soil is preferred, and protection from the wind is necessary. An elevation of more than 1,500 feet is necessary for eucalyptus.

Woodland suitability groups

The soils of this survey area have been placed in woodland suitability groups to help woodland owners in planning the use of the soils for wood crops. Each group is made up of soils that are suited to the same kinds of trees, that need about the same management if the vegetation is similar, and that have the same potential productivity.

Each woodland group is identified by a three-part symbol, for example, 2o1, 2c2, and 3d2. The *potential productivity* of the soils in the group is indicated by the first number in the symbol: *1* means very high; *2*, high; *3*, moderately high; *4*, moderate; and *5*, low. These ratings are based on field estimates of the potential productivity in board feet per acre per year of two kinds of trees, Honduras pine and Honduras mahogany.

The second part of the woodland group symbol is a small letter that indicates the major kind of soil limitation. The letter *o* means that the soil has few limitations that restrict its use as woodland. The letter *x* means that the use of the soil is restricted by stones or rocks. The letter *d* means that the use of the soil is restricted by the rooting depth, for example, soils that are shallow to hard rock. The letter *c* means that the use of the soil is restricted by the amount of clay in the upper part of the soil. The letter *r* means that the use of the soil is restricted by the steepness of slopes.

The last part of the symbol is a number that indicates a difference in management. For example, the soils in woodland group 2c1 require management that differs from that required by the soils in group 2c2.

In table 5 the soils that are suitable for commercial production of wood crops are rated for various management hazards or limitations. *Slight, moderate,* and *severe* are used to indicate the degree of the limitation.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if some measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings. Plant competition is not considered in the ratings. Seedlings from good planting stock that are properly planted during a period of sufficient rainfall are rated. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 per-

TABLE 5.—*Woodland management and productivity*

[Only soils suitable for production of commercial trees are listed]

Soil	Woodland group	Potential productivity		Limitations		
		Important trees	Annual growth per acre	Erosion hazard	Equipment limitation	Seedling mortality
			Board feet			
Adjuntas clay, 40 to 60 percent slopes, eroded.	3r1	Honduras pine Teak Honduras mahogany	900 250 300	Severe	Severe	Slight.
Aguilita gravelly clay loam, 12 to 20 percent slopes.	2x1	Honduras mahogany Teak	400 500	Slight	Slight	Moderate.
Aguilita gravelly clay loam, 20 to 60 percent slopes.	3x1	Honduras mahogany Teak	300 500	Severe	Severe	Moderate.
Aguilita stony clay loam, 20 to 60 percent slopes.	3x1	Honduras mahogany Teak	300 500	Severe	Severe	Moderate.
Alonso clay, 20 to 40 percent slopes, eroded.	2c1	Honduras pine Eucalyptus Kadam	1,350 2,000 1,800	Moderate	Moderate	Slight.
Alonso clay, 40 to 60 percent slopes, eroded.	3c1	Honduras pine Eucalyptus Kadam	1,100 2,000 1,800	Severe	Severe	Slight.
Caguabo gravelly clay loam, 20 to 60 percent slopes, eroded.	4d1	Honduras pine	700	Severe	Severe	Moderate.
Callabo silty clay loam, 12 to 20 percent slopes.	3d1	Honduras mahogany	250	Moderate	Moderate	Moderate.
Callabo silty clay loam, 20 to 40 percent slopes.	3d1	Honduras mahogany	250	Moderate	Moderate	Moderate.
Callabo silty clay loam, 40 to 60 percent slopes, eroded.	4d2	Honduras mahogany	200	Severe	Severe	Moderate.
Consumo clay, 40 to 60 percent slopes, eroded.	3c1	Honduras pine Teak	1,100 250	Severe	Severe	Slight.
Daguey clay, 12 to 20 percent slopes	2c2	Honduras pine Teak	1,300 500	Slight	Moderate	Slight.
Humatas clay, 20 to 40 percent slopes, eroded.	2c1	Honduras pine Teak	1,100 400	Moderate	Moderate	Slight.
Humatas clay, 40 to 60 percent slopes, eroded.	3c1	Honduras pine	900	Severe	Severe	Slight.
Humatas complex, 20 to 60 percent slopes.	3c1	Honduras pine	900	Severe	Severe	Slight.
Jacana clay, 5 to 12 percent slopes	2d1	Honduras mahogany	400	Slight	Slight	Slight.
Juana Diaz clay loam, 12 to 20 percent slopes.	3d1	Honduras mahogany	300	Moderate	Moderate	Moderate.
Juana Diaz clay loam, 20 to 40 percent slopes.	3d1	Honduras mahogany	300	Moderate	Moderate	Moderate.
Lares clay, 5 to 12 percent slopes	2c2	Honduras pine Teak	1,300 500	Slight	Moderate	Slight.
Lirios clay loam, 40 to 60 percent slopes, eroded.	3c1	Honduras pine Teak	900 250	Severe	Severe	Slight.

TABLE 5.—*Woodland management and productivity*—Continued

Soil	Woodland group	Potential productivity		Limitations		
		Important trees	Annual growth per acre	Erosion hazard	Equipment limitation	Seedling mortality
			Board feet			
Los Guineos clay, 20 to 40 percent slopes.	2c1	Honduras pine Eucalyptus Kadam	1,400 2,000 1,800	Moderate	Moderate	Slight.
Los Guineos clay, 40 to 60 percent slopes.	2c3	Honduras pine Eucalyptus Kadam	1,300 2,000 1,800	Moderate	Severe	Slight.
Los Guineos-Maricao association, steep	2c3	Honduras pine Eucalyptus Kadam	1,300 2,000 1,800	Severe	Severe	Slight.
Los Guineos-Maricao-Stony rock land association, steep.	3x2	Honduras pine Eucalyptus Kadam	1,100 1,800 1,600	Moderate	Severe	Slight.
Maraguez silty clay loam, 40 to 60 percent slopes, eroded.	3r1	Honduras pine Mahogany Kadam	800 400 1,400	Severe	Severe	Slight.
Maricao clay, 20 to 60 percent slopes, eroded.	2c3	Honduras pine Eucalyptus	1,300 2,000	Severe	Severe	Slight.
Morado clay loam, 20 to 40 percent slopes, eroded.	3d2	Honduras pine Mahogany Kadam	800 400 1,400	Moderate	Moderate	Slight.
Morado clay loam, 40 to 60 percent slopes, eroded.	3d3	Honduras pine Mahogany Kadam	800 400 1,400	Severe	Severe	Slight.
Mucara silty clay, 12 to 20 percent slopes, eroded.	3d2	Honduras pine Mahogany Kadam	900 400 1,400	Moderate	Moderate	Slight.
Mucara silty clay, 20 to 40 percent slopes, eroded.	3d2	Honduras pine Mahogany Kadam	900 400 1,400	Moderate	Moderate	Slight.
Mucara silty clay, 40 to 60 percent slopes, eroded.	3d3	Honduras pine Mahogany Kadam	900 400 1,400	Severe	Severe	Slight.
Pellejas clay loam, 40 to 60 percent slopes, eroded.	3r1	Honduras pine Teak Mahogany	1,000 250 300	Severe	Severe	Slight.
Quebrada silty clay loam, 12 to 20 percent slopes, eroded.	2c4	Honduras pine Mahogany	1,100 450	Moderate	Moderate	Slight.
Quebrada silty clay loam, 20 to 40 percent slopes, eroded.	2c4	Honduras pine Mahogany	1,100 450	Moderate	Moderate	Slight.
Quebrada silty clay loam, 40 to 60 percent slopes, eroded.	3r1	Honduras pine Mahogany	1,000 275	Severe	Severe	Slight.
Yauco silty clay loam, 2 to 5 percent slopes.	2o1	Honduras mahogany	500	Slight	Slight	Slight.
Yauco silty clay loam, 5 to 12 percent slopes.	2o1	Honduras mahogany	500	Slight	Slight	Slight.

cent; *moderate,* 25 to 50 percent; and *severe,* more than 50 percent.

Recreation

The soils of the survey area are rated in table 6 according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration of flooding and the season when flooding occurs. Onsite assessment of height, duration, and frequency of flooding is essential in planning recreation facilities.

In table 6 the limitations of soils are rated as moderate or severe. *Moderate* indicates that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* indicates that the soil properties are not favorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 6 can be supplemented by additional information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, dwellings without basements, and local roads and streets, which are given in table 8.

Camp areas require such site preparation as shaping and leveling tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet nor subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet nor subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over rock should be sufficient to allow necessary grading.

Paths and trails for walking, horseback riding, and bicycling should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Engineering uses of the soils

This section is useful to planning commissions, town and city managers, land developers, engineers, contractors, farmers, and others who need information about soils that are used as structural material or as a foundation on which structures are built.

Among the properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who–

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the soils on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables. Table 7 shows estimated soil properties significant in engineering. Table 8 gives interpretations for various engineering uses. Table 9 shows the results of engineering laboratory tests on soil samples.

This information, along with the soil map and data in other parts of this publication, can be used to make interpretations, in addition to those given in tables 7 and 8, and to make useful maps.

This information, however, does not eliminate the need for further investigation at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths of more than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil can include small areas of other soils that have strongly contrasting properties and different suitability or limitations for soil engineering.

[2] PEDRO CATONI, engineer, Soil Conservation Service, helped to prepare this section.

TABLE 6.—*Recreation*

Soil and map symbols	Degree and kind of limitation for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Adjuntas: AaF2	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.
Aguilita: AgD, AgF, AhF	Severe: slope, coarse fragments.	Severe: slope, coarse fragments.	Severe: slope	Severe: slope, coarse fragments on surface.
Alonso: AnE2, AnF2	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.
Caguabo: CbF2, CdF	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Callabo: CoD, CoE, CoF2	Severe: slope	Severe: slope	Severe: slope	Moderate if slope is 12 to 25 percent; severe if slope is more than 25 percent.
Cintrona: Cr	Severe: flooding, surface soil texture, poorly drained.	Severe: flooding, surface soil texture, poorly drained.	Severe: flooding, surface soil texture, poorly drained.	Severe: poorly drained, surface soil texture.
Constancia: Ct	Severe surface soil texture, somewhat poorly drained, flooding.	Severe: surface soil texture, somewhat poorly drained, flooding.	Severe: surface soil texture, somewhat poorly drained, flooding.	Severe: surface soil texture.
Consumo: CuF2	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.
Cortada: Cx	Moderate: surface soil texture, flooding.	Moderate: surface soil texture, flooding.	Moderate: surface soil texture, flooding.	Moderate: surface soil texture.
Cuyon: CyB	Severe: flooding	Severe: flooding	Severe: flooding	Moderate: flooding.
Daguey: DaD	Severe: surface soil texture, slope.	Severe: surface soil texture, slope.	Severe: surface soil texture, slope.	Severe: surface soil texture, slope.
Ensenada: EnC	Severe: surface soil texture, coarse fragments.	Severe: surface soil texture, coarse fragments.	Severe: surface soil texture, coarse fragments.	Severe: surface soil texture, coarse fragments on surface.
Fe: Fe	Severe: permeability, surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture.
Fraternidad: FtB, FtC2	Severe: surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture, permeability.	Severe: surface soil texture.
Guanabano: GoF	Severe: slope, coarse fragments.	Severe: slope, coarse fragments.	Severe: slope, coarse fragments.	Severe: slope, coarse fragments on surface.
Humatas: HmE2, HmF2, HxF.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.
Hydraquents: Hy. Soil material too variable for interpretations.				
Hydraquents, saline: Hz	Severe: very poorly drained.	Severe: very poorly drained.	Severe: very poorly drained.	Severe: very poorly drained.
Jacaguas: Jg	Moderate: flooding surface soil texture.	Moderate: flooding, surface soil texture.	Moderate: flooding, surface soil texture.	Moderate: surface soil texture.
Jacana: JnC	Severe: surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture, permeability.	Severe: surface soil texture.
Juana Diaz: JzD, JzE	Severe: slope	Severe: slope	Severe: slope	Moderate if slope is 12 to 25 percent; severe if slope is more than 25 percent.

TABLE 6.—*Recreation*—Continued

Soil and map symbols	Degree and kind of limitation for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Lares: LeC	Severe: surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture.
Lirios: LmF2	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Llanos: LnB, LnC2	Severe: surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture.
Los Guineos: LuE, LuF, LyFX, LzFX.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.
Machuelo: Ma	Severe: poorly drained, surface soil texture, flooding.	Severe: poorly drained, surface soil texture, flooding.	Severe: poorly drained, surface soil texture, flooding.	Severe: poorly drained, surface soil texture.
Maraguez: MeF2	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Maricao: MkF2	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.
Meros: Mr	Moderate: surface soil texture.	Moderate: surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture.
Montegrande: MsC	Severe: surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture.
Morado: MtE2, MtF2	Severe: slope	Severe: slope	Severe: slope	Moderate if slope is 12 to 25 percent; severe if slope is more than 25 percent.
Mucara: MuD2, MuE2, MuF2.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.	Severe: slope, surface soil texture.
Paso Seco: PaB	Severe: surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture, permeability.	Severe: surface soil texture.
Pellejas: PeF2	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Quebrada: QeD2, QeE2, QeF2.	Severe: slope	Severe: slope	Severe: slope	Moderate if slope is 12 to 25 percent; severe if slope is more than 25 percent.
Reilly: Re	Severe: flooding	Severe: flooding	Severe: flooding	Moderate: flooding.
Riverwash: Rw	Severe: flooding, coarse fragments, stones.	Severe: flooding, coarse fragments, stones.	Severe: flooding, coarse fragments on surface, stones.	Severe: flooding, coarse fragments on surface, stones.
San Anton: Sa	Moderate: flooding, surface soil texture.	Moderate: flooding surface soil texture.	Moderate: flooding, surface soil texture.	Moderate: flooding, surface soil texture.
Serrano: Se	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.
Teresa: Te	Severe: surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture.	Severe: surface soil texture.
Tidal flats: Tf. Soil material too variable for interpretations.				
Toa: To	Moderate: flooding, surface soil texture.	Moderate: flooding, surface soil texture.	Moderate: flooding, surface soil texture.	Moderate: flooding, surface soil texture.
Tuque: TuF	Severe: slope, coarse fragments.	Severe: slope, coarse fragments.	Severe: slope, coarse fragments.	Severe: coarse fragments on surface.

TABLE 6.—*Recreation*—Continued

Soil and map symbols	Degree and kind of limitation for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Yauco: YcB, YcC	Moderate: surface soil texture.	Moderate: surface soil texture.	Moderate if slope is 2 to 6 percent; severe if slope is more than 6 percent: surface soil texture.	Moderate: surface soil texture.

Some of the terms used in this soil survey have a special meaning in soil science. The Glossary defines many of these terms.

Soil properties significant in engineering

Several estimated soil properties significant in engineering are given in table 7. 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 survey areas. Following are explanations of some of the column headings in table 7.

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

Depth to seasonal high water table is distance from the surface of the drained soil to the highest level that ground water reaches in the soil in most years.

Soil *texture* is described in table 7 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used are defined in the Glossary of this soil survey.

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*2*) used by SCS engineers, the Department of Defense, and others and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

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

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As an 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 AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 9; the estimated classification, without group index numbers, is given in table 7 for all soils mapped in the survey area.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from semisolid to plastic. If the moisture content is further increased, the material changes from plastic to liquid. The plastic limit is the moisture content at which the soil material changes from semisolid to plastic; and the liquid limit, from plastic to liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. The data on liquid limit and plasticity index in table 7 are estimates, but in table 9 they are based on tests of soil samples.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 7 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume of soil material to be expected with changes in moisture content, that is, the extent to which the soil

TABLE 7.—*Estimated soil properties*

[The symbol > means more than; < means less than.

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Feet	*Feet*	*Inches*				*Percent*
Adjuntas: AaF2	4–6	>5	0–24	Clay	MH	A–7	
			24–48	Strongly and partly weathered volcanic rock.			
Aguilita: AgD, AgF, AhF	>5	>5	0–13	Gravelly clay loam	GC, ML, CL	A–2, A–6 A–7	5–80
			13–60	Gravelly limestone that is more than 50 percent hard limestone fragments.			
Alonso: AnE2, AnF2	>5	>5	0–60	Clay	MH	A–7	
Caguabo: CbF2, CdF	1–1.5	>5	0–12	Gravelly clay loam	GM	A–2	0–20
			12–17	Highly weathered and partly weathered volcanic rock.			
			17	Hard, semiconsolidated volcanic rock.			
Callabo: CoD, CoE, CoF2	2–3	>5	0–13	Silty clay loam	MH	A–7	0–10
			13–19	Clay loam	ML, CL	A–7	0–10
			19–27	Highly weathered volcanic rock.			
			27	Semiconsolidated volcanic rock.			
Cintrona: Cr	>5	3–5	0–60	Clay	CH	A–7	
Constancia: Ct	>5	3–5	0–65	Silty clay, clay	MH, CH	A–7	
Consumo: CuF2	>5	>5	0–60	Clay, silty clay	MH	A–7	
Cortada: Cx	>5	>5	0–28	Silty clay loam	CL, ML	A–7	
			28–68	Silt loam	ML	A–4	
Cuyon: CyB	>5	>5	0–11	Loam	ML	A–4	
			11–60	Sand and gravel	GP, GM	A–1	0–50
Daguey: DaD	>5	>5	0–60	Clay	MH	A–7	
Ensenada: EnC	>5	>5	0–60	Gravelly clay	GC	A–2	0–30
Fe: Fe	>5	>5	0–60	Clay	CH	A–7	0–5
Fraternidad: FtB, FtC2	>5	>5	0–60	Clay	CH	A–7	
Guanabano: GoF	4–6	>5	0–11	Clay	MH, CH	A–7	10–20
			11–50	Silty clay loam	MH, CL	A–7	0–10
			50–60	Gravelly silty clay loam	GM, ML	A–4	0–25
Humatas: HmE2, HmF2, HxF	>5	>5	0–60	Clay	MH	A–7	
Hydraquents: Hy. Properties too variable to be estimated.							
Hydraquents, saline: Hz. Properties too variable to be estimated.							
Jacaguas: Jg	>5	>5	0–14	Silty clay loam	CL	A–6	5–10
			14–60	Very cobbly clay loam	GC, SC, CL	A–4, A–2	30–70
Jacana: JnC	2–3	>5	0–27	Clay	MH, CH	A–7	
			27	Weathered volcanic rock.			

See footnote at end of table.

significant in engineering

Corrosivity estimates apply to the entire soil profile]

Percentage passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
						Inches per hour	*Inches per inch of soil*	*pH*			
95–100	95–100	85–95	70–90	55–60	15–20	0.6–2.0	0.11–0.14	4.5–5.5	Moderate	High	High.
40–80	30–80	25–75	25–50	25–50	10–20	0.6–2.0	0.08–0.10	7.9–8.4	Moderate	Low	Low.
100	100	85–100	85–95	60–70	15–25	0.6–2.0	0.12–0.15	4.5–5.5	Moderate	Moderate	High.
30–50	25–45	20–40	15–35	55–65	17–22	0.6–2.0	0.06–0.10	6.1–6.5	Moderate	Low	Low.
90–100	90–100	85–95	80–90	55–60	20–25	0.6–2.0	0.12–0.16	6.1–7.3	Moderate	Low	Low.
85–100	85–100	75–90	55–70	40–45	10–15	0.6–2.0	0.12–0.16	6.1–7.3	Moderate	Low	Low.
100	100	90–100	80–95	75–80	45–50	0.06–0.2	0.14–0.16	6.6–8.4	High	High	Low.
100	95–100	85–95	70–90	75–85	40–50	0.06–0.2	0.10–0.14	7.9–8.4	High	High	Low.
100	100	95–100	75–90	70–76	26–30	0.6–2.0	0.14–0.16	4.5–5.0	Moderate	High	High.
100	100	95–100	85–95	40–45	15–20	0.6–2.0	0.10–0.14	7.9–8.4	Moderate	Low	Low.
100	100	90–100	70–90	30–40	4–6	2.0–6.0	0.08–0.10	7.9–8.4	Low	Low	Low.
95–100	95–100	80–90	55–70	30–40	4–8	2.0–6.0	0.07–0.09	6.6–7.8	Low	Low	Low.
20–30	15–20	10–15	5–10	[1] NP	[1] NP	>20.0	<0.05	6.6–7.8	Low	Low	Low.
100	100	90–100	75–95	70–90	25–40	0.6–2.0	0.12–0.15	4.5–5.5	Moderate	High	High.
35–65	35–65	26–65	20–60	40–50	20–24	0.6–2.0	0.07–0.09	7.9–8.4	Low	High	Low.
90–100	75–100	70–99	65–90	70–85	45–50	0.06–0.2	0.15–0.18	7.9–9.0	High	High	High.
100	100	90–100	75–95	75–85	50–60	0.06–0.2	0.15–0.18	6.1–7.8	High	High	Low.
85–100	85–100	75–85	60–80	70–80	35–45	0.6–2.0	0.13–0.16	7.9–8.4	High	High	Low.
85–100	85–100	75–85	60–80	40–60	10–30	0.6–2.0	0.13–0.16	7.9–8.4	Moderate	Low	Low.
45–60	45–60	45–60	45–60	30–40	4–10	0.6–2.0	0.11–0.13	7.9–8.4	Low	Low	Low.
100	100	85–100	75–100	65–85	20–36	0.6–2.0	0.12–0.16	4.5–5.0	Moderate	High	High.
100	100	90–100	65–95	30–40	15–20	0.6–2.0	0.08–0.10	6.6–7.8	Low	Low	Low.
55–85	50–80	25–75	20–60	20–30	5–10	>20.0	<0.05	6.6–7.3	Low	Low	Low.
100	100	90–100	70–95	65–75	30–40	0.2–0.6	0.12–0.14	7.4–7.8	High	High	Low.

TABLE 7.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Feet	*Feet*	*Inches*				
Juana Diaz: JzD, JzE	1–1.5	>5	0–12	Clay loam	ML, CL	A–6	
			12–18	Silt loam	ML, CL–ML	A–4	
			18	Semiconsolidated sandstone.			
Lares: LeC	>5	2.5–5.0	0–60	Clay	MH	A–7	
Lirios: LmF2	>5	>5	0–28	Clay	MH	A–7	
			28–60	Clay loam	ML, CL	A–4	
Llanos: LnB, LnC2	>5	>5	0–29	Clay	CH	A–7	
			29–50	Clay loam, sandy clay loam	CL, ML	A–7	
			50–60	Sandy loam	SM–SC	A–2, A–4	0
Los Guineos: LuE, LuF, LyFX, LzFX.	>5	>5	0–72	Clay	MH	A–7	
Machuelo: Ma	>5	1.5–3	0–60	Clay	CH	A–7	
Maraguez: MeF2	>5	>5	0–12	Silty clay loam, clay loam	MH	A–7	
			12–60	Loam	ML	A–4	
Maricao: MkF2	>5	>5	0–60	Clay	MH	A–7	
Meros: Mr	>5	>5	0–60	Sand	SP–SM, SM	A–3, A–2	
Montegrande: MsC	>5	2.5–5	0–25	Clay	CH	A–7	
			25–60	Gravelly clay	GM–GC	A–2	
Morado: MtE2, MtF2	1.5–3	>5	0–30	Clay loam	CL	A–7	
			30	Semiconsolidated volcanic rock.			
Mucara: MuD2, MuE2, MuF2	2–3	>5	0–19	Silty clay	MH, CH	A–7	
			19–30	Weathered volcanic rock.			
			30	Semiconsolidated volcanic rock.			
Paso Seco: PaB	>5	>5	0–32	Clay	CH	A–7	
			32–60	Gravelly loam	GM	A–1	10–40
Pellejas: PeF2	>5	>5	0–15	Clay loam	CL	A–7	
			15–60	Loamy sand	SM	A–2	
Quebrada: QeD2, QeE2, QeF2	>5	>5	0–14	Silty clay loam, silty clay	MH	A–7	0–10
			14–60	Silty clay loam	CL	A–6	
Reilly: Re	>5	2.5–5	0–8	Gravelly loam	GM	A–2	0–5
			8–60	Sand and gravel	GP	A–1	0–20
Riverwash: Rw. Properties too variable to be estimated.							
San Anton: Sa	>5	>5	0–34	Clay loam, silty clay loam	CL	A–6	
			34–60	Silt loam, loam	CL	A–4	
Serrano: Se	>5	2.5–3.5	0–21	Sandy loam	SM	A–2	
			21–60	Sand	SW–SM, SM	A–2	
Teresa: Te	>5	2.5–3.5	0–50	Clay, silty clay loam	CH, MH	A–7	
			50–60	Sandy loam	SM, SP–SM	A–2, A–4	
Tidal flats: Tf. Properties too variable to be estimated.							

significant in engineering—Continued

Percentage passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
						Inches per hour	*Inches per inch of soil*	*pH*			
100	100	90–100	70–80	30–45	10–20	0.6–2.0	0.07–0.09	6.6–7.3	Low	Low	Low.
100	100	90–100	70–90	25–30	4–8	2.0–6.0	0.07–0.09	7.4–7.8	Low	Low	Low.
100	100	90–100	75–95	55–70	15–25	0.6–2.0	0.09–0.11	4.5–5.5	Moderate	High.	High.
100	100	90–100	75–95	60–70	20–29	0.6–2.0	0.10–0.14	4.5–5.0	Moderate	High	High.
100	100	90–100	70–90	30–40	10–15	2.0–6.0	0.07–0.10	4.5–5.0	Low	High	High.
90–100	85–100	80–90	65–85	60–70	30–40	0.2–0.6	0.13–0.16	6.6–7.3	High	High	Low.
90–100	85–100	75–85	50–60	40–45	15–20	0.2–0.6	0.13–0.16	7.4–7.8	Moderate	Moderate	Low.
100	100	60–70	20–40	10–20	4–6	2.0–6.0	0.03–0.05	7.4–7.8	Low	Low	Low.
100	100	95–100	75–95	55–70	11–20	0.6–2.0	0.12–0.15	4.5–5.5	Moderate	High	High.
100	100	90–100	75–95	60–100	30–50	0.06–0.2	0.13–0.16	7.4–8.4	High	High	Low.
100	100	95–100	85–95	50–60	20–30	0.6–2.0	0.09–0.11	5.6–6.5	Moderate	Low	Low.
100	100	85–95	60–75	35–50	6–15	2.0–6.0	0.08–0.10	5.6–6.5	Low	Low	Low.
100	100	90–100	75–95	60–75	25–30	0.6–2.0	0.14–0.16	4.5–5.0	Moderate	High	High.
100	100	50–70	5–15	NP	NP	>20.0	<0.05	6.6–8.4	Low	Low	Low.
100	100	90–100	75–95	70–80	50–60	0.2–0.6	0.15–0.17	5.1–6.5	High	High	Low.
45–55	45–55	35–45	30–35	28–32	10–15	0.6–2.0	0.10–0.12	7.4–8.4	Moderate	Moderate	Low.
100	100	90–100	70–80	40–50	20–30	0.6–2.0	0.11–0.13	6.1–7.3	Moderate	Moderate	Low.
100	100	90–100	80–90	60–75	30–35	0.6–2.0	0.15–0.17	5.6–6.5	High	High	Low.
90–100	90–100	80–90	65–85	55–60	40–45	0.06–0.2	0.15–0.18	6.6–7.8	High	High	Low.
40–65	40–65	25–50	12–20	NP	NP	2.0–6.0	0.06–0.08	7.4–7.8	Low	Low	Low.
100	100	90–100	70–80	40–50	20–30	2.0–6.0	0.11–0.15	4.5–5.5	Low	Low	High.
100	100	50–75	15–30	NP	NP	6.0–20.0	0.06–0.08	4.5–5.5	Low	Low	High.
90–100	80–100	80–95	80–95	55–65	15–25	0.6–2.0	0.12–0.14	5.6–7.3	Moderate	Moderate	Low.
90–100	90–100	80–95	75–85	30–40	12–25	0.6–2.0	0.12–0.14	5.6–7.3	Low	Moderate	Low.
40–70	60–70	50–70	20–50	32–40	4–8	2.0–6.0	0.06–0.07	5.6–6.5	Low	Low	Moderate.
25–40	20–40	5–10	0–4	NP	NP	>20.0	<0.05	5.6–6.5	Low	Low	Moderate.
90–95	85–90	75–90	60–85	30–40	15–20	0.6–2.0	0.11–0.14	6.6–8.4	Moderate	Low	Low.
100	100	85–100	60–90	20–30	5–10	2.0–6.0	0.09–0.11	6.6–8.4	Low	Low	Low.
90–95	85–90	50–65	25–35	5–10	NP	6.0–20.0	0.04–0.05	9.0–10.0	Low	High	Low.
90–95	85–90	40–65	5–15	NP	NP	>20.0	<0.05	9.0–10.0	Low	High	Low.
100	100	90–100	75–95	65–75	35–45	0.2–0.6	0.10–0.14	9.0–10.0	High	High	Low.
100	100	50–70	10–40	NP	NP	6.0–20.0	<0.05	8.5–9.0	Low	High	Low.

TABLE 7.—*Estimated soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	Feet	*Feet*	*Inches*				
Toa: To	>5	2.5–5	0–60	Silty clay loam, clay loam	CL	A–7	
Tuque: TuF	>5	>5	0–11	Gravelly clay	GC	A–6	25–40
			11–19	Hard caliche.			
			19–60	Gravelly limestone.			
Yauco: YcB, YcC	>5	>5	0–21	Silty clay loam	ML, CL	A–7	0–10
			21–60	Soft limestone	ML, CL	A–4	0–25

[1] NP means nonplastic.

shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to the maintenance of structures built in, on, or with material having this rating.

Corrosivity pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity 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 and that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Engineering interpretations of the soils

The estimated interpretations in table 8 are based on the engineering properties of the soils shown in table 7, 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 in the Ponce Area. In table 8, ratings are used to summarize limitations or suitability of the soils for all listed purposes other than for drainage of cropland and pasture, irrigation, ponds and reservoirs, embankments, and terraces and diversions. For these particular uses, table 8 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* indicates that soil properties generally are favorable for the rated use, or in other words, the limitations are minor and easily overcome. *Moderate* indicates that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* indicates that soil properties are so unfavorable and so difficult to correct or overcome that major soil reclamation and special designs are required.

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

Following are explanations of some of the columns in table 8.

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 affects layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage, within a depth of 2 to 5 feet, long enough for bacteria to decompose the solids. A lagoon has a nearly level floor; its sides, or embankments, are of soil material compacted to medium density, and the pond is protected from flooding. Properties that affect the pond floor are permeability, organic matter content, and slope; if the floor needs to be leveled, depth to bedrock is a concern. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified system and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, for example, excavations for pipelines, sewer lines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence

significant in engineering—Continued

Percentage passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
						Inches per hour	*Inches per inch of soil*	*pH*			
100	100	95–100	85–95	40–45	16–21	0.6–2.0	0.12–0.14	6.1–6.5	Moderate	Moderate	Low.
40–65	40–60	40–50	40–50	30–50	10–20	6.0–20.0	0.07–0.09	7.9–8.4	Low	High	Low.
95–100	95–100	85–95	70–90	40–45	15–25	0.6–2.0	0.14–0.18	7.9–8.4	Moderate	Moderate	Low.
95–100	95–100	95–100	70–95	25–35	5–15	2.0–6.0	0.10–0.13	7.9–8.4	Low.		

of rock outcrops or large stones, and freedom from flooding or absence of a high water table.

Dwellings without basements, as rated in table 8, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load and to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 8 apply only to the soil material to a depth of about 6 feet, so a limitation of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet; nevertheless, every site should be investigated before it is selected.

Local roads and streets, as rated in table 8, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material and the shrink-swell potential indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Roadfill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 8 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source generally has a layer of sand or gravel at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, nor do they indicate quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as in preparing a seedbed; natural fertility of the material or plant response when fertilizer is added to the soil; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments affect suitability. Also considered in the ratings is damage that will result at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for use as pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Dikes, levees, and embankments require soil material that is resistant to seepage and piping and that is of favorable stability, shrink-swell potential, shear strength, and compactability. Stones or organic material in a soil are among factors that are unfavorable.

Drainage of cropland and pasture is affected by such soil properties as permeability, texture, and structure;

TABLE 8.—*Interpretations of*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills	Local roads and streets
Adjuntas: AaF2	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Aguilita: AgD, AgF, AhF	Severe: slope.	Severe: slope, moderate permeability, coarse fragments.	Severe: slope, stones.	Severe: slope, stones.	Severe: moderate permeability, stones.	Severe: slope, stones.
Alonso: AnE2, AnF2	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Moderate if slope is 12 to 25 percent. Severe if more than 25 percent.	Severe: slope.
Caguabo: CbF2, CdF	Severe: slope, shallow to hard rock.	Severe: slope, shallow to bedrock.	Severe: slope, shallow to bedrock.	Severe: slope, shallow to bedrock.	Severe: slope, shallow to bedrock.	Severe: slope, shallow to bedrock.
Callabo: CoD, CoE, CoF2	Severe: slope, moderately deep to hard rock.	Severe: moderately deep to bedrock, slope.	Severe: slope, moderately deep to bedrock.	Severe: slope.	Severe: moderately deep to bedrock, slope.	Severe: slope.
Cintrona: Cr	Severe: subject to flooding, very slow permeability, depth to water table.	Severe: subject to flooding.	Severe: subject to flooding, too clayey, depth to water table, poorly drained.	Severe: subject to flooding, poorly drained, depth to water table, high shrink-swell potential.	Severe: subject to flooding, poorly drained, too clayey.	Severe: poorly drained, subject to flooding, high shrink-swell potential.
Constancia: Ct	Severe: slow permeability, depth to water table, flooding.	Severe: flooding.	Severe: somewhat poorly drained, too clayey.	Severe: somewhat poorly drained, flooding, high shrink-swell potential.	Severe: somewhat poorly drained, flooding, too clayey.	Severe: somewhat poorly drained, flooding, high shrink-swell potential.
Consumo: CuF2	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Cortada: Cx	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, moderate permeability.	Severe: flooding.

engineering properties of the soils

Suitability as a source of—			Soil features affecting—				
Roadfill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: slope	Unsuited	Poor: slope	Moderate permeability, slope.	Shallow to partly weathered volcanic rock.	Well drained	Not needed	Not needed.
Fair: 15 to 25 percent slopes. Poor: 25 percent slopes.	Unsuited	Poor: slope, coarse fragments, thin layer.	Moderate permeability, slope, seepage, stones.	Slope, stones, poor compaction.	Well drained	Not needed	Not needed.
Poor: high clay content.	Unsuited	Poor: slope, high clay content.	Slope, moderate permeability.	High compressibility, slope.	Well drained	Not needed	Not needed.
Poor: slope, shallow to bedrock.	Unsuited	Poor: slope, coarse fragments, thin layer.	Moderate permeability, shallow to bedrock, slope.	Shallow to bedrock.	Well drained	Not needed	Not needed.
Poor: slope	Unsuited	Poor: slope	Permeability, moderately deep to bedrock, slope.	Moderately deep to bedrock, fair to poor compaction.	Well drained	Not needed	Not needed.
Poor: high shrink-swell potential, poorly drained.	Unsuited	Poor: poorly drained, too clayey.	Depth to water table.	High shrink-swell potential, high compressibility, fair to poor compaction.	Depth to water table, flooding, slow permeability.	Drainage needed, depth to water table.	Not needed.
Poor: high clay content, high shrink-swell potential, somewhat poorly drained.	Unsuited	Poor: too clayey, somewhat poorly drained.	Depth to water table.	High shrink-swell potential, high compressibility, poor compaction.	Slow permeability, depth to water table, flooding.	Need for drainage, depth to water table.	Clayey texture, slow permeability.
Poor: slope	Unsuited	Poor: slope	Moderate permeability, slope, seepage.	High compressibility, poor compaction, susceptibility to piping.	Well drained	Not needed	Not needed.
Fair: clay content, moderate shrink-swell potential.	Unsuited	Good	Moderate permeability.	High susceptibility to piping, fair to poor compaction.	Well drained	All features favorable.	All features favorable.

TABLE 8.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills	Local roads and streets
Cuyon: CyB	Severe: flooding, potential pollution of ground water.	Severe: very rapid permeability, flooding, potential pollution of ground water.	Severe: flooding, texture of substratum.	Severe: flooding.	Severe: very rapid permeability, texture of substratum.	Severe: flooding.
Daguey: DaD	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: too clayey.	Severe: slope.
Ensenada: EnC	Slight if slope is 2 to 8 percent. Moderate if 8 to 12 percent.	Severe: moderate permeability.	Severe: substratum too clayey.	Slight if slope is 2 to 8 percent. Moderate if 8 to 12 percent.	Severe: substratum too clayey.	Slight if slope is 2 to 8 percent. Moderate if 8 to 12 percent.
Fe: Fe	Severe: slow permeability, flooding.	Severe: flooding.	Severe: somewhat poorly drained, flooding, too clayey.	Severe: flooding, high shrink-swell potential.	Severe: flooding, soil texture.	Severe: flooding, high shrink-swell potential.
Fraternidad: FtB, FtC2	Severe: slow permeability.	Moderate if slope is 2 to 7 percent; severe if slope is more than 7 percent.	Severe: too clayey.	Severe: high shrink-swell potential.	Severe: too clayey.	Severe: high shrink-swell potential.
Guanabano: GoF	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Humatas: HmE2, HmF2, HxF	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: clayey texture, slope.	Severe: slope.
Hydraquents: Hy. Material too variable for interpretations.						
Hydraquents, saline: Hz	Severe: flooding, depth to water table.	Severe: depth to water table, flooding.	Severe: depth to water table, flooding.	Severe: depth to water table, flooding.	Severe: very poorly drained, flooding.	Severe: very poorly drained, flooding.
Jacaguas: Jg	Severe: flooding, pollution hazard.	Severe: rapid permeability, flooding.	Severe: flooding, texture of substratum.	Severe: flooding.	Severe: flooding, rapid permeability, texture of substratum.	Severe: flooding.

properties of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Roadfill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Good	Fair	Poor: coarse fragments, thin layer.	Very rapid permeability, seepage.	Shallow to gravel, very rapid permeability, susceptibility to piping.	Excessively drained.	Available water capacity, very rapid permeability, depth of soil.	Not needed.
Poor: high clay content.	Unsuited	Poor: too clayey.	Moderate permeability, slope.	High compressibility, poor compaction.	Well drained	Not needed	Not needed.
Good	Poor	Poor: coarse fragments.	Seepage	Susceptibility to piping.	Well drained	Slope	Slope, stones, depth to unfavorable material.
Poor: high clay content, high shrink-swell potential.	Unsuited	Poor: clay texture, soluble salts.	All features favorable.	Salinity and alkalinity, high compressibility, fair to poor compaction.	Slow permeability, salinity, alkalinity.	Need for drainage, salinity, alkalinity.	Not needed.
Poor: high shrink-swell potential.	Unsuited	Poor: high clay content.	All features favorable.	High compressibility, poor compaction, high shrink-swell potential.	Slow permeability.	Slope	Slope, clayey texture, slow permeability.
Poor: slope	Unsuited	Poor: slope, coarse fragments.	Moderate permeability, seepage, slope.	Poor compaction.	Well drained	Not needed	Not needed.
Poor: high clay content, slope.	Unsuited	Poor: clayey texture, slope.	Moderate permeability, slope.	Fair to poor compaction, high susceptibility to piping.	Well drained	Not needed	Not needed.
Poor: very poorly drained.	Unsuited	Poor: very poorly drained, soluble salts.	Not needed	Not needed	Depth to water table, salinity, alkalinity.	Need for drainage.	Not needed.
Good	Fair	Fair: soil texture, thin layer.	Rapid permeability, seepage.	Shallow to gravel, high permeability, susceptibility to piping.	Excessively drained.	Rapid permeability, depth of soil.	Not needed.

TABLE 8.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills	Local roads and streets
Jacana: JnC	Severe: depth to bedrock, moderately slow permeability.	Severe: depth to bedrock.	Severe: depth to bedrock.	Severe: high shrink-swell potential.	Severe: depth to bedrock, too clayey.	Severe: shrink-swell potential.
Juana Diaz: JzD, JzE	Severe: shallow to bedrock, slope.	Severe: slope, shallow to bedrock.	Severe: slope, shallow to bedrock.	Severe: slope, shallow to bedrock.	Severe: shallow to bedrock.	Severe: slope, shallow to bedrock.
Lares: LeC	Moderate: moderate permeability.	Moderate: moderate permeability. Moderate if slope is 2 to 7 percent. Severe if more than 7 percent.	Moderate: drainage, too clayey.	Moderate: shrink-swell potential.	Severe: too clayey.	Moderate: shrink-swell potential.
Lirios: LmF2	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Llanos: LnB, LnC2	Moderate: moderately slow permeability, potential pollution of ground water.	Severe: moderately slow permeability of substratum, potential pollution of ground water.	Slight if slope is 2 to 8 percent; moderate if 8 to 12 percent.	Severe: high shrink-swell potential.	Severe: moderately slow permeability of substratum, potential pollution of ground water.	Severe: high shrink-swell potential.
Los Guineos: LuE, LuF, LyFX, LzFX. For Maricao part of LyFX and LzFX, see Maricao series. No interpretations for Stony rock land part of LzFX.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Moderate if slope is 15 to 25 percent; severe if more than 25 percent.	Severe: slope.
Machuelo: Ma	Severe: flooding, slow permeability, depth to water table.	Severe: flooding.	Severe: flooding, depth to water table, too clayey.	Severe: poorly drained, depth to water table, flooding, shrink-swell potential.	Severe: depth to water table, flooding, too clayey.	Severe: poorly drained, flooding, shrink-swell potential.
Maraguez: MeF2	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Maricao: MkF2	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

properties of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Roadfill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: high shrink-swell potential, high clay content.	Unsuited	Poor: high clay content.	Depth to bedrock.	High compressibility, shallow to bedrock.	Well drained	Slope, hazard of erosion.	Slope, depth to bedrock.
Fair if slope is 15 to 25 percent; poor if more than 25 percent.	Unsuited	Poor: slope	Shallow to bedrock.	Slope, shallow to bedrock.	Well drained	Not needed	Not needed.
Fair: shrink swell potential.	Unsuited	Poor: too clayey.	Moderate permeability.	High compressibility, poor compaction.	All features favorable.	Not needed	Slope.
Poor: slope	Unsuited	Poor: slope	Moderate permeability, slope, seepage.	Susceptibility to piping, fair to poor compaction.	Well drained	Not needed	Not needed.
Poor: high shrink-swell potential.	Unsuited	Poor: too clayey.	Moderately slow permeability, seepage.	High shrink-swell potential.	Compressibility, soil compaction.	Slope, moderately slow permeability in substratum.	Slope, depth to unfavorable material, texture.
Poor: high clay content.	Unsuited	Poor: slope, high clay content.	Slope, moderate permeability.	High compressibility, slope.	Slope	Not needed	Not needed.
Poor: high clay content, shrink-swell potential, poorly drained.	Unsuited	Poor: clayey texture, poorly drained.	Depth to water table.	High shrink-swell potential, high compressibility, fair to poor compaction.	Slow permeability, depth to water table, flooding, ponding.	Need for drainage, depth to water table.	Texture, slow permeability.
Poor: slope	Unsuited	Poor: slope	Slope, moderate permeability.	High susceptibility to piping, fair to poor compaction.	Well drained	Not needed	Not needed.
Poor: slope, high clay content.	Unsuited	Poor: slope, too clayey.	Moderate permeability, slope.	High compressibility, poor compaction.	Well drained	Not needed	Not needed.

TABLE 8.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills	Local roads and streets
Meros: Mr	Severe: very rapid permeability, pollution hazard.	Severe: very rapid permeability, pollution hazard.	Severe: sandy texture, sidewall stability.	Slight	Severe: very rapid permeability, pollution hazard.	Slight
Montegrande: MsC	Severe: permeability.	Moderate if slope is 2 to 7 percent; severe if slope is 7 to 12 percent.	Severe: too clayey.	Severe: high shrink-swell potential.	Severe: soil texture.	Severe: high shrink-swell potential, high clay content.
Morado: MtE2, MtF2	Severe: slope.	Severe: shallow to bedrock, slope.	Severe: slope, shallow to bedrock.	Severe: slope.	Severe: shallow to bedrock.	Severe: slope.
Mucara: MuD2, MuE2, MuF2	Severe: slope, shallow to hard rock.	Severe: slope, shallow to hard rock.	Severe: slope, shallow to hard rock.	Severe: slope.	Severe: shallow to bedrock.	Severe: slope.
Paso Seco: PaB	Severe: slow permeability, pollution hazard.	Severe: slow permeability of substratum, pollution hazard.	Severe: clay texture.	Severe: high shrink-swell potential.	Severe: clay texture.	Severe: high shrink-swell potential.
Pellejas: PeF2	Severe: slope.	Severe: slope, moderately rapid permeability.	Severe: slope.	Severe: slope.	Severe: slope, moderately rapid permeability.	Severe: slope.
Quebrada: QeD2, QeE2, QeF2	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Moderate if slope is 15 to 25 percent; severe if more than 25 percent.	Severe: slope.
Reilly: Re	Severe: flooding, depth to water table, pollution hazard.	Severe: very slow permeability, depth to water table, flooding, pollution hazard.	Severe: flooding, gravelly substratum.	Severe: flooding.	Severe: flooding, very slow permeability, pollution hazard.	Severe: flooding.
Riverwash: Rw	Severe: flooding, depth to water table, stones.	Severe: flooding, depth to water table, coarse fragments.	Severe: depth to water table, flooding.	Severe: depth to water table, flooding. stones.	Severe: flooding, stones.	Severe: flooding, stones.

properties of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Roadfill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Good	Fair: sand	Poor: sandy texture.	Not needed	Not needed	Excessively drained.	Not needed	Not needed.
Poor: high clay content, high shrink-swell potential.	Unsuited	Poor: too clayey.	Moderately slow permeability.	High shrink-swell potential.	Moderately slow permeability, slope, too clayey.	Not needed	Slope, too clayey, moderately slow permeability, depth to unfavorable material.
Poor: thickness of suitable material.	Unsuited	Poor: slope	Moderate permeability, shallow to bedrock, slope.	Shallow to bedrock, high susceptibility to piping, fair to poor compaction.	Well drained	Not needed	Not needed.
Fair if slope is 15 to 25 percent; severe if more than 25 percent.	Unsuited	Poor: high clay content.	Seepage potential, slope.	Shallow to bedrock, slope.	Well drained	Not needed	Not needed.
Poor: high shrink-swell potential.	Unsuited	Poor: too clayey.	Moderately rapid permeability below 32 inches.	Compaction characteristics, high shrink-swell potential.	Permeability is slow in surface layer and moderately rapid below surface layer.	Slope	Slope, depth to unfavorable material.
Poor: slope	Poor: improbable source.	Poor: slope	Moderately rapid permeability, seepage, slope.	Susceptibility to piping, medium strength.	Somewhat excessively drained.	Not needed	Not needed.
Fair if slope is 15 to 25 percent; severe if more than 25 percent.	Unsuited	Poor: slope	Moderate permeability, seepage, slope.	Susceptibility to piping, fair to poor compaction.	Well drained	Not needed	Not needed.
Good	Good: gravel.	Poor: thickness of material, coarse fragments.	Not needed	Not needed	Excessively drained.	Available water capacity, depth of soil, rate of water intake.	Not needed.
Fair: stones.	Good for gravel.	Poor: stones, coarse fragments.	Not needed	Not needed	Excessively drained.	Not needed	Not needed.

TABLE 8.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfills	Local roads and streets
San Anton: Sa	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.
Serrano: Se	Severe: depth to water table, flooding.	Severe: depth to water table, rapid permeability, soluble salts, flooding.	Severe: poorly drained, depth to water table, flooding, sandy texture.	Severe: poorly drained, flooding.	Severe: poorly drained, flooding, rapid permeability, sandy texture.	Severe: poorly drained, flooding.
Teresa: Te	Severe: depth to water table, flooding.	Severe: depth to water table, flooding.	Severe: somewhat poorly drained, depth to water table, flooding.	Severe: flooding.	Severe: depth to water table, flooding.	Severe: flooding.
Tidal flats: Tf. Soil material too variable for interpretations.						
Toa: To	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.
Tuque: TuF	Severe: stones, slope, shallow to hard rock.	Severe: slope, coarse fragments, shallow to bedrock.	Severe: slope, shallow to bedrock, stones.	Severe: slope, stones, shallow to bedrock.	Severe: shallow to bedrock, stones.	Severe: slope, shallow to bedrock, stones.
Yauco: YcB, YcC	Slight if slope is 2 to 8 percent; moderate if 8 to 12 percent.	Severe: moderate permeability.	Slight if slope is 2 to 8 percent; moderate if 8 to 12 percent.	Slight if slope is 2 to 8 percent; moderate if 8 to 12 percent.	Slight	Moderate: Unified soil group CL.

depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulation of salts and alkali; depth of root zone; rate of water intake at the surface; permeability below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage, or depth to water table or bedrock.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slopes; depth to bedrock or to other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Engineering test data

Table 9 contains engineering test data for four soils in the Ponce Area. The tests were made to help evaluate the soils for engineering purposes. The engineering classifications are based on data obtained by mechani-

properties of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Roadfill	Sand and gravel	Topsoil	Pond reservoir areas	Dikes, levees, and embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Fair: moderate shrink-swell potential.	Unsuited	Fair: soil texture.	Moderate to moderately rapid permeability, seepage.	Susceptibility to piping.	Well drained	All features favorable.	All features favorable.
Poor: poorly drained.	Fair for sand.	Poor: soluble salts, poorly drained sandy texture.	Rapid permeability, depth to water table, soluble salts.	Soluble salts	Depth to water table, stability of ditchbanks, flooding and ponding, salinity.	Low available water capacity, rate of water intake, need for drainage, salinity, rapid permeability.	Not needed.
Poor: high clay content, high shrink-swell potential.	Unsuited	Poor: soluble salts.	Not needed	Not needed	Salinity	Salinity	Not needed.
Fair: moderate shrink-swell potential.	Unsuited	Fair: consistence, too clayey.	Depth to water table, moderate permeability, seepage.	Poor compaction, high susceptibility to piping.	All features favorable.	Not needed	All features favorable.
Poor: stones.	Unsuited	Poor: coarse fragments, stones, slope.	Shallow to bedrock, slope.	Shallow to bedrock, stones.	Well drained	Not needed	Not needed.
Fair: Unified soil group CL.	Unsuited	Poor: high calcium carbonate equivalent.	Moderate permeability.	Compressibility strength, susceptibility to piping, fair compaction.	Well drained	Slope, moderate permeability.	Slope, depth to unfavorable material.

cal analyses and by tests to determine liquid limit and plastic limit. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction (or moisture-density) data are important in earthwork. If a soil material is compacted at successively higher moisture contents, assuming that the compactive effort 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.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material, as has been explained for table 7.

Formation, morphology, and classification of the soils

This section gives information about the formation, morphology, and classification of the soils in the Ponce Area.

Factors of soil formation

Soils are formed through the interaction of five major factors. These factors are climate, plants and ani-

TABLE 9.—*Engineering*

[Tests performed by the Department of Transportation

Soil name and location	Parent material	Bureau of Public Roads Report No.	Depth from surface	Horizon	Moisture-density[1]	
					Maximum dry density	Optimum moisture content
			Inches		*Lb. per cu. ft.*	*Percent*
Daguey clay:						
250 meters south of kilometer marker 7.6 on highway 526.	Highly weathered volcanic rocks.	3–89	0–8	A	----------	----------
		3–90	16–24	B	----------	----------
		3–88	41–60	C	----------	----------
Humatas clay:						
450 meters north of kilometer marker 72.5 on highway 135.	Highly weathered volcanic rocks.	3–91	0–5	A	----------	----------
		3–92	11–20	B	----------	----------
		3–93	40–60	C	----------	----------
San Anton clay loam:						
10 meters west of kilometer marker 2.35 on highway 506.	Alluvial sediments of mixed origin.	3–81	0–22	A	110	16
		3–79	34–60	C	109	16
Yauco clay:						
2.4 kilometers west of kilometer marker 30.5 on highway 510.	Soft, marly limestone.	3–83	0–11	A	98	21
		3–82	11–21	B	96	23
		3–84	21–60	C	104	17

[1] Based on AASHTO designation T–99 (*1*).

[2] Mechanical analyses according to the AASHTO designation T–88 (*1*). Results from this procedure differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of the material including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from the calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

mals, parent material, relief, and time. The relative influence of each factor generally varies from place to place. Soils in the same area vary because of differences in the kind of parent material and in topography and drainage. In places, one factor can dominate the formation of a soil and determine most of the soil's properties.

Climate

Climate, especially temperature and precipitation, governs the rate of weathering of rocks and the decomposition of minerals. Climate is probably the most influential factor in soil formation. Temperature has a great influence on the rate at which the chemical and physical processes affect profile development. Climate directly affects the accumulation of soil parent material and the differentiation of horizons. It also largely determines the kinds of plants and animals that live in an area.

The Ponce Area has two climatic zones. In the northern part of the area the climate is humid; the mean annual rainfall is 60 to 90 inches, and the temperature is 72° to 76° F. In the southern part the climate is semiarid; the mean annual rainfall is 30 to 60 inches, and the temperature is 78° to 80° F. The soils and vegetation in these two areas differ greatly.

Plants and animals

All living organisms, including vegetation, animals, bacteria, and fungi, are important in soil formation. Vegetation generally determines the amount of organic matter and nutrients in the soil and the color of the surface layer. Living organisms mainly affect horizon differentiation. Animals such as earthworms and ants help to keep the soil open and porous. Bacteria and fungi decompose vegetation and thus release nutrients for plants. Pasture vegetation has greatly influenced the soils in the semiarid area. Man has affected the surface and subsurface layers of the soils by clearing and plowing the land, fertilizing, mixing horizons, and accelerating the rate of erosion.

Parent material

Parent material is the unconsolidated mass in which a soil forms. It determines the mineralogical composition of the soil and influences the rate at which a soil forms. The parent material is altered as horizons develop. The rate at which rock weathers and the fragments that are produced through weathering are affected by the composition and structure of the rocks and have a great influence on the kind of soil that forms. In the Ponce Area, for example, most of the soils

test data

and Public Works, Commonwealth of Puerto Rico]

Mechanical analysis [2]									Liquid limit	Plasticity index	Classification	
Percentage passing sieve number—					Percentage smaller than—							
4 (4.7 mm)	10 (2.0 mm)	40 (0.42 mm)	60 (0.25 mm)	200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm			AASHTO [3]	Unified [4]
									Percent			
--------	--------	100	99	97	95	92	85	68	84	34	A–7–5(20)	MH
--------	--------	--------	100	98	96	93	81	68	84	34	A–7–5(20)	MH
--------	100	99	96	84	80	72	54	42	75	25	A–7–5(18)	MH
--------	--------	--------	100	99	98	92	80	64	72	28	A–7–5(19)	MH
--------	--------	--------	100	99	99	95	87	76	82	36	A–7–5(20)	MH
--------	100	99	98	93	92	88	66	45	65	22	A–7–5(17)	MH
--------	100	92	86	69	62	43	25	17	30	9	A–4(6)	CL
--------	--------	100	98	70	56	33	19	13	29	7	A–4(6)	CL
100	99	95	94	88	79	60	42	35	44	19	A–7–6(13)	CL
99	99	95	95	88	81	65	50	40	45	20	A–7–6(13)	CL
--------	100	97	95	77	69	50	32	22	30	9	A–4(8)	CL

[3] Based on AASHTO designation M 145–49 (*1*).
[4] Based on the Unified Soil Classification System, Technical Memorandum No. 3–357, Volume 1, Waterways Experiment Station, Corps of Engineers, March 1953.

have formed in place from weathered volcanic rock or limestone. Other soils in the survey area formed in sediment that was derived from weathered volcanic rock or limestone.

Relief

Relief, or topography, influences soil formation through its effect on runoff and drainage. Runoff generally is rapid on mountainsides and slow on level plains. In sloping areas where runoff is medium to very rapid, the soils generally are well drained, have a bright colored and unmottled subsoil, and are leached to a greater depth than the wetter soils in the same area, for example, the Humatas and Consumo soils. In the more gently sloping areas where runoff is slower, the soils generally are wet for a short period and have mottles in the subsoil; the Lares soils are an example. In level areas or slight depressions where the water table is at or near the surface for a long period, the soils have greater evidence of wetness; the Machuelo and Cintrona soils are examples. The permeability of a soil and the length, steepness, and shape of slopes influence the kind of soil that is formed. Local differences in soils mainly are the result of differences in parent material and relief.

Time

Time is required to change parent material into a soil. The length of time necessary is determined by the kind of parent material and by the condition of this material. For example, a very long time is needed for a soil to develop from freshly exposed hard limestone because limestone dissolves slowly. Millions of years may be required for this kind of rock to weather and for a soil to form.

The soils that formed on low bottoms are subject to varying degrees of flooding and can receive new deposits of sediment each time they are flooded. These soils have weak soil structure and weak differences in color between their horizons; Reilly soils are an example. Soils that have well developed horizons, such as Humatas soils, have been developing for a longer period than Reilly soils.

Morphology of the soils

The results of the soil-forming factors are evidenced by the different layers, or horizons, in a soil profile. The soil profile extends from the surface down to material that is little altered by the soil-forming processes.

Most soils have three major horizons: the A, B, and

C horizons. These horizons can be further subdivided by adding numbers or letters, or both, to indicate various differences in a horizon. An example is the B2t horizon, which is a B horizon that has an accumulation of clay.

The A horizon is the surface layer. This is the horizon of maximum leaching, or eluviation, of clay and iron. The A1 horizon is the layer that has the largest accumulation of organic matter.

The B horizon underlies the A horizon and is commonly called the subsoil. This is the horizon of maximum accumulation, or illuviation, of clay, iron, aluminum, or other compounds that are leached from the surface layer. In some soils the B horizon is formed by alteration in place rather than by illuviation. This alteration can be caused by the oxidation and reduction of iron or by the weathering of clay minerals. The B horizon commonly has blocky or prismatic structure. It generally is firmer and lighter colored than the A1 horizon but is darker colored than the C horizon.

The C horizon is below the A or B horizon. It consists of material that is little altered by the processes of soil formation, but it can be modified by weathering.

In the Ponce Area, the processes that affect the formation of soil horizons are the accumulation of organic matter, the leaching of soluble salts, the reduction and transfer of iron, the formation of soil structure, and the formation and translocation of clay minerals. These processes are continually taking place throughout the profile.

As plants decompose, organic matter accumulates and is incorporated into the surface layer. It darkens the surface layer and helps to form the A1 horizon.

For a soil to have a distinct subsoil, lime and other soluble salts must be leached before the clay minerals are translocated. Leaching of salts or other soluble substances is affected by the kinds of salts originally present, the depth to which the soil solution percolates, and the texture of the soil material.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*4*). Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable or measurable, but the properties are selected so that soils of similar genesis are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Table 10 shows the classification of each soil series of the Ponce Area by family, subgroup, and order, according to the current system.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487–69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(4) United States Department of Agriculture. 1975. Soil taxonomy: a basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv. U.S. Dep. Agric. Handb. 436. 754 pp., illus.

Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

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

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

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

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

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

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

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

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

Cemented.—Hard; little affected by moistening.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Fluvial. Existing, growing, or living in or about a stream or river.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified

TABLE 10.—*Classification of the soils*

Soil name	Family	Subgroup	Order
Adjuntas	Fine, kaolinitic, isohyperthermic	Typic Humitropepts	Inceptisols.
Aguilita	Loamy-skeletal, carbonatic, isohyperthermic, shallow	Typic Calciustolls	Mollisols.
Alonso	Clayey, kaolinitic, isohyperthermic	Orthoxic Tropohumults	Ultisols.
Caguabo	Loamy-skeletal, mixed, isohyperthermic	Lithic Eutropepts	Inceptisols.
Callabo	Fine, mixed, isohyperthermic	Typic Ustropepts	Inceptisols.
Cintrona	Fine, mixed, isohyperthermic	Typic Calciaquolls	Mollisols.
Constancia	Fine, mixed, isohyperthermic	Aeric Calciaquolls	Mollisols.
Consumo	Clayey, mixed, isohyperthermic	Dystropeptic Tropudults	Ultisols.
Cortada	Fine-loamy, mixed, isohyperthermic	Cumulic Haplustolls	Mollisols.
Cuyon	Sandy-skeletal, mixed, isohyperthermic	Fluventic Haplustolls	Mollisols.
Daguey	Clayey, oxidic, isohyperthermic	Orthoxic Tropohumults	Ultisols.
Ensenada	Clayey-skeletal, mixed, isohyperthermic	Typic Argiustolls	Mollisols.
Fe	Fine, mixed, isohyperthermic	Paleustollic Chromusterts	Vertisols.
Fraternidad	Very fine, montmorillonitic, isohyperthermic	Udic Chromusterts	Vertisols.
Guanabano	Fine-silty, mixed, isohyperthermic	Typic Argiustolls	Mollisols.
Humatas	Clayey, kaolinitic, isohyperthermic	Typic Tropohumults	Ultisols.
Jacaguas	Loamy-skeletal, mixed, isohyperthermic	Fluventic Haplustolls	Mollisols.
Jacana	Fine, mixed, isohyperthermic	Vertic Ustropepts	Inceptisols.
Juana Diaz	Loamy, mixed, isohyperthermic, shallow	Typic Ustropepts	Inceptisols.
Lares	Clayey, mixed, isohyperthermic	Aquic Tropohumults	Ultisols.
Lirios	Clayey over loamy, mixed, isohyperthermic	Typic Tropudults	Ultisols.
Llanos	Fine, mixed, isohyperthermic	Vertic Ustropepts	Inceptisols.
Los Guineos	Clayey, mixed, isothermic	Epiaquic Tropohumults	Ultisols.
Machuelo	Fine, mixed (calcareous), isohyperthermic	Tropic Fluvaquents	Entisols.
Maraguez	Fine-loamy, mixed, isohyperthermic	Typic Eutropepts	Inceptisols.
Maricao	Clayey, mixed, isothermic	Dystropeptic Tropudults	Ultisols.
Meros	Mixed, isohyperthermic	Typic Ustipsamments	Entisols.
Montegrande	Fine, mixed, isohyperthermic	Vertic Eutropepts	Inceptisols.
Morado	Fine-loamy, mixed, isohyperthermic	Typic Eutropepts	Inceptisols.
Mucara	Clayey, montmorillonitic, isohyperthermic, shallow	Vertic Eutropepts	Inceptisols.
Paso Seco	Clayey over loamy-skeletal, mixed, isohyperthermic	Udic Chromusterts	Vertisols.
Pellejas	Fine-loamy over sandy or sandy-skeletal, mixed, isohyperthermic	Typic Dystropepts	Inceptisols.
Quebrada	Fine, mixed, isohyperthermic	Typic Eutropepts	Inceptisols.
Reilly	Sandy-skeletal, mixed, isohyperthermic	Fluventic Hapludolls	Mollisols.
San Anton	Fine-loamy, mixed, isohyperthermic	Cumulic Haplustolls	Mollisols.
Serrano	Fine-loamy over sandy or sandy-skeletal, mixed, isohyperthermic	Tropic Fluvaquents	Entisols.
Teresa	Fine, mixed, isohyperthermic	Vertic Halaquepts	Inceptisols.
Toa	Fine, mixed, isohyperthermic	Fluventic Hapludolls	Mollisols.
Tuque	Clayey-skeletal, mixed, isohyperthermic, shallow	Petrocalcic Calciustolls	Mollisols.
Yauco	Fine-silty, carbonatic, isohyperthermic	Typic Calciustolls	Mollisols.

organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

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

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—few, common, and many; size—fine, medium, and coarse; and contrast—faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Pressure face. A relatively smooth surface on peds, generally indicating that the surface has been subjected to pressure. Pressure faces generally persist through successive drying and wetting cycles.

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

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither

acid nor alkaline. The degree of acidity or alkalinity is expressed as—

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

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Saprolite (geology). Soft, earthy, clay-rich, thoroughly decomposed rock formed in place by chemical weathering of igneous and metamorphic rock. In soil surveys, the term saprolite is applied to any unconsolidated residual material underlying the soil and grading to hard bedrock below.

Semiconsolidated rock. Rock that cannot be penetrated by a spade or auger. (In terms of soil taxonomy, a lithic contact.)

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

Slickenside. A polished and grooved surface produced by one mass sliding past another. In soils, slickensides occur at the base of slip surfaces on the steeper slopes; on the face of blocks, prisms, and columns; and in swelling clayey soils where there is marked change in moisture content.

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

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

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

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

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

Truncated (soil). Pertaining to a soil profile in which upper horizons are missing.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathered rock. Rock that has been acted on by physical and chemical factors of weathering to the point where it can be penetrated by a spade or auger, even though it retains original characteristics of the bedrock such as joint planes and crystal outlines.

GUIDE TO MAP UNITS

Map symbol	Map unit	Page	Capability unit		Woodland suitability group
			Nonirrigated	Irrigated	
AaF2	Adjuntas clay, 40 to 60 percent slopes, eroded	8	VIIe-1	------	3r1
AgD	Aguilita gravelly clay loam, 12 to 20 percent slopes	9	VIe-2	------	2x1
AgF	Aguilita gravelly clay loam, 20 to 60 percent slopes	9	VIIe-4	------	3x1
AhF	Aguilita stony clay loam, 20 to 60 percent slopes	10	VIIs-2	------	3x1
AnE2	Alonso clay, 20 to 40 percent slopes, eroded	11	IVe-1	------	2c1
AnF2	Alonso clay, 40 to 60 percent slopes, eroded	11	VIe-1	------	3c1
CbF2	Caguabo gravelly clay loam, 20 to 60 percent slopes, eroded	12	VIIs-3	------	4d1
CdF	Caguabo-Rock land complex, 20 to 60 percent slopes	12	VIIs-3	------	---
CoD	Callabo silty clay loam, 12 to 20 percent slopes	13	IVe-3	------	3d1
CoE	Callabo silty clay loam, 20 to 40 percent slopes	13	VIe-4	------	3d1
CoF2	Callabo silty clay loam, 40 to 60 percent slopes, eroded	14	VIIe-3	------	4d2
Cr	Cintrona clay	15	VIs-2	IIIw-1	---
Ct	Constancia silty clay	16	IIIc-2	IIw-1	---
CuF2	Consumo clay, 40 to 60 percent slopes, eroded	16	VIIe-1	------	3c1
Cx	Cortada silty clay loam	17	IIc-1	I-3	---
CyB	Cuyon loam, 0 to 5 percent slopes	18	VIs-1	------	---
DaD	Daguey clay, 12 to 20 percent slopes	19	IIIe-1	------	2c2
EnC	Ensenada gravelly clay, 2 to 12 percent slopes	20	IVc-5	IIIs-1	---
Fe	Fe clay	21	VIs-2	------	---
FtB	Fraternidad clay, 2 to 5 percent slopes	22	IIIc-1	IIs-1	---
FtC2	Fraternidad clay, 5 to 12 percent slopes, eroded	22	IVc-1	IIIe-2	---
GoF	Guanabano clay, 40 to 60 percent slopes	23	VIIe-3	------	---
HmE2	Humatas clay, 20 to 40 percent slopes, eroded	23	IVe-1	------	2c1
HmF2	Humatas clay, 40 to 60 percent slopes, eroded	24	VIe-1	------	3c1
HxF	Humatas complex, 20 to 60 percent slopes	24	VIIe-1	------	3c1
Hy	Hydraquents	24	VIIIw-1	------	---
Hz	Hydraquents, saline	24	VIIIs-1	------	---
Jg	Jacaguas silty clay loam	25	IVc-4	IIIs-1	---
JnC	Jacana clay, 5 to 12 percent slopes	26	IVc-1	IIIe-3	2d1
JzD	Juana Diaz clay loam, 12 to 20 percent slopes	26	VIe-4	------	3d1
JzE	Juana Diaz clay loam, 20 to 40 percent slopes	27	VIIe-3	------	3d1
LeC	Lares clay, 5 to 12 percent slopes	27	IIIe-1	------	2c2
LmF2	Lirios clay loam, 40 to 60 percent slopes, eroded	28	VIIe-1	------	3c1
LnB	Llanos clay, 2 to 5 percent slopes	29	IIIc-1	IIs-3	---
LnC2	Llanos clay, 5 to 12 percent slopes, eroded	29	IVc-1	IIIe-5	---
LuE	Los Guineos clay, 20 to 40 percent slopes	30	VIe-1	------	2c1
LuF	Los Guineos clay, 40 to 60 percent slopes	31	VIIe-1	------	2c3
LyFX	Los Guineos-Maricao association, steep	31	VIIe-1	------	2c3
LzFX	Los Guineos-Maricao-Stony rock land association, steep	31	VIIs-5	------	3x2
Ma	Machuelo clay	32	IVc-2	IIIw-1	---
MeF2	Maraguez silty clay loam, 40 to 60 percent slopes, eroded	33	VIIe-2	------	3r1
MkF2	Maricao clay, 20 to 60 percent slopes, eroded	33	VIIe-1	------	2c3
Mr	Meros sand	34	VIIs-1	------	---
MsC	Montegrande clay, 2 to 12 percent slopes	35	IIw-2	------	---
MtE2	Morado clay loam, 20 to 40 percent slopes, eroded	36	VIe-3	------	3d2
MtF2	Morado clay loam, 40 to 60 percent slopes, eroded	36	VIIe-2	------	3d3
MuD2	Mucara silty clay, 12 to 20 percent slopes, eroded	37	IVe-2	------	3d2
MuE2	Mucara silty clay, 20 to 40 percent slopes, eroded	37	VIe-3	------	3d2
MuF2	Mucara silty clay, 40 to 60 percent slopes, eroded	37	VIIe-2	------	3d3
PaB	Paso Seco clay, 2 to 5 percent slopes	38	IIIc-1	IIs-2	---
PeF2	Pellejas clay loam, 40 to 60 percent slopes, eroded	39	VIIe-5	------	3r1
QeD2	Quebrada silty clay loam, 12 to 20 percent slopes, eroded	39	IVe-2	------	2c4
QeE2	Quebrada silty clay loam, 20 to 40 percent slopes, eroded	39	VIe-3	------	2c4
QeF2	Quebrada silty clay loam, 40 to 60 percent slopes, eroded	40	VIIe-2	------	3r1
Re	Reilly gravelly loam	40	IVs-1	------	---
Rw	Riverwash	41	VIIIs-2	------	---
Sa	San Anton clay loam	42	IIc-1	I-2	---
Se	Serrano sand	43	VIIs-4	------	---
Te	Teresa clay	44	VIs-2	------	---
Tf	Tidal flats	44	VIIIs-1	------	---
To	Toa silty clay loam	44	I-1	------	---
TuF	Tuque stony clay loam, 12 to 60 percent slopes	45	VIIs-2	------	---
YcB	Yauco silty clay loam, 2 to 5 percent slopes	46	IVc-3	IIIe-4	2o1
YcC	Yauco silty clay loam, 5 to 12 percent slopes	46	IVc-3	IIIe-4	2o1

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