Series 1961, No. 41

Issued March 1966

SOIL SURVEY
Alameda Area, California

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
CALIFORNIA AGRICULTURAL EXPERIMENT STATION

HOW TO USE THIS SOIL SURVEY REPORT

THIS SOIL SURVEY of the Alameda Area, California, will serve several groups of readers. It will help farmers and ranchers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; and help prospective buyers and others in appraising a farm or other tract.

Locating the Soils

At the back of this report is an index map and a soil map consisting of many sheets. On the index map are rectangles numbered to correspond to the sheets of the soil map so that the sheet showing any area can be located easily. On each map sheet, the soil boundaries are outlined and there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside the area and a pointer shows where it belongs. For example, an area on the map has the symbol AaC. The legend for the set of maps shows that this symbol identifies Altamont clay, 3 to 15 percent slopes. That soil and all others mapped in the county are described in the section "Descriptions of the Soils."

Finding Information

In the "Guide to Mapping Units," at the back of this report, each soil is listed in the alphabetic order of its map symbol. This guide gives the page where each soil is described, and the page of the capability unit and range site in which the soil has been placed. It also shows where to find the acreage of each soil, the yields that can be expected, and information about engineering uses of the soils.

Farmers and those who work with farmers can learn about the soils on a farm by reading the description of each soil and of its capability unit and other groupings. A convenient way of doing this is to turn to the soil map and list the soil symbols of a farm and then to use the "Guide to Mapping Units" in finding the pages where each soil and its groupings are described.

Ranchers and others interested in pasture and range will find the subsection "Use of Soils for Pasture and Range" helpful. In that subsection the soils of the county are placed in groups according to their suitability for grazing, and the management of each group is discussed.

Engineers and builders will find in the subsection "Engineering Interpretations of Soils" tables that give engineering descriptions of the soils in the county; name soil features that affect engineering practices and structures; and rate the soils according to their suitability for several kinds of use.

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

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest.

Newcomers in the Alameda Area will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the Area," which gives additional information about the county.

* * * * *

Fieldwork for this survey was completed in 1961. Unless otherwise indicated, all statements in the report refer to conditions in the Area at the time the survey was in progress. The soil survey of the Alameda Area was made as part of the technical assistance furnished by the Soil Conservation Service to the Eastern and Western Alameda County Soil Conservation Districts.

Cover picture: **Irrigated strawberries on Yolo loam, 0 to 3 percent slopes. Fruits and vegetables are important agricultural products in the Alameda Area. Positas and Perkins soils in background are used for grazing.**

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SOIL SURVEY OF THE ALAMEDA AREA, CALIFORNIA

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA AGRICULTURAL EXPERIMENT STATION

THE AREA covered by the soil survey is in Alameda County in the west-central part of California. It is mainly within the San Francisco Bay drainage basin and is made up of fairly rugged highlands of the Diablo Range, of upland terraces, and of intermountain valleys.

The acreage used for agriculture has been curtailed by residential and industrial development, but farming is still of considerable importance and is well diversified. The principal crops are barley, vegetables, hay, sugar beets, and grapes. Cut flowers and fresh vegetables have a ready market in the nearby metropolitan areas. Livestock are produced in the foothills where forage is abundant.

Numerous manufacturing companies are located in Alameda County. Food processing is the largest single industry, but the manufacture of nonelectrical machinery, fabricated metals, and transportation equipment is also important. Many other industries contribute to the economy of the County.

The climate of the Area is mild, and temperatures are moderate during winter. The growing season is long enough for most crops, especially for vegetables and cut flowers. Rainfall is limited, however, in the summer, and irrigation is needed for crops.

General Nature of the Area

This section tells about the location and extent of the area surveyed and describes the physiography, relief, and drainage. It also gives some important facts about the climate.

Location and Extent

The Alameda Area comprises all of Alameda County except the urban areas along the coast. (See the general soil map in the back of the report.) The Area is in the west-central part of California (fig. 1). The area surveyed covers approximately 508 square miles, or about 325,000 acres. Oakland, the county seat of Alameda County, is the largest city in the county, but it is not in the area surveyed. Livermore and Pleasanton are the only incorporated towns in the Area. Livermore, the largest, has a population of about 16,000.

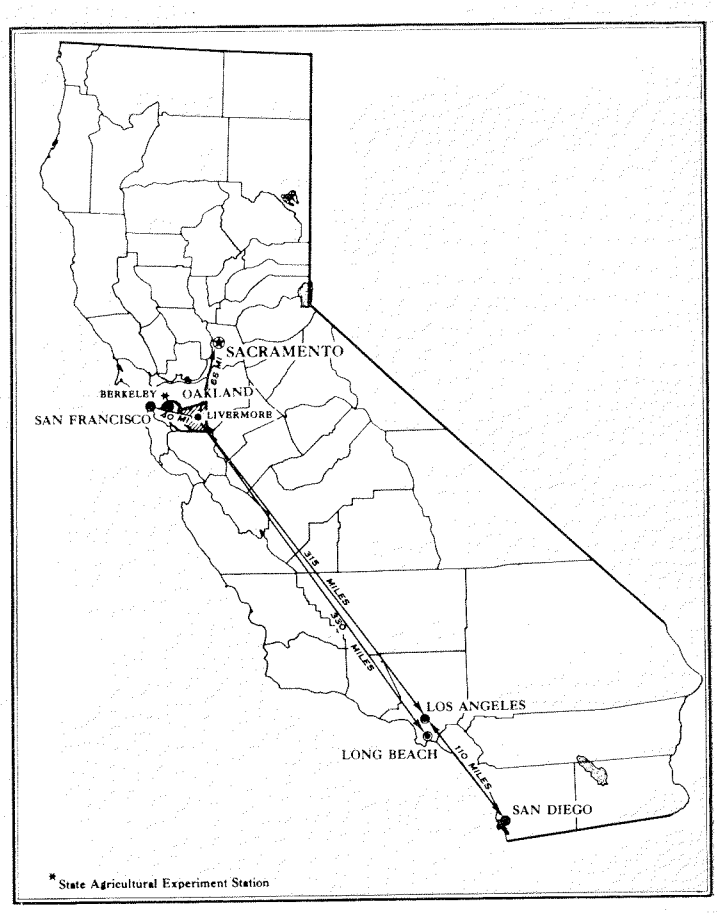

Figure 1.—Location of the Alameda Area in California.

Physiography, Relief, and Drainage

The Alameda Area comprises three general physiographic regions: The highlands of the Diablo Range, the upland terraces, and the intermountain valleys.

The Diablo Range consists of fairly rugged mountains that range in elevation from about 100 feet along the San Francisco Bay depression to about 4,000 feet along Valpe Ridge. Most mountain valleys are young and V-shaped. The uplands north and east of the Livermore

Valley typically are moderately steep to steep and have well-rounded ridges. In other uplands, particularly those south of the Livermore Valley, the slopes are steep to very steep, and the ridges are narrow and have numerous outcrops of bedrock. In some places small landslips are common.

The upland terraces are south of the Livermore Valley. They are characterized by smooth, wide ranges that dip at an angle of 10 to 30 degrees northward toward this valley and by steep to very steep V-shaped valleys. Slopes are smooth and well-rounded in the northwestern perimeter of the upland terraces.

The intermountain valleys consist of coalescing alluvial fans, low terraces, and flood plains. Typically, they are nearly level to gently sloping. The Livermore and Amador Valleys, which are adjacent to each other, are the largest of the coastal valleys. The Livermore Valley is east of Pleasanton. The main streams in this valley are the Arroyo Mocho, Arroyo del Valle, and Arroyo Las Positas, which flow in a westerly direction. Amador Valley is in the vicinity of Dublin. The principal streams in this valley are the Alamo and Tassajara Creeks, which flow in a southerly direction.

The drainage pattern of the Area is well developed. (See the general soil map in the back of this report.)

All the streams except Alameda Creek are intermittent. This creek maintains a small flow throughout the year. The smaller gullies and creeks contain water for only short periods during and after rains. The larger streams drain the areas of strongest relief and heaviest rainfall. These streams contain running water until the middle of summer, when the water sinks below the surface in most places or appears as waterholes at intervals along the streams. The basins east of Dublin are flooded once every 4 or 5 years.

The Area can be divided into three general drainage areas. These are the San Joaquin, the Coastal, and the San Francisco Bay drainage areas. The northeastern part of the Area occupies approximately 70 square miles and drains into the San Joaquin Valley. The two principal creeks in this area are Mountain House and Tesla. The western part occupies about 109 square miles and is drained by a large number of small streams that empty directly into San Francisco Bay. The rest is drained by streams that flow into the Livermore and Amador Valleys from all sides. These streams converge about 1 mile west of Pleasanton and form the Arroyo de la Laguna. This stream, in turn, converges with other streams of the Sunol Valley to form Alameda Creek, the largest creek of the area.

Climate [1]

The western end of the Alameda Area has a marine climate with very little change in temperature, but the eastern part has a more variable climate. Temperatures are moderate, however, over the entire county during winter and are high in the inland parts during summer. The growing season is long enough in all parts of the county to permit the maturity of most crops commonly grown. Rain falls mainly in the winter; little or no rain falls during the summer. The prolonged rainless period makes irrigation essential for the production of many crops, although forage plants and some early maturing crops are grown without irrigation.

Temperature.—The average annual temperature throughout the Area is uniform. It ranges between 56° and 58° F. west of the coastal hills, and increases to about 62° in the northeast corner. Temperatures in midsummer have exceeded 100° everywhere in the Area, and extremes as high as 115° have been reported in the Livermore area. The mean maximum temperature for July ranges from the middle 70's west of the coastal hills, to the upper 80's in the Livermore Valley, and to the lower 90's east of Altamont Pass. Maximum temperatures of 90° or higher occur about 4 days per year near the San Francisco Bay and may occur as many as 65 days per year inland.

Low temperatures during January average in the upper 30's or lower 40's. At one time or another, extreme low temperatures have been in the low 20's over all of the Area; the lowest reported temperature was 19° at Livermore. It is likely that slightly colder temperatures have occurred on higher elevations in the southeast corner of the Area, but no official records are available. Table 1 and figure 2 show further details of temperature.

On the average, freezing temperatures occur 7 to 10 days each year over all the Area. The median date of the last freezing temperature in spring ranges from near January 1 in the western part of the Area to the latter

TABLE 1.—*Temperature data for seven weather stations*

Month	Highest	Mean maximum	Mean temperature	Mean minimum	Lowest
	ALVARADO, CALIF.				
	°F.	°F.	°F.	°F.	°F.
January	74	58.4	49.8	41.3	23
February	76	60.7	52.5	44.2	33
March	83	65.0	55.8	46.7	35
April	87	66.9	57.6	48.3	35
May	96	70.5	61.1	51.7	38
June	96	72.5	63.2	53.9	42
July	99	73.7	64.6	55.4	43
August	92	73.4	64.3	55.3	45
September	109	75.7	65.1	54.5	45
October	96	72.8	61.9	51.0	38
November	91	66.7	55.5	44.4	30
December	79	60.2	50.9	41.6	23
Annual	109	67.5	58.5	49.0	23
	HAYWARD, CALIF.				
January	71	55.9	47.6	39.2	22
February	77	58.9	50.0	41.2	28
March	84	61.9	52.4	42.9	30
April	86	65.4	55.7	46.0	33
May	94	68.5	59.0	49.4	36
June	104	71.6	62.2	52.8	40
July	99	74.3	64.4	54.4	40
August	98	73.4	64.1	54.8	40
September	99	75.4	64.8	54.1	42
October	94	71.1	60.3	49.5	35
November	85	63.8	53.7	43.6	30
December	78	57.7	49.4	41.0	23
Annual	104	66.5	57.0	47.4	22

[1] By C. ROBERT ELFORD, State climatologist, U.S. Weather Bureau.

TABLE 1.—*Temperature data for seven weather stations*—Continued

LIVERMORE, CALIF.

Month	Highest	Mean maximum	Mean temperature	Mean minimum	Lowest
	°F.	°F.	°F.	°F.	°F.
January	77	56. 6	47. 6	36. 5	19
February	80	61. 0	50. 8	39. 3	23
March	88	65. 2	53. 4	41. 2	27
April	95	70. 5	56. 9	43. 5	30
May	108	75. 6	61. 4	47. 1	32
June	111	82. 3	66. 8	50. 9	38
July	113	88. 3	70. 6	53. 7	41
August	112	87. 3	70. 1	53. 4	40
September	115	85. 1	68. 3	51. 7	35
October	100	77. 1	62. 5	47. 4	29
November	93	67. 3	54. 4	40. 6	25
December	78	57. 9	48. 6	36. 9	20
Annual	115	72. 9	59. 3	45. 3	19

NEWARK, CALIF.

January	75	56. 9	45. 4	33. 8	22
February	78	59. 7	48. 8	38. 0	25
March	79	62. 6	51. 7	40. 7	29
April	87	68. 2	56. 0	43. 7	32
May	97	70. 4	59. 1	47. 7	35
June	99	74. 6	63. 0	51. 4	41
July	97	76. 7	64. 9	53. 1	41
August	99	77. 0	64. 8	52. 6	41
September	101	78. 3	64. 5	50. 7	40
October	88	72. 6	59. 7	46. 8	33
November	84	64. 6	52. 8	41. 0	26
December	75	59. 4	49. 1	38. 9	26
Annual	101	68. 4	56. 7	44. 9	22

OAKLAND AIRPORT, CALIF.

January	72	56. 0	47. 2	38. 4	24
February	82	60. 0	50. 7	41. 3	25
March	85	63. 4	53. 4	43. 3	32
April	88	65. 9	55. 6	45. 3	31
May	94	68. 5	58. 4	48. 3	36
June	107	71. 6	61. 6	51. 6	41
July	102	72. 0	62. 7	53. 4	46
August	95	72. 0	62. 9	53. 7	47
September	102	74. 0	63. 3	52. 6	41
October	94	71. 0	60. 0	48. 9	34
November	86	64. 3	53. 8	43. 2	27
December	74	57. 3	48. 6	39. 8	23
Annual	107	66. 3	56. 5	46. 7	23

OAKLAND (CHABOT), CALIF.

January	73	54. 3	47. 8	41. 2	24
February	75	57. 3	50. 4	43. 3	28
March	87	61. 4	53. 3	45. 3	32
April	88	64. 9	56. 1	47. 4	36
May	97	68. 3	59. 2	50. 1	38
June	97	71. 2	62. 2	53. 1	41
July	98	73. 0	63. 9	54. 8	48
August	99	73. 4	63. 9	54. 5	47
September	103	74. 6	64. 6	54. 6	44
October	98	70. 6	61. 3	52. 0	36
November	83	63. 4	55. 3	47. 1	32
December	69	55. 9	49. 5	43. 2	25
Annual	103	65. 0	56. 7	48. 9	24

TABLE 1.—*Temperature data for seven weather stations*—Continued

TRACY PUMPING PLANT, CALIF.

Month	Highest	Mean maximum	Mean temperature	Mean minimum	Lowest
	°F.	°F.	°F.	°F.	°F.
January	67	55. 8	46. 9	37. 9	23
February	76	60. 4	50. 5	40. 6	25
March	82	66. 9	55. 0	43. 0	30
April	92	72. 6	59. 8	47. 0	34
May	99	78. 8	65. 1	51. 3	40
June	110	88. 9	73. 3	57. 7	39
July	110	93. 3	76. 4	59. 4	51
August	108	92. 9	76. 1	59. 3	42
September	109	88. 6	73. 1	57. 6	46
October	97	78. 4	65. 1	51. 8	39
November	85	66. 9	54. 0	41. 1	26
December	73	57. 9	47. 5	37. 0	22
Annual	110	75. 1	61. 9	48. 6	22

part of March in cold spots in the hills between Livermore and the San Francisco Bay. The median date of the first freeze in the fall is as early as November 16 in the northeast corner of the Area and in the hills, and it is progressively later toward the bay. These dates, however, vary from year to year. There is a chance 1 year in 10 of a freeze as late as April 15 in the vicinity of Livermore and as early as October 15 east of the coastal hills.

The growing season, or the period between the last freezing temperature in spring and the first in fall, varies widely throughout the Area. The average length of this season is 250 to 255 days in that part of the Area just north of Livermore, but it is 300 days or more along San Francisco Bay.

The number of days between the last temperature of 32° or colder in spring and the first in fall and that between the last temperature of 28° or colder in spring and the first in fall varies widely. The number of days between the 32° temperatures in spring and fall is 306 at Hayward, 254 at Livermore, 293 at Newark, 333 at Oakland, and 258 at the Tracy Pumping Plant. The number of days between 28° temperatures in spring and fall is 365 at Hayward, 313 at Livermore, 365 at Newark, 365 at Oakland, and 308 at the Tracy Pumping Plant. The probability of freezing temperatures on specified dates is shown in table 2.

Precipitation.—The average monthly and annual precipitation at various stations in the Area is shown in table 3. Annual precipitation data are also shown in figure 3. Annual rainfall varies from about 10 inches at the eastern end of the Area and 12 inches in the southwestern corner to more than 20 inches on the higher elevations in the southeastern corner and near 30 inches on the hills in the extreme northern part. In general, precipitation increases inland from the bay with increasing elevation and reaches a maximum along the top of the coastal hills, which extend from Mt. Hamilton, a few miles south of the Alameda County line, to Grizzly Peak,

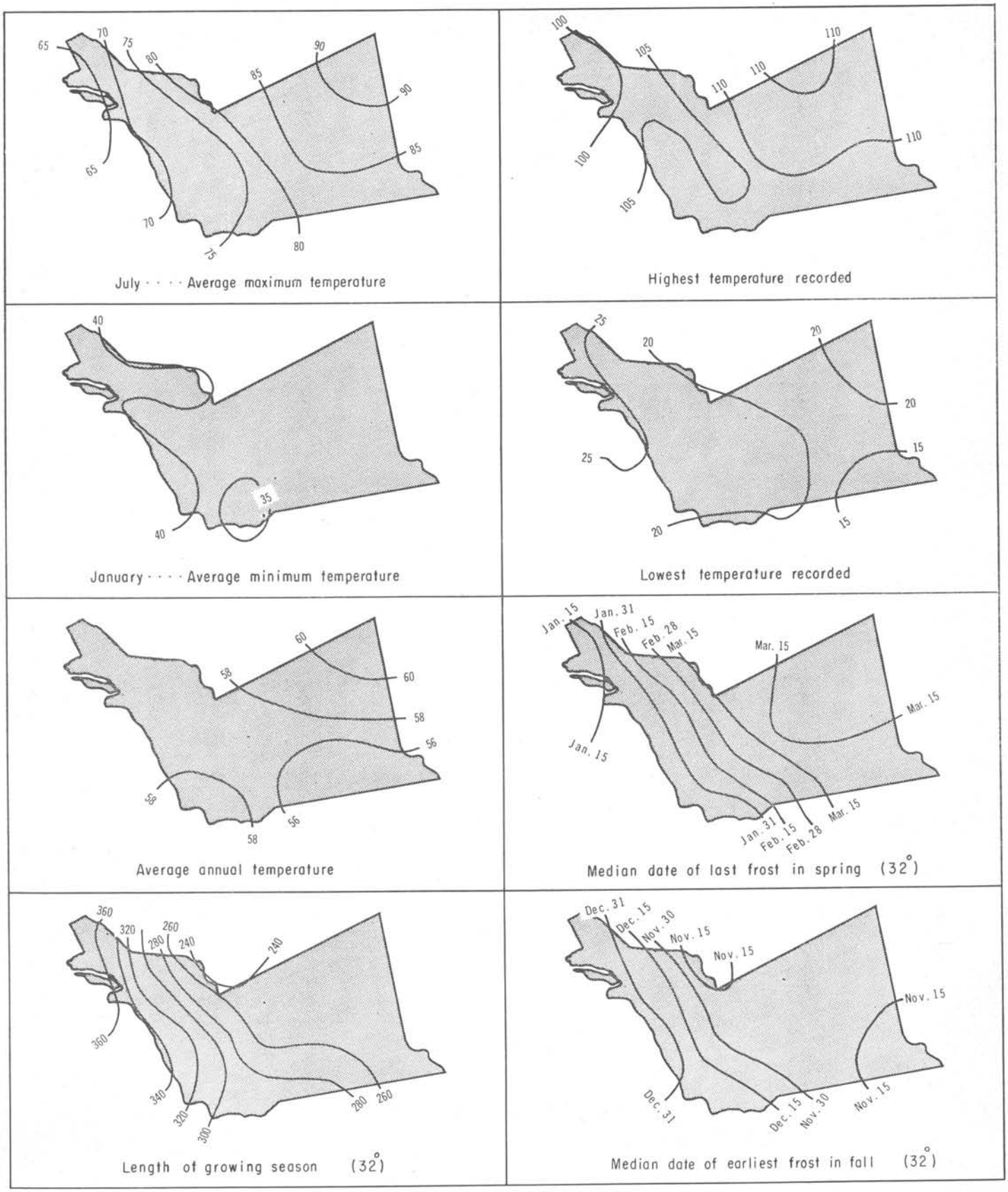

Figure 2.—**Temperature, frost data, and length of the growing season in the Alameda Area.**

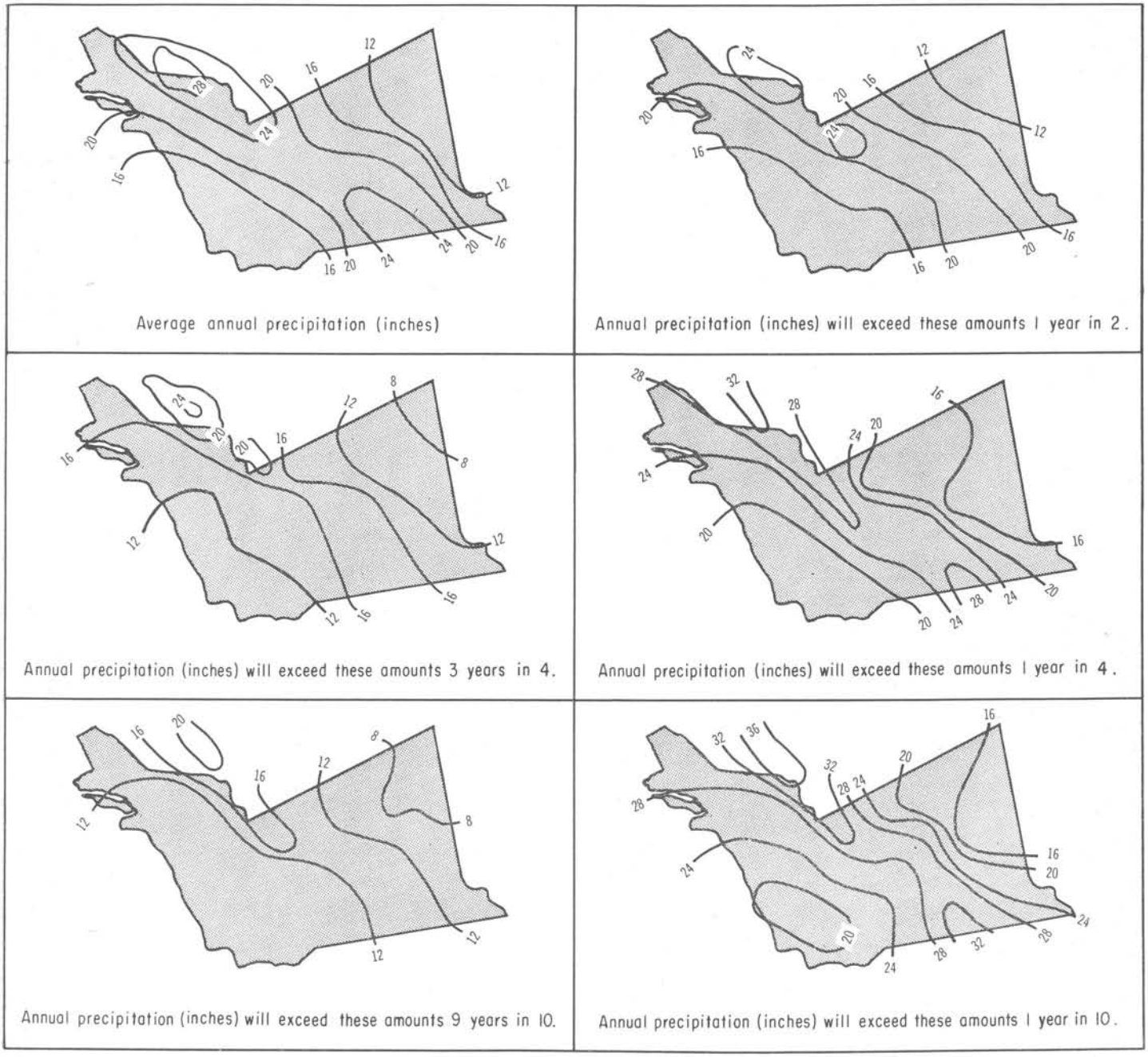

Figure 3.—**Average annual precipitation and frequencies of precipitation in the Alameda Area.**

just east of Berkeley. Annual total precipitation decreases rapidly from the peak eastward to the Alameda County line.

There is a wide variation in the seasonal or annual total precipitation from year to year. Table 4 and figure 3 show the annual rainfall that can be expected within the county at different frequencies. As shown in figure 3, in the eastern part of the Area, the annual precipitation may be less than 6 inches as often as 1 year in 10 and may be less than 14 inches in 9 years out of 10. Thus, in this part of the Area, the rainfall will exceed 14 inches only 1 year in 10. By taking the tabulated values in table 4 from the frequencies of 1 year in 4 and 3 years in 4, it is possible to determine the limits between which the annual totals may be expected to fall half of the time.

Most of the precipitation in the Area falls between the months of October and April; very little falls during the rest of the year. Localized showers, which are characteristic in some parts of the Nation, are infrequent in the Alameda Area. Most of the rain falls during general winter storms that move through the Area. These storms usually are of moderate duration and intensity, but at

TABLE 2.—*Probability of temperatures of 32° or colder and 28° or colder after a specified date in spring and before a specified date in fall*

Station and season	Temperature	1 in 10	2 in 10	3 in 10	4 in 10	5 in 10	6 in 10	7 in 10	8 in 10	9 in 10
Hayward:	°F.									
Spring	32	Mar. 29	Mar. 7	Feb. 26	Feb. 17	Feb. 11	Feb. 3	Jan. 26	Jan. 16	Jan. 3
Fall	32	Nov. 16	Nov. 25	Dec. 2	Dec. 9	Dec. 14	Dec. 23	Dec. 31	(1)	(1)
Spring	28	Jan. 29	Jan. 15	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Fall	28	Dec. 11	Dec. 31	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Livermore:										
Spring	32	Apr. 16	Apr. 4	Mar. 28	Mar. 19	Mar. 12	Mar. 5	Feb. 25	Feb. 16	Feb. 3
Fall	32	Oct. 30	Nov. 6	Nov. 12	Nov. 16	Nov. 21	Nov. 26	Dec. 1	Dec. 6	Dec. 14
Spring	28	Feb. 28	Feb. 21	Feb. 15	Feb. 8	Feb. 3	Jan. 27	Jan. 19	Jan. 7	(2)
Fall	28	Nov. 19	Nov. 27	Dec. 4	Dec. 8	Dec. 13	Dec. 18	Dec. 23	Dec. 29	(1)
Newark:										
Spring	32	Mar. 30	Mar. 18	Mar. 8	Feb. 27	Feb. 19	Feb. 11	Feb. 2	Jan. 22	Jan. 7
Fall	32	Nov. 24	Nov. 30	Dec. 3	Dec. 6	Dec. 9	Dec. 12	Dec. 15	Dec. 20	Dec. 24
Spring	28	Jan. 7	Jan. 5	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Fall	28	Dec. 16	Dec. 24	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Oakland:										
Spring	32	Feb. 27	Feb. 19	Feb. 14	Feb. 9	Jan. 30	Jan. 23	Jan. 20	Jan. 1	(1)
Fall	32	Nov. 14	Nov. 24	Dec. 6	Dec. 17	Dec. 29	(2)	(2)	(2)	(2)
Spring	28	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Fall	28	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Tracy Pumping Plant:										
Spring	32	Apr. 11	Mar. 29	Mar. 19	Mar. 10	Mar. 3	Feb. 24	Feb. 15	Feb. 6	Jan. 23
Fall	32	Oct. 17	Oct. 27	Nov. 4	Nov. 10	Nov. 16	Nov. 21	Nov. 28	Dec. 4	Dec. 14
Spring	28	Feb. 17	Feb. 9	Feb. 4	Jan. 30	Jan. 27	Jan. 22	Jan. 17	Jan. 13	Jan. 5
Fall	28	Nov. 21	Nov. 23	Nov. 25	Nov. 29	Dec. 1	Dec. 3	Dec. 6	Dec. 12	Dec. 16

[1] Before Jan. 1. [2] After Dec. 31.

TABLE 3.—*Average monthly and annual precipitation at stated stations*

Station	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Altamont Creek	2.73	2.30	1.73	0.85	0.40	0.08	(1)	(1)	0.22	0.56	1.38	2.61	12.86
Alvarado (near)	3.54	3.47	2.32	1.13	.43	.11	(1)	0.03	.11	.68	.94	3.30	16.06
Alviso	2.41	1.71	1.90	.92	.42	.12	0.01	.01	.21	.50	1.46	2.69	12.36
Arroyo del Valle	4.42	4.20	3.18	1.47	.54	.10	.01	(1)	.27	.83	1.83	4.34	21.19
Arroyo Mocho	2.45	2.49	1.80	1.10	.43	.12	.01	.01	.25	.60	1.29	2.28	12.83
Calaveras Reservoir	3.64	3.64	2.76	1.50	.67	.18	.01	.01	.30	.78	1.95	3.60	19.04
Cayetano Creek	3.03	2.66	1.93	1.09	.42	.09	0	.01	.23	.54	1.53	2.77	14.30
Centerville	3.24	3.07	2.66	1.21	.50	.12	.02	.03	.07	.90	1.78	3.45	17.05
Chabot Reservoir	4.52	3.82	3.20	1.65	.79	.19	.01	.04	.31	1.68	2.24	3.93	22.38
Gerber Ranch	3.67	3.48	2.25	1.35	.44	.10	.02	.01	.32	.63	1.71	3.57	17.55
Hayward High School	4.08	3.84	2.70	1.54	.86	.19	.01	.04	.32	.92	1.89	3.99	20.38
Hayward (near)	5.13	4.05	3.68	2.31	1.12	.16	.03	.04	.31	1.34	2.03	5.22	25.42
Jensen Ranch	5.19	4.35	3.37	1.65	.98	.27	.02	.02	.32	1.09	2.40	4.31	23.97
Livermore	2.97	2.47	2.24	1.03	.51	.12	.01	.02	.27	.58	1.51	2.72	14.45
Newark	1.86	2.57	2.47	.85	.46	.11	.03	.01	.03	.99	1.89	2.37	13.64
Niles	3.69	3.07	2.94	1.40	.74	.19	(1)	.03	.29	1.01	2.08	3.35	18.79
Oakland	3.30	3.51	2.31	1.46	.61	.15	.01	.02	.09	.91	1.95	3.42	17.74
Old Weidemann Ranch	5.20	4.52	3.21	1.75	.96	.25	.01	.02	.27	1.12	2.67	4.60	24.58
Pleasanton	3.31	3.39	2.35	1.44	.49	.12	.01	.01	.21	.77	1.86	3.39	17.35
San Ramon	4.79	3.81	2.72	1.12	.56	.11	(1)	.01	.26	.83	2.22	3.94	20.37
Sunol	3.98	3.89	2.56	1.40	.70	.15	(1)	.02	.40	.95	1.77	3.72	19.54
Upper San Leandro Reservoir	5.34	4.90	3.61	2.10	1.07	.23	.02	.03	.24	1.47	2.81	4.90	26.72

[1] Trace.

times rainfall is heavy enough or persistent enough to cause flooding. The intensity and frequency of storms that can be expected in the drier, eastern part of the Area and along the bay and adjoining coastal hills are shown in table 5.

Hail has been observed at times, but it is infrequent and does not usually cause much damage.

Soil moisture.—Rainfall during the winter usually saturates the root zone of the soil, and the prolonged rainless period in summer nearly always exhausts the

TABLE 4.—*Probability of receiving less than the tabulated amount of annual precipitation at 22 weather stations*

Station	Length of record	Frequency of precipitation								
		1 year in 20	1 year in 10	1 year in 4	1 year in 3	1 year in 2	2 years in 3	3 years in 4	9 years in 10	19 years in 20
	Years	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Altamont Creek	43	7.10	8.16	9.96	10.71	12.20	13.83	16.85	17.38	19.00
Alvarado (near)	18	7.87	9.10	11.40	12.30	14.43	16.65	17.96	21.57	24.03
Alviso	12	7.65	8.54	10.16	10.86	12.24	13.80	14.64	17.00	18.60
Arroyo del Valle	35	11.07	12.88	16.16	17.52	20.57	23.50	25.31	30.40	33.90
Arroyo Mocho	40	7.54	8.58	10.45	11.22	12.82	14.52	15.51	18.26	19.97
Calaveras Reservoir	46	9.21	11.08	14.19	15.70	18.56	21.41	23.28	28.50	31.62
Cayetano Creek	43	8.19	9.34	11.46	12.29	14.15	16.06	17.15	20.22	22.27
Centerville	13	10.76	11.88	14.03	14.89	16.68	18.46	19.64	22.44	24.38
Chabot Reservoir	82	11.87	13.57	16.96	18.23	21.20	24.16	25.97	30.74	34.13
Gerber Ranch	50	9.16	10.68	13.35	14.42	16.74	19.14	22.60	26.70	29.64
Hayward High School	47	11.15	12.85	15.69	17.10	19.66	22.30	24.10	28.44	31.28
Hayward (near)	20	16.08	17.80	21.16	22.53	25.46	28.47	30.10	34.83	37.67
Jensen Ranch	55	14.62	16.30	19.49	21.42	23.35	26.38	28.14	32.42	35.45
Livermore	90	7.72	8.97	11.17	12.05	14.04	16.10	17.42	20.58	22.71
Newark	18	8.88	9.85	11.64	12.33	13.94	15.50	16.51	19.00	21.80
Niles	84	11.29	12.51	14.88	15.86	17.87	20.00	21.17	24.58	26.46
Oakland	32	9.52	10.97	13.60	14.71	16.92	19.38	20.80	24.65	27.37
Old Weidemann Ranch	42	13.75	15.73	19.35	20.80	23.87	27.06	29.26	31.68	37.85
Pleasanton	39	9.80	11.17	13.63	14.65	16.75	19.00	20.30	23.85	26.10
San Ramon	46	10.98	12.64	15.68	16.85	19.50	22.27	24.00	28.52	31.56
Sunol	43	11.24	12.63	15.20	16.28	18.47	20.88	22.27	25.92	28.25
Upper San Leandro Reservoir	36	14.64	16.80	20.64	22.32	25.56	29.16	31.20	36.84	40.56

TABLE 5.—*Frequency of storms of specified intensity in the Alameda Area*

Duration of storm	Frequency			
	Once in 2 years—		Once in 100 years—	
	Eastern part will have—	Hills and bay area will have—	Eastern part will have—	Hills and bay area will have—
	Inches	*Inches*	*Inches*	*Inches*
1 hour	0.45	0.70	1.10	1.40
6 hours	1.00	1.50	2.30	3.00
24 hours	1.20	3.00	2.75	6.00

stored moisture and dries the soil. The computed moisture storage and use indicate that plants continue to grow on natural moisture until late in May or early in June in an average year, but they dry up then if they are not irrigated. The length of time plants will grow on natural moisture may vary a month either way from year to year, depending on the distribution of rainfall during winter. On occasion, rains early in fall have caused annual grass seeds to germinate and then be killed by the dry weather that followed. This situation creates problems in forage production if the grasses are primarily annuals.

Some of the significant differences in soil moisture at various places within the Area are shown in table 6 and figure 4. The figures on annual precipitation in table 6 are self-explanatory. The column headed annual ETp in this table shows the potential evapotranspiration, or the amount of moisture, in inches, a plant could use in a 12-month period if it had all the moisture it needed. This amount is controlled primarily by temperature. The column headed ETp32 and figure 4 show the potential evapotranspiration, or the amount of moisture a plant could use during the growing season, that is, between the last freeze in spring and the first in fall. The column headed ETa shows the actual evapotranspiration, or the amount of moisture a plant can be expected to use for a 12-month period under dry-farmed conditions, and column ETa32 and figure 4 show the same data for only the growing season. In computing the data in these columns, the controlling effect of temperature and the limiting effect of natural rainfall were considered. Also, in computing the values for actual evapotranspiration (ETa), 4 inches of available water holding capacity in the root zone has been assumed. The length of the growing season is shown in the last column of the table.

Relative humidity.—During the winter the relative humidity is about 85 to 90 percent at night and decreases to 60 or 70 percent during the afternoon. Humidity is less during the spring, but it increases at night during the summer months on the west side of the coastal hills. The afternoon humidity is near 60 percent near the bay but is near 40 percent in the eastern end of the Area. The driest part of the year is the fall, when humidity in the western part of the Area ranges from 50 percent during the day to 70 percent during the night. In the eastern part, the humidity ranges from around 30 percent to nearly 50 at these times.

Cloudiness.—The maximum cloudiness occurs in midwinter, when the mean sky cover is approximately 60 percent along the bay and 70 percent inland. Much of the

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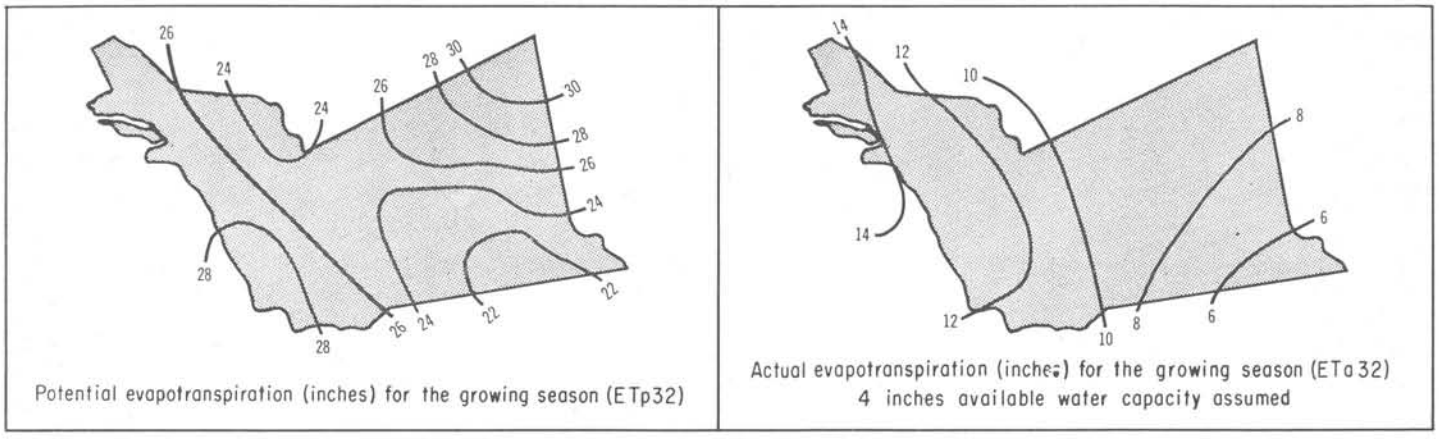

***Figure 4.*—Potential and actual evapotranspiration for the growing season at various stations.**

TABLE 6.—*Evapotranspiration, potential (ETp) and actual (ETa), at stated stations* [1]

Station	Annual precipitation	ETp (annual)	ETp32 (growing season)	ETa (annual)	ETa32 (growing season)	Growing season
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Days*
Alvarado (near)	16. 06	29. 56	29. 56	12. 30	12. 30	365
Hayward High School	20. 38	27. 91	25. 98	14. 12	12. 19	306
Livermore	14. 45	30. 64	27. 22	11. 56	8. 14	254
Newark	13. 64	27. 64	25. 41	12. 52	10. 29	293
Oakland	17. 74	27. 47	26. 28	13. 66	12. 47	333
Tracy Pumping Plant	11. 13	34. 58	31. 79	10. 39	8. 13	258

[1] Available water-holding capacity in root zone of 4 inches is assumed.

cloudiness inland is associated with the ground fog that drifts in from the Central Valley and persists for several days at a time during winter. The ocean cloudiness holds the sky cover to 30 or 40 percent along the bay, even during midsummer, but inland the sky cover drops to as low as 10 percent during July.

In the interior the number of clear days ranges from about 6 days each month during the winter to 28 days each month during the summer. Cloudy days average 20 each month during the winter and only about 1 each month during the summer. Because of cloudiness from the ocean in summer, however, the number of cloudy days is more uniform throughout all seasons in areas near the bay. In these areas clear days range from 8 or 9 each month during the winter to 15 each month during the summer, and cloudy days range from 15 days each month in winter to 3 or 4 in summer. The number of days that have rain is fairly uniform across the Area. About 10 days each month have rain during the winter, and less than 1 day each month has rain during the summer.

Wind.—During the growing season the wind blows mainly from the ocean through the Area toward the San Joaquin Valley. The direction varies from point to point, depending upon local influences, but the prevailing direction is from a westerly quadrant. At Livermore the wind blows from the southwest about 23 percent of the time and from the southwest quadrant more than 50 percent of the time. Strong winds are unusual. Windspeeds are less than 6 miles per hour for more than 50 percent of the time and exceed 12 miles per hour for only 10 percent of the time.

Persistent winds are characteristic of the Altamont Pass during much of the growing season. Marine air flows through this gap in the hills into the San Joaquin Valley and results in moderately strong winds nearly every afternoon and evening during the summer. Although these summer winds are persistent and moderately strong in some places, the strongest are usually associated with winter storms. Winds from the north or east occasionally cause dry periods and are sometimes accompanied by cold during the winter and spring. Windspeeds are expected to reach 40 to 45 miles per hour at least once every 2 years, and as much as 85 to 90 miles per hour once in every 50 years.

How This Soil Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in the Alameda Area, where they are located, and how they can be used.

They went into the Area knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the Area, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of plants or crops; kinds of rock;

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

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to uniform procedures. For successful use of this report, it is necessary to know the kinds of groupings most used in a local soil classification.

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

Many soil series contain soils that differ in texture of their surface layer. According to this difference in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Rincon loam and Rincon clay loam are two soil types in the Rincon series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Los Osos silty clay loam, 7 to 30 percent slopes, is one of several phases of Los Osos silty clay loam, a soil type that ranges from gently sloping to very steep.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. They used aerial photographs for their base map because they show buildings, field borders, trees, and similar detail that greatly help in drawing soil boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

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

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so close together and so small in size that it is not practical to show them separately on the map. Therefore, they show these soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major soil series in it; for example, Los Gatos-Los Osos complex, 30 to 45 percent slopes, eroded. In other places two or more soils may be mapped together as an undifferentiated unit if the differences between them are too small to justify separate recognition for the purpose of the soil survey; for example, Los Osos and Millsholm soils, 7 to 30 percent slopes. Also, in most mapping, there are areas to be shown that are so rocky, so shallow, or so frequently worked by wind and water that they cannot be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Rock land or Riverwash.

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey reports. The soil scientists set up trial groups, based on the yield and practice tables and other data, and test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The soils of the Alameda Area occur in definite patterns. By drawing lines around the different patterns on a small map, one may obtain a general map of the soils. Each kind of pattern is called a soil association. The pattern, of course, is not strictly uniform in each association, but a few major soils and several minor soils are present in somewhat the same arrangement. The general map is useful to those who want a general idea of the soils, who want to compare different parts of a county, or who want to locate large areas suitable for a particular kind of farming or other broad land use. It does not show accurately the kinds of soils on a single farm or small tract.

The seven general soil associations, or kinds of patterns, in the Alameda Area are shown on the colored general soil map in the back of this report. Three associations are classed as Soils of the Uplands, and four as Soils of the Terraces, Alluvial Fans, and Flood Plains. Each association is named for the major soil series in it, but soils of other series may also be present. The major

soils of one association may occur in another association, but in a different pattern.

The Yolo-Pleasanton and the Clear Lake-Sunnyvale associations are the most important agriculturally in the Area and are the most intensively used. The other associations are large, and each has a distinct pattern of soils. The soil differences within each association are important to agriculture.

Soils of the Uplands

Soils on uplands make up about 72 percent of the survey Area. At the higher elevations in the uplands there are generally sloping to steep mountains. The foothills are generally sloping to steep and have many very steep canyons. The rocks are dominantly sedimentary and metasedimentary, but basic igneous rocks occur in some small areas.

Soil associations have been mapped principally on the basis of soil differences that are related to differences in parent rocks. The three soil associations in the uplands are:

1. Altamont-Diablo association: Moderately sloping to very steep, brownish and dark-gray, moderately deep soils on soft sedimentary rocks.
2. Vallecitos-Parrish association: Moderately steep and very steep, brownish and reddish-brown soils on metasedimentary and basic igneous rocks.
3. Millsholm-Los Gatos-Los Osos association: Moderately sloping to very steep, brownish soils on moderately hard sedimentary rocks.

1. *Altamont-Diablo association*

This association occurs in the uplands north and east of Livermore Valley. It is characterized by smooth, rounded hills. In general, the topography is rolling to steep, but there are some very steep slopes along streams. Elevations range from 700 to 1,700 feet, and the average rainfall is between 10 and 15 inches. The vegetation consists mainly of annual grasses and a few scattered oaks. This association occupies about 17 percent of the Area.

The Altamont soils make up about 25 percent of the association; Diablo soils, about 25 percent; and Linne soils, about 30 percent. The rest consists of Los Osos, Pescadero, and Solano soils.

The Altamont, Diablo, and Linne soils formed in material that weathered from interbedded sedimentary rock. They are typically moderately fine and fine textured. The Altamont and Diablo soils are similar, except that the Altamont soils are dark brown and the Diablo soils are gray. The surface layer of the Altamont and Diablo soils is clayey, neutral to mildly alkaline, and very hard. On drying, it breaks to strong, prismatic or blocky structure. Except for a few nodules of lime, this layer is noncalcareous. It grades to a very hard, slightly to strongly calcareous, clayey subsoil. The Linne soils are strongly calcareous, granular, and dark gray or dark grayish brown throughout the profile.

The soils of this association are typically well drained, but in some places they are excessively drained. They are moderately deep to deep and have moderate to high fertility and available water holding capacity.

Along small valleys in this association are the poorly drained, saline-alkali soils of the Pescadero and Solano series. These soils are minor in extent, and their use is limited to saltgrass pasture. Also in this association are small areas of Los Osos soils, which are brownish, slightly acid, and shallow to moderately deep.

Many of the soils in this association are moderately eroded, primarily because they were cultivated in the past. Because of low rainfall, hilly topography, and lack of irrigation water, farming is limited to dry-farmed grain, mainly barley, and to grazing. Good yields of barley can be expected, and yields of forage are high. The farms range in size from 160 to 6,000 acres and average about 1,000 acres.

2. *Vallecitos-Parrish association*

This association is in the uplands in the southeastern part of the Area. It is characterized by steep and very steep mountainous terrain and frequent outcrops of bedrock. Elevations range from about 1,000 feet to about 3,800 feet, and the annual rainfall, on the average, is between 15 and 25 inches. The vegetation is mainly annual grasses and oaks, but on the heavily forested, north-facing slopes it consists of oak, laurel, poison-oak, various shrubs, some digger and Coulter pine, and an understory of annual and perennial grasses. A few areas have a dense stand of manzanita, chamise, and yerba-santa. This association occupies about 25 percent of the Area.

The Vallecitos soils make up about 50 percent of the association; the Parrish soils, about 20 percent; and the Henneke soils, about 25 percent. The Livermore and Pleasanton soils make up the rest.

The Vallecitos soils are shallow, and the surface soil is typically loam. They have frequent outcrops of bedrock. The Parrish soils formed from parent material similar to that of Vallecitos soils. Typically, they are moderately deep, gravelly loam and are on the higher elevations along the southern county line. The Henneke soils, which are reddish brown, shallow, and moderately alkaline, occur under a solid stand of brush. These soils generally are moderately eroded, but in many places they are severely eroded.

The Vallecitos, Parrish, and Henneke soils are well drained to excessively drained. Generally, they are shallow and have low available water holding capacity and fertility.

Along small valleys in this association are the well-drained Livermore and Pleasanton soils. These soils are of minor extent.

Many of the soils in this association are moderately eroded. Because they are steep and shallow, these soils are used entirely for grazing. Forage yields, however, are low to moderate.

The size of farms ranges from 1,200 to 15,000 acres and averages about 2,000 acres.

3. *Millsholm-Los Gatos-Los Osos association*

This association is in the uplands in the western part of the Area. It extends from the Calaveras Reservoir to the Upper San Leandro Reservoir. It is characterized by strongly sloping to very steep topography. Elevations range from about 600 feet to about 2,500 feet, and

the annual rainfall, on the average, is between 15 and 20 inches. The vegetation consists of annual grasses and oaks. On very steep north-facing slopes, the vegetation consists mainly of oak, laurel, coyotebrush, poison-oak, various shrubs, and some annual and perennial grasses. On the very steep south-facing slopes, the vegetation is mainly rabbitbrush, California sage, and some annual grasses. This association makes up approximately 30 percent of the Area.

The Millsholm soils make up about 40 percent of the association; the Los Osos soils, about 25 percent; the Los Gatos soils, about 20 percent; and the Gaviota soils, about 5 percent. The Lobitos, Danville, Yolo, and Los Osos, seeped variant, soils make up the rest.

The Los Osos and Millsholm soils are strongly sloping to steep soils in the uplands. Local landslides occur in both soils but are more frequent in the finer textured Los Osos soils. The Los Gatos soils have steep and very steep forested slopes. The Gaviota soils generally have very steep south-facing slopes. The Millsholm soils range in color from olive to yellowish brown. The Los Osos soils range in color from grayish brown to dark grayish brown. The Los Gatos soils are brown with a reddish-brown subsoil and are slightly acid or neutral throughout. The Gaviota soils are shallow and very shallow, brown, slightly acid loams and sandy loams.

The Millsholm, Los Osos, Los Gatos, and Gaviota soils are well drained to excessively drained. They are very shallow to moderately deep and have low to moderate available water holding capacity and fertility.

Also in this association are the Lobitos and Los Osos, seeped variant, soils. The Los Osos, seeped variant, soils are grayish brown, mottled, and imperfectly drained to moderately well drained. They occur in the small upland valleys. The Lobitos soils are shaly loams that have a grayish-brown surface soil and a pinkish-gray subsoil. They are strongly acid throughout and developed in diatomaceous shale. Also, along the small valleys in this association are the well-drained Danville and Yolo soils. These soils are of minor extent.

Many of the soils in this association are moderately eroded, and some areas have frequent landslides. Because of low rainfall, steep topography, and lack of water, farming is limited to pasture and range, but an occasional crop of grain is grown in some areas. Yields of forage range from low to high.

The size of farms ranges from 160 to 3,000 acres and averages about 640 acres.

Soils of the Terraces, Alluvial Fans, and Flood Plains

The soils on terraces, alluvial fans, and flood plains make up only about 28 percent of the survey area, but most of the agricultural land and most of the urban land in the Area are on these soils. Elevations range from 250 to 1,500 feet. The topography is variable. Some of the high terraces are very steep, but the lower terraces, fans, and flood plains are nearly level. The average annual rainfall is about 12 to 15 inches. The vegetation consists mainly of annual grasses, but there are also some oak trees. The parent material consists of alluvium and old terrace material. Because sedimentary rocks are dominant in most of the uplands, they are the main source of the alluvium.

The four soil associations mapped to show the different patterns of soils are the following:

4. Yolo-Pleasanton association: Nearly level to sloping, grayish-brown, very deep soils on flood plains and low terraces.
5. Positas-Perkins association: Nearly level to very steep, brown, shallow to moderately deep soils on high terraces.
6. Clear Lake-Sunnyvale association: Nearly level to sloping, dark-gray, very deep, well-drained to imperfectly drained soils on flood plains and basins.
7. Rincon-San Ysidro association: Nearly level, shallow to very deep, pale-brown and grayish-brown soils on older fans and flood plains.

4. *Yolo-Pleasanton association*

This association occurs in the valley, in the vicinity of Pleasanton and Livermore. It is characterized by nearly level topography and a few strongly sloping escarpments on the low terraces. Elevations range from 220 to 800 feet, and the average annual rainfall is about 14 inches. The vegetation in areas not cultivated consists of annual grasses and scattered oaks. This association occupies approximately 10 percent of the Area.

The Yolo soils make up about 30 percent of the association; the Pleasanton soils, about 20 percent; the Sycamore soils, about 20 percent; the Livermore soils, about 20 percent; and the Zamora and other soils make up the rest.

The Yolo series consists of very deep, well-drained, grayish-brown soils that are neutral to mildly alkaline and in some areas have a calcareous subsoil. The Sycamore soils are similar to the Yolo soils, except that they are calcareous throughout and have a mottled subsoil that indicates that they were formed under poor drainage. The Livermore and the Pleasanton soils are similar; both are very deep and well drained. The Pleasanton soils, however, have a more prominent subsoil than the Livermore, and the Livermore soils are typically very gravelly. The Pleasanton soils are grayish brown, slightly acid, and gravelly. They have a brown, slightly acid clay loam subsoil. The Livermore soils are brown, slightly acid, very gravelly coarse sandy loam. The Zamora are minor soils in this association. They are very deep, well-drained, grayish-brown soils that have a mildly alkaline surface layer and a moderately alkaline subsoil.

The soils of this association are the most intensively cultivated in the Area. Well water is available throughout most of this association. Much of the acreage around Pleasanton and Sunol is used for irrigated pasture, row crops, roses, and walnuts. Most of the vineyards are limited to the gravelly soils south of Livermore, and nearly all are irrigated in spring by sprinklers. In areas where water is not available, the main crop is dry-farmed grain or grain hay. The farms range from 100 to 600 acres in size. Their average size is between 200 and 300 acres.

5. *Positas-Perkins association*

This association is on the terraces south of the Livermore Valley. The relief is gently sloping to very steep. Elevations range from 300 to 1,500 feet, and the average annual rainfall is between 12 and 15 inches. The vegetation consists primarily of annual grasses on the more gentle slopes and annual grasses and scattered oaks on the steeper slopes. This association occupies about 10 percent of the Area.

The Positas soils make up about 70 percent of the association; the Shedd soils, about 10 percent; the Perkins soils, about 5 percent; and the Azule soils, about 5 percent. Diablo clay, very deep, makes up the rest.

The Positas soils are mainly on the gravelly high terraces that have a gently sloping crest. They are shallow to a claypan. The surface soil is brown, medium acid gravelly loam. The fertility and available water holding capacity are low. The Perkins soils are on the lower terraces. They are similar to Positas soils but lack the claypan subsoil. They are moderately deep, and the available water holding capacity and fertility are low to moderate. The surface soil is a pale-brown, medium acid loam that is underlain by a yellowish-brown, slightly acid gravelly clay loam. The Shedd soils are on the upper edge of the high terraces on steep and very steep topography, where highly calcareous lacustrine material is exposed. They have a light brownish-gray, calcareous silt loam surface soil that grades to a highly calcareous, similarly colored silt loam subsoil. The fertility and available water holding capacity are low to moderate. The Shedd soils are the most erodible soils in the Area.

The Azule, Diablo clay, very deep, and Shedd soils developed in finer textured material than the Perkins soils. These soils are usually characterized by smooth, rounded hills broken by an occasional landslide. The Azule soils are mainly on the gravelly high terraces that have a gently sloping crest. They are slightly acid, moderately deep, grayish-brown clay loam. The subsoil is dark grayish-brown, slightly acid clay. The available water holding capacity is low to moderate, and fertility is moderate.

The Diablo clay, very deep, soils developed in fine-textured, calcareous, terrace material. These soils have thick, dark-gray, clayey surface and subsurface layers and are underlain by calcareous silty clay. Their available water holding capacity and fertility are high. The Shedd soils generally occur along the upper edge of high terraces and have developed in pale-olive to olive, calcareous, lacustrine material. These soils have a light brownish-gray, calcareous silt loam surface and subsurface soil. Their available water holding capacity and fertility are moderate.

Many of the soils in this association are moderately eroded because of cultivation in the past. Farming now is limited to grazing and the growing of some grain and grain hay. The yields on the Azule and Diablo soils are high, but yields on the Positas, Perkins, and Shedd soils are low to moderate.

The size of farms ranges from 160 to 3,000 acres and averages about 1,000 acres.

6. *Clear Lake-Sunnyvale association*

This association is in the basin areas and on low terraces east of Dublin and also on low terraces along the southwestern part of the Area. It is characterized by nearly level topography, although soils on the terraces are moderately sloping in places. Elevations range from about 100 to 900 feet, and the average annual rainfall is about 14 or 15 inches. This association makes up 5 percent of the Area.

The Clear Lake, Sunnyvale, Pescadero, and Danville are the principal soils of this association. All except the Danville soils were formed under poor drainage.

The Clear Lake soils are in the basin area and are imperfectly drained and moderately well drained. The surface soil is clayey, neutral to mildly alkaline, and very hard. It breaks to strong prismatic or blocky structure on drying. It grades to a very hard, strongly calcareous, clayey subsoil. The Clear Lake soils have high fertility, and the available water holding capacity is high. The Sunnyvale soils formed in a similar area, but the surface soil consists of recent outwash of gray, calcareous clay loam. It is underlain by dark-gray, calcareous clay. Sunnyvale soils have high fertility, and the available water holding capacity is high. The Pescadero are saline-alkali soils that formed along the basin rim. The surface soil is gray, slightly acid clay loam. It is very thin and is underlain at a depth of a few inches by a very dark gray or black, alkaline clay. The fertility and available water holding capacity of Pescadero soils are low. The Danville are very deep soils that formed on low terraces and fans. The surface soil is grayish-brown, slightly acid silty clay loam that grades to a slightly acid silty clay. The Danville soils have high available water holding capacity and fertility.

Use of these soils is limited mainly to grain and grain hay. A small acreage of Clear Lake soils is used for irrigated pasture. The saline-alkali Pescadero and Solano soils are used almost entirely for saltgrass pasture. The size of farms ranges from 160 to 3,000 acres and averages about 500 acres.

7. *Rincon-San Ysidro association*

This association occurs in the northeast corner of the Area and in the Livermore Valley. It is characterized by nearly level to gently sloping fans and flood plains, but small areas have hummocky microrelief. Elevations range from 5 to 125 feet in the northeast corner of the county and from 500 to 600 feet in the northeast corner of Livermore Valley. The vegetation consists mainly of annual grasses. This association makes up about 3 percent of the Area.

The Rincon and San Ysidro are the principal soils of this association. There are also small areas of the Solano soils. The soils in this association formed in alluvium that weathered from sedimentary rock and have a loamy texture.

The surface layer of the Rincon soils is grayish-brown, neutral clay loam. It grades to a brown, neutral to mildly alkaline clay subsoil. The Rincon soils have a high available water holding capacity and moderate fertility. The surface layer of San Ysidro soils is a pale-brown, medium acid loam that lies abruptly on

brown, neutral clay (claypan). The clay becomes calcareous with increasing depth. The San Ysidro soils have low fertility and low available water holding capacity.

The saline-alkali soils of the Solano series have a very pale brown, medium acid fine sandy loam surface soil. It grades rather abruptly to a pale-brown, neutral loam. The amount of salts increases with increasing depth.

Intensive agriculture in this association is limited to the Rincon soils, which are irrigated. Irrigated alfalfa and pasture are the main crops. The rest of the association is used for grain, grain hay, pasture, and range. Yields of irrigated pasture are high, and those of alfalfa are moderate. Yields of crops on the San Ysidro and Solano soils are low.

The size of farms ranges from about 80 to 2,000 acres and averages about 160 acres.

Descriptions of the Soils

This section is provided for those who want detailed information about the soils. It describes the soil series and the single soils, or mapping units, in each series.

For more generalized information about soils of different parts of the Area, the reader can refer to the section "General Soil Map." The approximate acreage and proportionate extent of the soils are given in table 7, and a list of the soils mapped, along with the capability unit of each, is given at the back of this report. More detailed descriptions of the soil series are given in the sections "Formation and Classification of Soils" and "Descriptions of Soil Profiles."

Altamont Series

The Altamont series consists of well-drained, moderately deep to deep soils on the rolling to very steep uplands north and east of Livermore Valley. These soils formed in material that weathered from interbedded shale and fine-grained sandstone. Their vegetation is mainly annual grasses and a few scattered oaks. The Altamont soils are in the same general area as the Diablo and Linne soils of the uplands, and the Pescadero, San Ysidro, and Clear Lake soils of the small upland valleys.

The surface soil is dark-brown, very hard, neutral to mildly alkaline clay. When dry, it breaks into a strong prismatic or blocky structure. In most places, this layer is noncalcareous except for a few nodules of lime. It grades to a finely mottled, dark-brown and dark yellowish-brown, very hard, calcareous clay subsoil. The substratum is yellowish-brown, very hard, calcareous silty clay. Depth to bedrock ranges from 18 to 60 inches.

Altamont soils are used mainly for dry-farmed grain, grain hay, pasture, and range.

Altamont clay, 15 to 30 percent slopes (AaD).—This soil occurs mostly in large bodies on smooth hills.

Representative profile:

0 to 28 inches, dark-brown clay; strong to moderate prismatic structure that breaks to strong to moderate blocky structure; very hard when dry, very firm when moist, sticky and very plastic when wet; neutral to mildly alkaline.

28 to 37 inches, finely mottled dark-brown and dark yellowish-brown clay; few whitish lime films and nodules; weak prismatic structure that breaks to moderate blocky structure; very hard when dry, very firm when moist, sticky and very plastic when wet; mildly alkaline.

37 to 50 inches, yellowish-brown silty clay; many whitish lime segregations and nodules; weak blocky structure; very hard when dry, very firm when moist, plastic and sticky when wet; moderately alkaline.

50 inches +, shattered shale and fine-grained sandstone.

The color of the surface soil ranges from brown to dark brown, light grayish brown, or very dark grayish brown. The texture is clay loam in places. In some places, the surface soil is slightly calcareous.

The soil is well drained and slowly permeable. Runoff is medium. When the soil is dry and deeply cracked, it absorbs water readily. Root penetration is deep, and the available water holding capacity is moderate to high. The soil generally has good tilth and can be cultivated best when the moisture content is about one-half field capacity. Fertility is high. The erosion hazard is moderate if the soil is cultivated.

The soil is used for dry-farmed grain, grain hay, pasture, and range. (Capability unit IVe–5)

Altamont clay, 3 to 15 percent slopes (AaC).—Except for more gentle slopes, this soil is similar to Altamont clay, 15 to 30 percent slopes. The erosion hazard is slight. The soil is somewhat difficult to work and is used mainly for dry-farmed grain and grain hay. (Capability unit IIIe–5)

Altamont clay, moderately deep, 30 to 45 percent slopes, eroded (AmE2).—This soil occurs on steep, smooth, well-rounded hills. Depth to the bedrock that restricts penetration of roots ranges from 18 to 36 inches. Otherwise, this soil is similar to Altamont clay, 15 to 30 percent slopes. Runoff is medium to rapid. The available water holding capacity and fertility are moderate. The soil is very difficult to work and susceptible to severe erosion. It is used mainly for pasture and range, but a few areas are used for dry-farmed grain and grain hay. (Capability unit VIe–5; Clayey Hills range and pasture site)

Altamont clay, moderately deep, 45 to 75 percent slopes, eroded (AmF2).—This soil is very steep and has occasional rock outcrops. Depth to bedrock ranges from 18 to 30 inches. Otherwise, the soil is similar to Altamont clay, 15 to 30 percent slopes. Root penetration is moderately deep. The available water holding capacity and fertility are moderate. The erosion hazard is very severe. The soil is very difficult to cultivate and is used only for pasture and range. (Capability unit VIIe–5; Steep Clayey Slopes range site)

Altamont rocky clay, moderately deep, 7 to 30 percent slopes (ArD).—This soil is gently rolling to hilly and has many rock outcrops. The underlying rock that restricts root penetration is at a depth of 18 to 36 inches. Otherwise, this soil is similar to Altamont clay, 15 to 30 percent slopes. This soil is very difficult to cultivate because of rock outcrops. It is used for pasture and range. (Capability unit VIe–5; Clayey Hills range and pasture site)

Azule Series

The Azule series consists of well-drained, moderately deep soils on gently rolling to very steep terraces. These soils formed in moderately fine-textured, semiconsolidated material. Their vegetation is mainly annual

TABLE 7.—*Approximate acreage and proportionate extent of the soils of the Alameda Area*

Soil symbol	Soil	Acres	Percent	Soil symbol	Soil	Acres	Percent
AaC	Altamont clay, 3 to 15 percent slopes	1,006	0.3	LuD	Los Osos and Millsholm soils, 7 to 30 percent slopes	4,185	1.3
AaD	Altamont clay, 15 to 30 percent slopes	9,283	2.9	LuE2	Los Osos and Millsholm soils, 30 to 45 percent slopes, eroded	5,466	1.7
AmE2	Altamont clay, moderately deep, 30 to 45 percent slopes, eroded	8,641	2.7	LsC	Los Osos loam, seeped variant, 3 to 15 percent slopes	650	.2
ArD	Altamont rocky clay, moderately deep, 7 to 30 percent slopes	5,546	1.7	MhE2	Millsholm silt loam, 30 to 45 percent slopes, eroded	12,334	3.7
AmF2	Altamont clay, moderately deep, 45 to 75 percent slopes, eroded	2,858	.9	MhF2	Millsholm silt loam, 45 to 75 percent slopes, eroded	11,061	3.3
AzD	Azule clay loam, 3 to 30 percent slopes	1,019	.3	PaE2	Parrish gravelly loam, 30 to 45 percent slopes, eroded	1,825	.6
AzE2	Azule clay loam, 30 to 45 percent slopes, eroded	376	.1	PaF2	Parrish gravelly loam, 45 to 75 percent slopes, eroded	3,981	1.2
AzF2	Azule clay loam, 45 to 60 percent slopes, eroded	221	(1)	PcD	Perkins loam, 3 to 30 percent slopes	329	.1
CdA	Clear Lake clay, drained, 0 to 3 percent slopes	3,336	1.0	PcF2	Perkins loam, 45 to 75 percent slopes, eroded	1,049	.3
CdB	Clear Lake clay, drained, 3 to 7 percent slopes	1,316	.4	Pd	Pescadero clay	1,779	.6
Cc	Clear Lake clay, 0 to 3 percent slopes	1,716	.5	PgA	Pleasanton gravelly loam, 0 to 3 percent slopes	2,587	.8
CoC2	Cotati fine sandy loam, eroded	826	.2	PgB	Pleasanton gravelly loam, 3 to 12 percent slopes	3,071	1.0
DaA	Danville silty clay loam, 0 to 3 percent slopes	410	.1	PoC2	Positas gravelly loam, 2 to 20 percent slopes, eroded	8,984	2.8
DaB	Danville silty clay loam, 3 to 10 percent slopes	2,445	.8	PoE2	Positas gravelly loam, 20 to 40 percent slopes, eroded	8,179	2.5
DbC	Diablo clay, 7 to 15 percent slopes	141	(1)	PoF2	Positas gravelly loam, 40 to 60 percent slopes, eroded	3,335	1.0
DbD	Diablo clay, 15 to 30 percent slopes	5,565	1.7	PtB2	Positas gravelly loam, thick surface, 2 to 10 percent slopes, eroded	2,271	.7
DbE2	Diablo clay, 30 to 45 percent slopes, eroded	7,836	2.4	Rc	Rincon loam, 0 to 3 percent slopes	2,075	.7
DmF2	Diablo clay, moderately deep, 45 to 60 percent slopes, eroded	2,983	.9	RdA	Rincon clay loam, 0 to 3 percent slopes	3,511	1.1
DvC	Diablo clay, very deep, 3 to 15 percent slopes	2,462	.8	RdB	Rincon clay loam, 3 to 7 percent slopes	1,069	.3
DvD2	Diablo clay, very deep, 15 to 30 percent slopes, eroded	1,588	.5	Rh	Riverwash	2,925	.8
DvE2	Diablo clay, very deep, 30 to 45 percent slopes, eroded	1,648	.5	RoF	Rock land	8,677	2.7
DvF2	Diablo clay, very deep, 45 to 60 percent slopes, eroded	383	.1	Sa	San Ysidro loam	2,243	.7
GaE2	Gaviota rocky sandy loam, 5 to 40 percent slopes, eroded	2,348	.7	SdD2	Shedd silt loam, 15 to 30 percent slopes, eroded	646	.2
GaF2	Gaviota rocky sandy loam, 40 to 75 percent slopes, eroded	3,600	1.1	SdE2	Shedd silt loam, 30 to 45 percent slopes, eroded	1,766	.6
Gp	Gravel pit	677	.2	SdF3	Shedd silt loam, 45 to 75 percent slopes, severely eroded	1,171	.4
HnF2	Henneke rocky loam, eroded	9,044	2.8	Sf	Solano fine sandy loam	1,098	.4
LaC	Linne clay loam, 3 to 15 percent slopes	7,083	2.2	Sn	Sunnyvale clay loam, drained	528	.2
LaD	Linne clay loam, 15 to 30 percent slopes	7,201	2.2	Sl	Sunnyvale clay loam	426	.2
LaE2	Linne clay loam, 30 to 45 percent slopes, eroded	6,761	2.1	Sm	Sunnyvale clay loam over clay	2,246	.7
LcF2	Linne clay loam, shallow, 45 to 75 percent slopes, eroded	1,797	.7	So	Sycamore silt loam	2,505	.8
Lg	Livermore gravelly loam	4,308	1.3	Sy	Sycamore silt loam over clay	242	(1)
Lm	Livermore very gravelly coarse sandy loam	1,134	.4	VaE2	Vallecitos rocky loam, 30 to 45 percent slopes, eroded	24,914	7.5
LoE2	Lobitos shaly loam, eroded	761	.2	VaF2	Vallecitos rocky loam, 45 to 75 percent slopes, eroded	30,096	9.0
LpE2	Los Gatos-Los Osos complex, 30 to 45 percent slopes, eroded	1,193	.4	YmA	Yolo loam, 0 to 3 percent slopes	4,529	1.4
LpF2	Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded	33,971	10.2	YmB	Yolo loam, 3 to 10 percent slopes	824	.3
LtD	Los Osos silty clay loam, 7 to 30 percent slopes	4,034	1.3	Ys	Yolo sandy loam, 0 to 3 percent slopes	306	(1)
LtE2	Los Osos silty clay loam, 30 to 45 percent slopes, eroded	7,636	2.4	Yr	Yolo gravelly loam, 0 to 3 percent slopes	421	.1
LtF2	Los Osos silty clay loam, 45 to 75 percent slopes, eroded	4,381	1.4	Yo	Yolo loam over gravel, 0 to 3 percent slopes	852	.3
				Zc	Zamora silty clay loam, 0 to 3 percent slopes	680	.2
				Za	Zamora silt loam, 0 to 4 percent slopes	2,280	.7
					Ditches and spoilbanks	350	.1
					Total	325,000	99.7

[1] Less than 0.1 percent. These soils total 0.3 percent.

grasses and a few scattered oaks. The Azule soils are in the same general area as the Positas, Pleasanton, and Diablo soils.

The surface soil is grayish-brown, slightly acid clay loam. When dry, it is very hard and is massive or has weak, coarse, blocky structure. It grades to a dark grayish-brown, slightly acid clay subsoil that is very hard and breaks to blocky structure when dry. The substratum consists of light yellowish-brown gravelly clay loam.

The Azule soils are used mainly for pasture and range but to some extent for dry-farmed grain and grain hay.

Azule clay loam, 3 to 30 percent slopes (AzD).—This soil occurs in small bodies in smooth, gently rolling to hilly areas.

Representative profile:

0 to 6 inches, grayish-brown clay loam; massive or weak, coarse, blocky structure; very hard when dry, firm when moist, plastic and sticky when wet; slightly acid.
6 to 25 inches, dark grayish-brown clay; moderate prismatic to medium blocky structure; very hard when dry, very firm when moist, very plastic and sticky when wet; slightly acid.
25 inches +, light yellowish-brown gravelly clay loam; massive; very hard when dry, firm when moist, plastic and sticky when wet.

The thickness of the surface soil ranges from 6 to 18 inches. The color ranges from grayish brown, gray, or dark gray to very dark gray. The texture ranges from silt loam to light clay. The color of the subsoil ranges from dark grayish brown to grayish brown. The color of the substratum ranges from light yellowish brown or yellowish brown to light olive brown, and the texture ranges from gravelly clay loam to silty clay. The substratum is slightly calcareous in some areas. Depth to the substratum ranges from 18 to 36 inches.

This soil is well drained, but it has a slowly permeable subsoil. Runoff is slow to medium. Root penetration is moderately deep, and the available water holding capacity is moderate. The soil generally has fair tilth, and cultivation is difficult on the steeper slopes. Fertility is moderate. The erosion hazard is slight to moderate if the soil is cultivated. The soil is used for pasture and range and some dry-farmed grain and grain hay. (Capability unit IVe–5)

Azule clay loam, 30 to 45 percent slopes, eroded (AzE2).—Except for steeper slopes, this soil is similar to Azule clay loam, 3 to 30 percent slopes. Runoff is medium to rapid, and the hazard of erosion is severe if the soil is cultivated. This soil is very difficult to work. It is used mainly for pasture and range, but a few acres are used for dry-farmed grain and grain hay. (Capability unit VIe–5; Clayey Hills range and pasture site)

Azule clay loam, 45 to 60 percent slopes, eroded (AzF2).—This soil has a surface layer that ranges from 12 to 24 inches in thickness and is typically dark gray in color. Otherwise, it is similar to Azule clay loam, 3 to 30 percent slopes. It is very difficult to work because of steepness. Runoff is rapid to very rapid, and the erosion hazard is very severe. This soil is used for pasture and range. (Capability unit VIIe–5; Steep Clayey Slopes range site)

Clear Lake Series

The Clear Lake series consists of very deep, moderately well drained and imperfectly drained, clayey soils in nearly level basins in the Livermore and Amador Valleys. These soils formed in fine-textured alluvium from sedimentary rock. In uncultivated areas the vegetation is mainly annual grasses and sedges. The Clear Lake soils are in the same general area as the Pescadero and Sunnyvale soils of the valleys and the Altamont, Diablo, and Linne soils of the uplands.

The upper 36 inches, which consists of the surface soil and subsurface soil, is dark-gray, very hard, slightly acid to moderately alkaline clay. When the soil is dry, it breaks to a strong prismatic or blocky structure. Except for a few nodules of lime, this layer is noncalcareous. It grades to a dark-gray, very hard, calcareous clay. The substratum consists of a dark grayish-brown and light olive-brown, calcareous silty clay.

Clear Lake soils are used mainly for irrigated pasture, dry-farmed grain, and grain hay.

Clear Lake clay, drained, 0 to 3 percent slopes (CdA).—This soil occurs mostly in large bodies in nearly level basins.

Representative profile:

0 to 36 inches, dark-gray clay; strong prismatic structure that breaks to moderate blocky structure; very hard when dry, very firm when moist, very plastic and sticky when wet; slightly acid in upper part, moderately alkaline in lower part.
36 to 48 inches, dark-gray clay; many seams of gypsum and nodules of lime; weak prismatic structure that breaks to moderate blocky; very hard when dry, firm when moist, very plastic and sticky when wet; moderately alkaline.
48 to 65 inches, dark grayish-brown and light olive-brown silty clay; contains whitish lime nodules; moderate blocky structure; very hard when dry, friable when moist, plastic and sticky when wet; moderately alkaline.

The surface soil is dark gray, very dark gray, very dark grayish brown, or very dark brown. In some areas the soil is calcareous throughout. In a few small valleys, there is an overwash of 12 to 18 inches of very dark grayish-brown, noncalcareous silty clay or light-gray, calcareous clay loam. In a few small areas the lime has been leached below a depth of 5 feet. In areas transitional to the Pescadero soils, this soil is slightly affected by salts and alkali.

This soil is slowly permeable, and runoff is very slow. Drainage is moderately good. It has been improved by the deepening of natural channels by erosion and by the extensive pumping of water for irrigation and for domestic use. When the soil is dry and deeply cracked, it absorbs water readily. Root penetration is very deep, and the available water holding capacity is high. The soil has fair tilth and can be cultivated best when moisture is about one-half field capacity. Fertility is high. Erosion is not a problem. The soil is used for irrigated pasture, dry-farmed grain, and grain hay. (Capability unit IIIs–5)

Clear Lake clay, drained, 3 to 7 percent slopes (CdB).—Except for steeper slopes, this soil is similar to Clear Lake clay, drained, 0 to 3 percent slopes. Runoff is slow, and

the hazard of erosion is slight. The soil is used mainly for dry-farmed grain and grain hay. (Capability unit IIIe–5)

Clear Lake clay, 0 to 3 percent slopes (Cc).—This imperfectly drained soil has an intermittent water table that is generally within 5 feet of the surface. The substratum is mottled olive, dark gray, and greenish gray. Otherwise, this soil is similar to Clear Lake clay, drained, 0 to 3 percent slopes. It is used mainly for irrigated pasture, dry-farmed grain, and grain hay (fig. 5). (Capability unit IIIw–5)

Cotati Series

The Cotati series consists of imperfectly drained, gray, moderately deep claypan soils on the moderately sloping to strongly sloping uplands northeast of Hayward. These soils formed from soft sandstone and shale. Their vegetation is mainly annual grasses and a few scattered oaks. The Cotati soils are in the same general area as the Los Osos soils.

The surface soil is gray, massive, slightly hard, medium acid fine sandy loam. The subsurface soil is grayish-brown and light grayish-brown, massive, hard, medium acid heavy loam. This layer grades abruptly to a layer of medium acid light brownish-gray clay that has faint yellowish-brown mottles. When dry, the clay layer is extremely hard and breaks to weak prismatic structure. This layer grades gradually to a light olive-brown clay loam layer that has faint yellowish-brown mottles. Depth to bedrock ranges from 24 to 48 inches or more. Cotati soils are used mainly for pasture and range.

Cotati fine sandy loam, eroded (CoC2).—This soil is in small bodies on moderately sloping to strongly sloping uplands. Slopes range from 5 to 20 percent.

Representative profile:

0 to 18 inches, gray fine sandy loam that grades to dark grayish-brown loam with depth; massive; slightly hard when dry, friable when moist, nonsticky to slightly sticky and nonplastic when wet; medium acid.

18 to 27 inches, grayish-brown and light brownish-gray heavy loam; few, faint, gray and strong-brown mottles; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; medium acid.

Figure 5.—**Irrigated pasture on Clear Lake clay, 0 to 3 percent slopes.**

27 to 42 inches, light brownish-gray clay; few, fine, faint, yellowish-brown mottles; weak prismatic structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; medium acid.

42 to 49 inches, light yellowish-brown gritty clay loam; few, fine, faint, yellowish-brown mottles; massive; very hard when dry, firm when moist, sticky and plastic when wet; medium acid.

49 inches +, pale-yellow shattered sandstone.

The texture of the surface soil is sandy loam, fine sandy loam, or loam. The color varies from gray or dark gray to grayish brown. In areas transitional to the Los Osos soils, the subsoil is clay loam instead of clay and is not mottled.

This soil is imperfectly drained and has a very slowly permeable subsoil. Runoff is medium, and the available water holding capacity is low. Root penetration is moderately deep. The soil has fair tilth, and cultivation is easy to somewhat difficult, depending on slope. Fertility is low. The erosion hazard is slight to moderate if the soil is cultivated. This soil is used mainly for pasture. (Capability unit IVe–3)

Danville Series

The Danville series consists of well-drained, very deep silty clay loam soils on nearly level to strongly sloping fans and terraces in the western part of the Alameda Area. These soils formed in alluvium from sandstone and shale. The vegetation is mainly annual grasses and a few scattered oaks, but coyotebrush has encroached in some areas. The Danville soils occur in the same general area as the Los Osos soils and the Los Gatos-Los Osos complex of soils in the uplands.

In most places the surface soil is grayish-brown to dark-gray, slightly acid silty clay loam. When dry, it breaks to weak granular structure. It grades to a grayish-brown, slightly acid silty clay loam subsoil. The subsoil has strong blocky structure when dry. The substratum is at a depth of 61 to 80 inches and is grayish-brown, neutral silty clay loam.

In nearly level areas and in places where irrigation water is available, these soils are used for vegetables, pasture, and fruit. In other areas the soils are used for dry-farmed grain, grain hay, pasture, or range.

Danville silty clay loam, 3 to 10 percent slopes (DaB).—This soil occurs mostly in small bodies on gently to moderately sloping fans and terraces.

Representative profile:

0 to 21 inches, dark-gray silty clay loam; weak granular structure; hard when dry, friable when moist, sticky and plastic when wet; slightly acid.

21 to 53 inches, grayish-brown silty clay; strong blocky structure; very hard when dry, firm when moist, very sticky and plastic when wet; slightly acid.

53 to 61 inches, grayish-brown silty clay loam; moderate, coarse, blocky structure; hard when dry, friable when moist, sticky and plastic when wet; neutral.

61 to 80 inches, grayish-brown silty clay loam; massive; hard when dry, friable when moist, sticky and plastic when wet; neutral.

In color, the surface soil ranges from gray, very dark gray, or grayish brown to dark grayish brown. In texture, it ranges from heavy loam to silty clay. The subsoil is more strongly developed in some areas. In some places the substratum is slightly calcareous.

This soil is well drained and slowly permeable. Runoff is slow to medium, and the available water holding capacity is high. Root penetration is deep. The soil generally has good tilth, and cultivation is easy, except on the steeper slopes. Fertility is high. The erosion hazard is slight to moderate when the soil is cultivated. The soil is used primarily for dry-farmed grain, grain hay, pasture, and range. (Capability unit IIe–3)

Danville silty clay loam, 0 to 3 percent slopes (DaA).—Except for more gentle slopes, this soil is similar to Danville silty clay loam, 3 to 10 percent slopes. Runoff is slow, and the erosion hazard is slight. The soil used for irrigated vegetables, apricots, and pasture and for dry-farmed grain, and grain hay. (Capability unit IIs–3)

Diablo Series

The Diablo series consists of deep to moderately deep, well-drained, clayey soils on rolling to very steep uplands north and east of the Livermore Valley. These soils formed in material that weathered from soft, calcareous, interbedded shale and fine-grained sandstone. The vegetation consists mainly of annual grasses and a few scattered oaks.

The Diablo soils are in the same general area as the Altamont and Linne soils on uplands and the Pescadero and Clear Lake soils in small upland valleys.

The surface soil typically is dark-gray, very hard, slightly acid to mildly alkaline clay. When dry, it breaks to prismatic or blocky structure. Except for a few nodules of lime, this layer is noncalcareous. It grades to mottled gray or olive-gray, very hard, slightly calcareous silty clay. The substratum is mottled olive-gray to light olive-gray silty clay loam that is moderately calcareous and moderately alkaline. Depth to bedrock ranges from 18 to 60 inches.

Diablo soils are used mainly for dry-farmed grain, grain hay, pasture, and range.

Diablo clay, 15 to 30 percent slopes (DbD).—This soil occurs mostly in large bodies on smooth hilly uplands.

Representative profile:

0 to 15 inches, dark-gray clay; strong prismatic structure that breaks to moderate blocky structure; very hard when dry, very firm when moist, sticky and very plastic when wet; slightly acid to mildly alkaline; few lime nodules.

15 to 32 inches, mottled gray and olive-gray silty clay; few fine, whitish nodules of lime; moderate prismatic structure that breaks to medium blocky; very hard when dry, very firm when moist, sticky and very plastic when wet; slightly calcareous; mildly alkaline.

32 to 50 inches, mottled olive-gray and light olive-gray silty clay loam; many shale fragments and white nodules of lime; weak subangular blocky structure; very hard when dry, very firm when moist, plastic and slightly sticky when wet; moderately calcareous; moderately alkaline.

50 inches +, light olive-gray, calcareous, shattered shale and fine-grained sandstone.

Areas of this soil on south-facing slopes have a gray surface soil. Areas that are transitional to the Altamont soils have a very dark grayish-brown surface soil; areas transitional to the Linne soils, have a slightly calcareous surface soil. Depth to bedrock ranges from 36 to 60 inches.

This soil is well drained and slowly permeable. Runoff is medium. When the soil is dry and deeply cracked, it absorbs water rapidly. Root penetration is deep, and the available water holding capacity is moderate. The soil has fair tilth, but it is difficult to work. It can be cultivated best when the moisture content is about one-half field capacity. Fertility is high. If the soil is cultivated, the erosion hazard is moderate. The soil is used for dry-farmed grain, grain hay, pasture, and range. (Capability unit IVe–5)

Diablo clay, 30 to 45 percent slopes, eroded (DbE2).—Except for steeper slopes, this soil is similar to Diablo clay, 15 to 30 percent slopes. It is on smooth, well-rounded hills. The surface is broken in a few places near drainageways or seeps by small landslips. Runoff is medium to rapid, and the erosion hazard is severe. The soil is very difficult to work. It is used mainly for pasture and range, although a few fields are used for dry-farmed grain and grain hay. (Capability unit VIe–5; Clayey Hills range and pasture site)

Diablo clay, 7 to 15 percent slopes (DbC).—This soil is similar to Diablo clay, 15 to 30 percent slopes, but it is less sloping. It is on smooth, rolling topography. Runoff is slow to medium, and the erosion hazard is slight to moderate. The soil is somewhat difficult to work. It is used mainly for dry-farmed grain, grain hay, pasture, and range. (Capability unit IIIe–5)

Diablo clay, moderately deep, 45 to 60 percent slopes, eroded (DmF2).—This soil is similar to Diablo clay, 15 to 30 percent slopes, but it is much steeper. The surface is broken in places by landslips. Depth to bedrock ranges from 18 to 36 inches. Root penetration is moderately deep, and the available water holding capacity is low. Runoff is rapid to very rapid, and the hazard of erosion is very severe. Tillage is very difficult. Fertility is moderate. The soil is used for pasture and range. (Capability unit VIIe–5; Steep Clayey Slopes range site)

Diablo clay, very deep, 15 to 30 percent slopes, eroded (DvD2).—This soil occurs mostly in large bodies on smooth, moderately steep uplands.

Representative profile:

0 to 13 inches, very dark gray clay in the upper part and finely mottled very dark gray and light brownish-gray clay in the lower part; strong prismatic structure that breaks to moderate blocky structure; extremely hard when dry, very firm when moist, plastic and sticky when wet; mildly alkaline in the upper part and moderately alkaline and calcareous in the lower part.

13 to 27 inches, finely mottled very dark gray and light olive-brown clay; medium prismatic structure that breaks to medium blocky; very hard when dry, very firm when moist, very plastic and sticky when wet; moderately alkaline and calcareous.

27 to 60 inches +, light yellowish-brown silty clay that has white lime seams; fine blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; moderately alkaline.

The color of the surface soil is gray to very dark gray, but in a few places, it is very dark grayish brown. In some areas, the surface layer is slightly calcareous. In areas that are transitional to the Azule soils, the subsoil is more developed.

This soil is well drained and slowly permeable. Runoff is medium. When the soil is dry and deeply cracked, it absorbs water readily. Root penetration is deep, and the available water holding capacity is high. The soil generally has fair tilth, and it can be cultivated best when the moisture content is about one-half field capac-

ity. Fertility is high. If the soil is cultivated, the erosion hazard is moderate. The soil is used for dry-farmed grain, grain hay, pasture, and range. (Capability unit IVe–5)

Diablo clay, very deep, 30 to 45 percent slopes, eroded (DvE2).—Except for steeper slopes, this soil is similar to Diablo clay, very deep, 15 to 30 percent slopes, eroded. It is on steep hills, and the surface is broken by an occasional landslide. Cultivation is very difficult because of steep slopes. Runoff is medium to rapid, and the hazard of erosion is severe. The soil is used mainly for pasture and range, although a few fields are used for grain and grain hay. (Capability unit VIe–5; Clayey Hills range and pasture site)

Diablo clay, very deep, 45 to 60 percent slopes, eroded (DvF2).—Except for steeper slopes, this soil is similar to Diablo clay, very deep, 15 to 30 percent slopes, eroded. It is on steep hills, and some areas the surface is broken by frequent landslides. Cultivation is very difficult because of steepness. Runoff is rapid to very rapid, and the erosion hazard is very severe. The soil is used mainly for pasture and range. (Capability unit VIIe–5; Steep Clayey Slopes range site)

Diablo clay, very deep, 3 to 15 percent slopes (DvC).—Except for slopes, this gently sloping to strongly sloping soil is similar to Diablo clay, very deep, 15 to 30 percent slopes, eroded. Runoff is slow to medium, and the erosion hazard is slight to moderate. Cultivation is somewhat difficult. The soil is used for dry-farmed grain, grain hay, pasture, and range. (Capability unit IIIe–5)

Gaviota Series

The Gaviota series consists of somewhat excessively drained, shallow, loamy soils on gently rolling to very steep uplands east and southeast of Hayward. These soils formed from hard sandstone. The vegetation consists of grasses, scattered oaks, and brush. The Gaviota soils are in the same general area as the Los Osos and Los Osos, seeped variant, soils of the uplands.

The surface soil is brown, slightly acid sandy loam, 6 to 24 inches thick. It is underlain by hard, yellowish-brown sandstone. Gaviota soils are used for pasture and range.

Gaviota rocky sandy loam, 5 to 40 percent slopes, eroded (GaE2).—This soil is mostly in large bodies. It is on rolling to steep uplands and has many rock outcrops.

Representative profile:

0 to 11 inches, brown sandy loam; massive; soft when dry, friable when moist, nonsticky and nonplastic when wet; slightly acid.
11 inches +, yellowish-brown hard sandstone.

The texture ranges from sandy loam to silt loam. In areas that are transitional to the Los Osos soils, there is a weakly developed subsoil. Also, some areas are free of rock outcrops.

This soil is somewhat excessively drained and has moderately rapid permeability. Runoff is slow to rapid, and the available water holding capacity is very low. Root penetration is shallow, and fertility is low. The limited depth of the soil and frequent rock outcrops make cultivation very difficult. The erosion hazard is slight to severe, depending on the degree of slope. The soil is used for pasture and range. (Capability unit VIe–8; Shallow Loamy Uplands range and pasure site)

Gaviota rocky sandy loam, 40 to 75 percent slopes, eroded (GaF2).—Except for steeper slopes, this soil is similar to Gaviota rocky sandy loam, 5 to 40 percent slopes. It is steep to very steep and excessively drained. Runoff is very rapid, and the erosion hazard is very severe. Tilling is very difficult. The soil is used for pasture and range. (Capability unit VIIe–8; Steep Shallow Loamy Uplands range site)

Gravel Pit (Gp)

This land type occurs along the southern edge of the Amador Valley between Livermore and Pleasanton. The areas consist of deep excavations that have water in the bottom in most places. They are usually clear of plant growth. (Capability unit VIIIw–4)

Henneke Series

The Henneke series consists of somewhat excessively drained, shallow to very shallow, rocky soils on very steep to extremely steep uplands in the vicinity of Cedar Mountain. These soils formed from serpentine and have many outcrops of parent rock. The vegetation is mainly shrubby plants, such as chamise, ceanothus, and manzanita, and a few scattered oaks and digger pines. The Henneke soils are in the same general area as the Parrish and Vallecitos soils and the Los Gatos-Los Osos complex of soils.

The surface soil is dark reddish-brown, moderately alkaline loam. The subsoil is dark reddish-brown, moderately alkaline light clay loam. There are many fragments of serpentine throughout the profile. In most places bedrock is 6 to 18 inches below the surface. Henneke soils are used for watersheds, recreation, and wildlife.

Henneke rocky loam, eroded (HnF2).—This soil is in large bodies on very steep uplands. Slopes range from 45 to 75 percent.

Representative profile:

0 to 7 inches, dark reddish-brown loam; massive; slightly hard when dry, friable when moist, slightly sticky when wet; moderately alkaline.
7 to 15 inches, dark reddish-brown light clay loam; weak subangular blocky structure; slightly hard when dry, friable when moist, and slightly sticky when wet; moderately alkaline.
15 inches +, weathered serpentine.

The color of the surface soil ranges from dark reddish brown or reddish brown to dark brown. Reaction ranges from neutral to moderately alkaline. In a few places, bedrock is as deep as 48 inches.

This soil is somewhat excessively drained and is moderately permeable. Runoff is very rapid. Root penetration is shallow to very shallow, and the available water holding capacity is very low. This soil has very low fertility. The erosion hazard is severe.

Cultivation is very difficult because of steepness, shallowness, and many rock outcrops. The soil is used for watersheds, recreation, and wildlife. (Capability unit VIIIs–9)

Linne Series

The Linne series consists of well-drained, shallow to deep, calcareous soils on rolling to very steep uplands north and east of the Livermore Valley. These soils formed from soft, calcareous, interbedded shale and fine-grained sandstone. The vegetation is mainly annual grasses and a few scattered oaks. The Linne soils are in the same general area as the Altamont and Diablo soils on uplands and the Pescadero and Clear Lake soils in small upland valleys.

The surface soil is dark-gray, strongly calcareous clay loam. It is slightly hard when dry and breaks to strong granular structure. This layer grades to a subsoil that is similar to the surface soil but contains many filaments and nodules of lime. Depth to bedrock ranges from 12 to 50 inches.

Linne soils are used mainly for dry-farmed grain, grain hay, pasture, and range.

Linne clay loam, 15 to 30 percent slopes (LaD).—This soil occurs in large bodies on smooth, moderately steep uplands (fig. 6).

Representative profile:

0 to 19 inches, dark-gray clay loam; strong granular structure; slightly hard when dry, very friable when moist, sticky and slightly plastic when wet; strongly calcareous; few, fine, whitish concretions of lime; moderately alkaline.

19 to 36 inches, dark-gray clay loam; moderate blocky structure; slightly hard when dry, very friable when moist, sticky and slightly plastic when wet; strongly calcareous; many filaments and nodules of lime; moderately alkaline.

36 inches +, light-gray sandstone that has whitish lime along cleavage planes.

The texture of this soil ranges from loam to silty clay. The coarser textured areas are typically grayish brown and have outcrops of sandstone in places. In areas that are transitional to the Diablo soils, the surface soil is slightly calcareous. In areas that are transitional to the Altamont soils, the soil is browner, and the surface soil is slightly calcareous.

This soil is well drained. Permeability is moderately slow. Runoff is medium, and the available water holding capacity is moderate. Root penetration is moderately deep. Fertility is high. The soil has good tilth, but cultivation is somewhat difficult because of steepness. The erosion hazard is moderate when the soil is cultivated. The soil is used for dry-farmed grain, grain hay, pasture, and range. (Capability unit IVe–5)

Linne clay loam, 3 to 15 percent slopes (LaC).—Except for more gentle slopes, this soil is similar to Linne clay loam, 15 to 30 percent slopes. It is on smooth, gently sloping and rolling uplands. Runoff is slow to medium. The erosion hazard is slight to moderate when the soil is cultivated. The soil is easy to cultivate. It is used for dry-farmed grain and grain hay. (Capability unit IIIe–5)

Linne clay loam, 30 to 45 percent slopes, eroded (LaE2).—Except for slopes, this soil is similar to Linne clay loam, 15 to 30 percent slopes. In some small areas, the depth to bedrock is 10 to 20 inches, and rock outcrops occur. Also, there are some small areas that are severely eroded. Runoff is medium to rapid, and the hazard of erosion is severe. The soil is difficult to cultivate. It is used mainly for pasture and range. (Capability unit VIe–5; Clayey Hills range and pasture site)

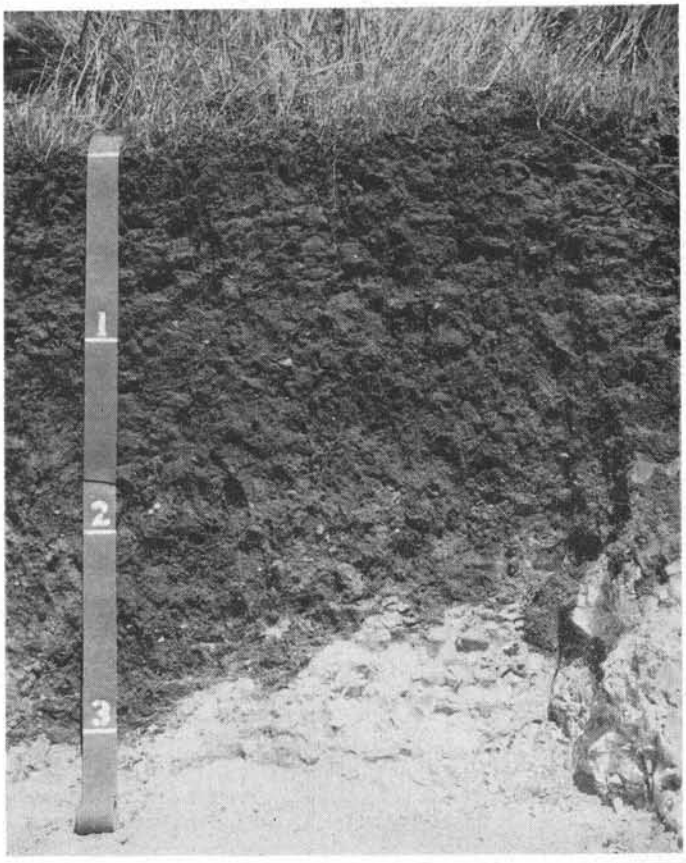

Figure 6.—**Profile of Linne clay loam, 15 to 30 percent slopes.**

Linne clay loam, shallow, 45 to 75 percent slopes, eroded (LcF2).—This soil is typically 12 to 24 inches deep to bedrock. In many places the bedrock crops out. The soil is steeper and shallower than Linne clay loam, 15 to 30 percent slopes. Small areas are severely eroded. Runoff is very rapid, and the hazard of erosion is very severe. The fertility is moderate. The available water holding capacity is low. This soil is very difficult to cultivate. It is used for pasture and range. (Capability unit VIIe–5; Steep Clayey Slopes range site)

Livermore Series

The Livermore series consists of somewhat excessively drained, very deep gravelly soils. These soils formed in alluvium from sandstone and shale under a cover of grasses and oaks. The Livermore soils are south of Livermore in the same general areas as the Pleasanton, Yolo, and Positas soils.

The surface soil is brown and dark grayish-brown, slightly acid to neutral very gravelly coarse sandy loam. When dry, this layer breaks to weak, fine, granular structure. It grades to brown very gravelly coarse sandy loam that is massive and neutral. The underlying material is brown very gravelly loamy coarse sand that is massive and neutral.

Livermore soils are used mainly for wine grapes, dry-farmed grain, and grain hay.

Livermore very gravelly coarse sandy loam (Lm).—This soil is mostly in large bodies and is nearly level to gently sloping. Slopes range from 0 to 7 percent. A few areas are moderately steep (fig. 7).

Representative profile:

0 to 21 inches, brown and dark grayish-brown very gravelly coarse sandy loam; weak, fine, granular structure; soft to slightly hard when dry, friable when moist, nonsticky to slightly sticky and nonplastic when wet; slightly acid to neutral.

21 to 34 inches, brown very gravelly coarse sandy loam; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral.

34 to 60 inches, brown very gravelly loamy coarse sand; massive; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; neutral.

The texture of the surface soil ranges from very gravelly coarse sandy loam to very gravelly loam or gravelly loam. The percentage of gravel, by volume, ranges from 40 to 75, and some cobbles and stones occur throughout the profile.

This soil is somewhat excessively drained and has rapid permeability. Runoff is very slow to slow, and the available water holding capacity is very low. Root penetration is very deep. The soil has poor tilth and is somewhat difficult to cultivate. It has low fertility. The erosion hazard is slight when the soil is cultivated. This soil is used for wine grapes (fig. 8). (Capability unit IVs–4)

Figure 7.—**Profile of Livermore very gravelly coarse sandy loam.**

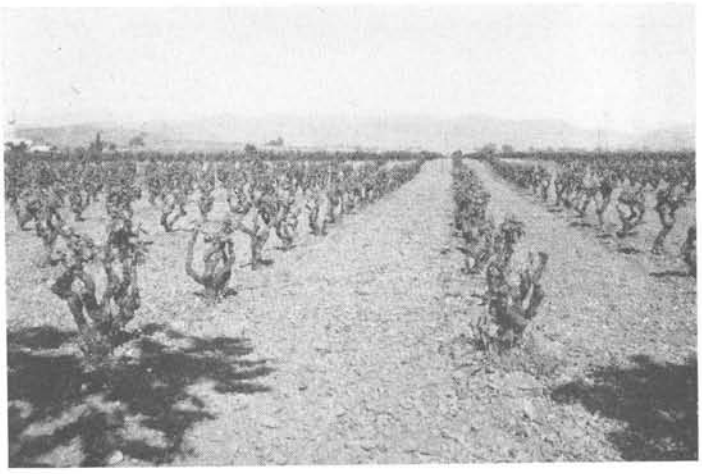

Figure 8.—**Grapes on Livermore very gravelly coarse sandy loam.**

Livermore gravelly loam (Lg).—This soil is finer textured throughout and has less gravel than Livermore very gravelly coarse sandy loam. The amount of gravel, by volume, ranges from 20 to 40 percent. Most areas of this soil are nearly level and have slopes of 3 percent or less; some areas, however, are gently sloping and have slopes as much as 7 percent. The available water holding capacity is low, and fertility is moderate. This soil is somewhat excessively drained. It is easy to cultivate and is used for wine grapes, dry-farmed grain, and grain hay. (Capability unit IIs–4)

Lobitos Series

The Lobitos series consists of well-drained, grayish-brown, shaly soils on moderately steep to steep uplands east of Niles. These soils formed in shattered diatomaceous shale. The vegetation is mainly annual grasses and a few oaks. The Lobitos soils are in the same general areas as the Los Osos and Gaviota soils and the Los Gatos-Los Osos complex of soils.

The surface soil is grayish-brown, slightly hard, strongly acid shaly loam that is massive and slightly hard when dry. This layer grades to a pinkish-gray, strongly acid shaly light clay loam subsoil. Depth to bedrock ranges from a few inches to 48 inches.

The Lobitos soils are used mainly for pasture and range.

Lobitos shaly loam, eroded (LoE2).—Nearly all of this soil is in large bodies on smooth, well-rounded, moderately steep to steep uplands. Slopes range from 9 to 45 percent.

Representative profile:

0 to 14 inches, grayish-brown shaly loam; massive; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; strongly acid.

14 to 38 inches, pinkish-gray shaly light clay loam; massive or weak granular structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly acid.

38 inches +, pinkish-gray, shattered diatomaceous shale.

The depth to bedrock varies considerably in short distances. The color of the surface soil ranges from grayish brown to brown. The outcrops of bedrock in most places are flush with the surface. In some areas, the subsoil is shaly light clay.

This soil is moderately permeable. Runoff is medium to rapid, and the available water holding capacity is low. Root penetration ranges from very shallow to moderately deep. This soil has fair tilth and is difficult to cultivate because of moderately steep to steep slopes and shallowness. Fertility is low. The erosion hazard is moderate to severe when the soil is cultivated. The soil is used mainly for pasture and range. (Capability unit VIe–8; Loamy Uplands range and pasture site)

Los Gatos Series

The Los Gatos series consists of well-drained and somewhat excessively drained, loamy, moderately deep soils on steep to very steep uplands. These soils formed from interbedded sandstone and shale. In the Alameda Area, the Los Gatos soils are mapped only in a complex with the Los Osos soils. They occur on steep hillsides under annual grasses and scattered oaks (fig. 9). On very steep slopes, the vegetation consists of oaks, laurel, poison-oak, sticky monkeyflower, California buckeye, California sage, and an understory of scattered annual and perennial grasses.

The surface soil is dark-brown, neutral loam. It is hard and massive when dry, but in the upper 5 inches it is slightly hard and has moderate subangular blocky structure. The upper part of the subsoil is neutral, reddish-brown heavy loam. The lower part is brown, slightly acid loam. Both parts are massive and slightly hard when dry. The depth to bedrock ranges from 12 to 48 inches.

The soils are used for pasture and range.

Los Gatos-Los Osos complex, 30 to 45 percent slopes, eroded (LpE2).—In most places this soil complex is in large areas. Los Gatos loam makes up about 40 percent of the complex; Los Osos silty clay loam, about 40 percent; and Gaviota rocky sandy loam, about 20 percent.

A representative profile of Los Gatos loam follows (a profile of a Los Osos soil and one of a Gaviota soil are described under the respective series):

0 to 11 inches, dark-brown loam; massive; hard or slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral; upper 5 inches of layer is slightly hard and has moderate, medium, subangular blocky structure.
11 to 32 inches, dark-brown loam grading to reddish-brown heavy loam; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral.
32 to 42 inches, brown loam; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly acid.
42 inches +, very pale brown sandstone.

The surface soil ranges from brown or dark brown to dark reddish brown. The subsoil ranges from dark brown to dark reddish brown. In some places the lower part of the subsoil is yellowish brown in color and ranges from a few inches to 20 inches in thickness.

In a small area about a mile south of Lake Chabot, the soils developed from basic igneous rock. These soils typically have a dusky-red, friable surface soil and a dark reddish-brown, clayey, slightly acid to neutral subsoil.

Los Gatos loam is well drained and has moderate permeability. Runoff is medium to rapid, and the available water holding capacity is low to moderate. Root penetration is shallow to moderately deep. The soil has fair tilth, but it is difficult to cultivate because of steepness. Fertility is low to moderate, and the erosion hazard is severe. (Los Gatos loam part, capability unit VIe–8, Shallow Loamy Uplands range and pasture site; Los Osos silty clay loam part, capability unit VIe–5, Loamy Uplands range and pasture site)

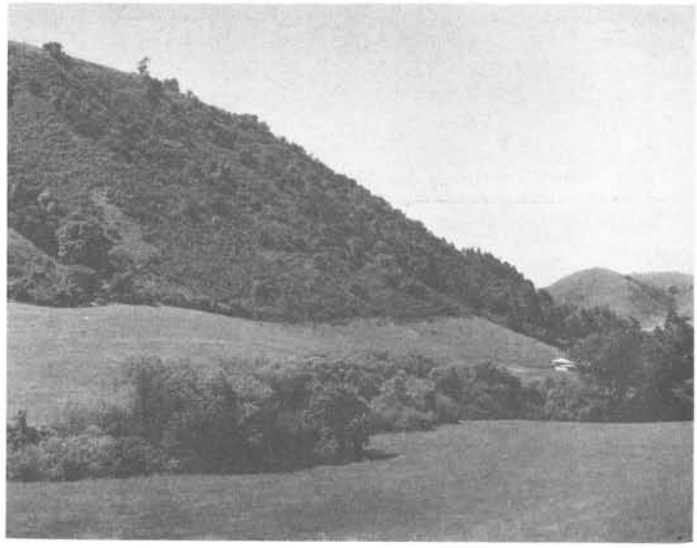

Figure 9.—**An area of the Los Gatos-Los Osos complex of soils.**

Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded (LpF2).—Except for very steep slopes, this soil complex is similar to Los Gatos-Los Osos complex, 30 to 45 percent slopes, eroded. Los Gatos loam makes up about 40 percent of the complex; Los Osos silty clay loam, about 40 percent; and Gaviota rocky sandy loam, about 20 percent. Los Gatos loam has very rapid runoff, and the erosion hazard is very severe. Cultivation is very difficult. (Los Gatos loam part, capability unit VIIe–1, Steep Shallow Loamy Uplands range site; Los Osos silty clay loam part, capability unit VIIe–5, Steep Loamy Slopes range site)

Los Osos Series

The Los Osos series consists of well-drained to somewhat excessively drained, moderately deep silty clay loam and silt loam soils on strongly sloping to very steep uplands. These soils formed from interbedded fine-grained sandstone, from shale, and, in places, from conglomerate rocks. Their vegetation is mainly annual grasses and scattered oaks, but in some places coyotebrush, poison-oak, and sticky monkeyflower make up an important part. These soils occur north of Hayward. They are in the same general area as the Lobitos and Gaviota soils and the Los Gatos-Los Osos complex of soils.

The surface layer of the Los Osos light silty clay loam soil is grayish-brown, medium acid, and massive. This layer grades to a dark grayish-brown subsoil that is heavy silty clay loam, slightly acid, and of moderate blocky structure. Depth to bedrock ranges from 18 to 48 inches.

Los Osos soils are used mainly for pasture and range.

Los Osos silty clay loam, 7 to 30 percent slopes (LtD).—This soil occurs mostly in large bodies. It is on strongly sloping to moderately steep uplands and is subject to frequent landslides.

Representative profile:

0 to 8 inches, grayish-brown light silty clay loam; massive; hard when dry, friable when moist, sticky and plastic when wet; medium acid.
8 to 30 inches, dark grayish-brown heavy silty clay loam; moderate blocky structure; hard when dry, friable when moist, sticky and plastic when wet; slightly acid.
30 inches +, pale-olive shale.

This soil is well drained and has moderately slow permeability. Runoff is medium, and the available water holding capacity is low to moderate. Root penetration is moderately deep. The soil has good tilth, but cultivation is somewhat difficult because of steepness. Fertility is moderate. The erosion hazard is moderate. The soil is used for pasture, range, dry-farmed grain, and grain hay. (Capability unit IVe–5)

Los Osos silty clay loam, 30 to 45 percent slopes, eroded (LtE2).—Except for slopes, this soil is similar to Los Osos silty clay loam, 7 to 30 percent slopes. Runoff is rapid. Cultivation is difficult, and the erosion hazard is severe. The soil is used for range, pasture, and dry-farmed grain. (Capability unit VIe–5; Loamy Uplands range and pasture site)

Los Osos silty clay loam, 45 to 75 percent slopes, eroded (LtF2).—Except for slopes, this soil is similar to Los Osos silty clay loam, 7 to 30 percent slopes. Runoff is rapid to very rapid, and the erosion hazard is very severe. Because of steepness, the soil is very difficult to cultivate. It is used for pasture and range. (Capability unit VIIe–5; Steep Loamy Slopes range site)

Los Osos loam, seeped variant, 3 to 15 percent slopes (LsC).—This imperfectly drained to moderately well drained, deep, loamy soil is in gently sloping to rolling upland valleys southeast of Hayward. The soil formed from soft sandstone and some alluvial material from sedimentary rock. The vegetation is mainly annual grasses, sedges, and, in a few places, dense stands of coyotebrush. This soil is in the same general area as the Los Osos and Gaviota soils on uplands. It is used for pasture, range, dry-farmed grain, and grain hay.

A representative profile of Los Osos loam, seeped variant, 3 to 15 percent slopes, follows:

0 to 20 inches, grayish-brown loam; few, fine, faint, dark yellowish-brown mottles at a depth of 14 to 20 inches; the upper part has very fine granular structure and the lower part is massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; medium acid.
20 to 41 inches, pale-brown and light brownish-gray sandy clay loam; many, coarse, distinct, yellowish-brown mottles; massive; very hard when dry, friable when moist, sticky and plastic when wet; medium acid in upper part and strongly acid in the lower 11 inches.
41 inches +, yellowish-brown soft sandstone.

The texture of the surface soil ranges from fine sandy loam to silt loam. In areas transitional to the well-drained Gaviota and Los Osos soils, the surface soil is not mottled, and there are few mottles in the subsoil. In some areas, however, the lower part of the subsoil is prominently mottled. Seepage may cause a temporarily high water table during winter and early in summer. In some areas the soil is drained by deep gullies. Bedrock crops out in places.

Permeability is moderately slow. Runoff is slow to medium, and the available water holding capacity is moderate. Root penetration is deep. The soil has fair tilth, but it is somewhat difficult to work. Fertility is moderate, and the erosion hazard is slight to moderate when the soil is cultivated. This soil is used mainly for dry-farmed grain and grain hay. (Capability unit IIIe–1)

Los Osos and Millsholm soils, 7 to 30 percent slopes (LuD).—This mapping unit occurs in large rolling to hilly areas. It is an undifferentiated group consisting of Los Osos and Millsholm soils in proportions that vary from place to place. The texture of both soils is generally silt loam, but it ranges from loam to silty clay loam. A representative profile of Millsholm soil is described for the Millsholm series.

Permeability of these soils is moderate to moderately slow. Runoff is slow to medium, and the available water holding capacity is low to moderate. Root penetration is moderately deep. These soils have low to moderate fertility and fair tilth, but cultivation is somewhat difficult because of steepness. The erosion hazard is moderate. The Los Osos soils are used for pasture, range, dry-farmed grain, and grain hay. (Both soils in capability unit IVe–3)

Los Osos and Millsholm soils, 30 to 45 percent slopes, eroded (LuE2).—Except for steeper slopes, this mapping unit is similar to Los Osos and Millsholm soils, 7 to 30 percent slopes. It consists of Los Osos silt loam and Millsholm silt loam in proportions that vary from place to place. Cultivation is difficult, and the erosion hazard is severe. The soils are used mainly for pasture and range. (Both soils in capability unit VIe–8; both soils in Loamy Uplands range and pasture site)

Millsholm Series

The Millsholm series consists of well-drained to somewhat excessively drained, shallow silt loam soils on steep and very steep uplands. These soils formed from interbedded fine-grained sandstone and shale. The vegetation is mainly annual grasses and scattered oaks, but in some areas coyotebrush, poison-oak, and sticky monkeyflower make up an important part. The Millsholm soils are in the same general area as the Lobitos, Gaviota, and Los Osos soils.

The surface soil is olive silt loam. It is medium acid and is massive. This layer grades to a light olive-brown heavy silt loam subsoil that is massive and is medium acid. Depth to bedrock ranges from 12 to 26 inches.

Millsholm soils are used mainly for pasture and range.

Millsholm silt loam, 30 to 45 percent slopes, eroded (MhE2).—This soil is mostly in large bodies on steep uplands. In places it is mapped in an undifferentiated group with Los Osos soils.

Representative profile:

0 to 17 inches, olive silt loam; massive; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; medium acid.
17 to 22 inches, light olive-brown heavy silt loam; massive; very hard when dry, firm when moist, plastic and sticky when wet; medium acid.
22 inches +, grayish-brown shale.

The texture of the surface layer ranges from loam or silt loam to light clay loam. The color ranges from olive, brown, or light brownish gray to dark grayish brown.

The subsoil ranges in color from light olive brown or brown to yellowish brown. It ranges in texture from light silt loam to clay loam.

This soil is well drained and has moderate permeability. Runoff is rapid, and the available water holding capacity is low. Root penetration is shallow. Cultivation is difficult because of steepness. Fertility is low, and the erosion hazard is severe. The soil is used for pasture and range. (Capability unit VIe–8; Loamy Uplands range and pasture site)

Millsholm silt loam, 45 to 75 percent slopes, eroded (MhF2).—This soil is similar to Millsholm silt loam, 30 to 45 percent slopes, eroded, but it is steeper and shallower. Runoff is very rapid, and the erosion hazard is very severe. The soil is used for pasture and range. (Capability unit VIIe–8; Steep Loamy Slopes range site)

Parrish Series

The Parrish series consists of well-drained, shallow to moderately deep soils in steep to very steep mountainous areas south of the Livermore Valley. These soils formed from hard sandstone and shale. The vegetation consists of annual grasses, oaks, scattered digger pines, and California sage. The Parrish soils are in the same general area as the Vallecitos and Henneke soils.

The surface soil is dark-brown, slightly acid to medium acid gravelly loam. The upper part of the subsoil is yellowish-red, medium acid gravelly clay loam; the lower part is strongly acid gritty clay. When it is dry, the subsoil breaks to weak subangular blocky structure. The underlying material is brown, very strongly acid clay loam. Depth to bedrock ranges from 12 to 48 inches.

Parrish soils are used for pasture and range.

Parrish gravelly loam, 30 to 45 percent slopes, eroded (PaE2).—This soil occurs mostly in large bodies in steep areas.

Representative profile:

0 to 13 inches, dark-brown gravelly loam; weak granular structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly acid to medium acid.
13 to 33 inches, yellowish-red gravelly clay loam and gritty clay; weak subangular blocky structure; hard to very hard when dry, firm when moist, slightly sticky and plastic when wet; medium acid in upper part and strongly acid in lower part.
33 to 36 inches, brown clay loam; weak subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; very strongly acid.
36 inches +, shattered shale and fine-grained sandstone.

The surface soil ranges in color from dark brown to reddish brown. Along narrow ridges and sharp breaks, the subsoil, if present, is thin, and rock crops out in many places. In some areas the subsoil is medium acid.

This soil is well drained and has slowly permeable subsoil. Runoff is medium to rapid, and the available water holding capacity is low to moderate. Root penetration is shallow to moderately deep. Fertility is low. The erosion hazard is severe, and tillage is difficult. The soil is used for pasture and range. (Capability unit VIe–8; Shallow Loamy Uplands range and pasture site)

Parrish gravelly loam, 45 to 75 percent slopes, eroded (PaF2).—Except for steeper slopes, this soil is similar to Parrish gravelly loam, 30 to 45 percent slopes, eroded. It occurs in very steep mountainous areas. Runoff is very rapid, and the erosion hazard is very severe. This soil is usedfor grazing. (Capability unit VIIe–1; Steep Shallow Loamy Uplands range and pasture site)

Perkins Series

The Perkins series consists of well-drained to somewhat excessively drained, deep, loamy soils on gently sloping to very steep terraces south of the Livermore Valley. These soils formed in semiconsolidated terrace material. The vegetation is mainly annual grasses and a few scattered oaks, but on north-facing slopes, the vegetation is grasses and oaks. The Perkins soils are in the same general area as the Positas, Azule, and Pleasanton soils.

The surface soil is pale-brown, massive, medium acid loam. The upper part of the subsoil is yellowish-brown gravelly clay loam that is very hard and slightly acid. It has moderate blocky structure. The lower part of the subsoil is brown, mildly alkaline very gravelly clay loam.

Perkins soils are used mainly for dry-farmed grain, grain hay, pasture, and range.

Perkins loam, 3 to 30 percent slopes (PcD).—Most of this soil is in small bodies on gently sloping to strongly sloping terraces.

Representative profile:

0 to 10 inches, pale-brown loam; massive; hard when dry, friable when moist, slightly plastic and slightly sticky when wet; medium acid.
10 to 33 inches, yellowish-brown gravelly clay loam; moderate blocky structure; very hard when dry, firm when moist, plastic and sticky when wet; slightly acid.
33 to 65 inches, brown very gravelly clay loam; moderate to weak blocky structure; hard when dry, firm when moist, plastic and slightly sticky when wet; mildly alkaline.

The subsoil is reddish brown in areas that are transitional to the Positas soils. The texture of the lower part of the subsoil ranges from very gravelly clay loam to gravelly clay loam.

This soil is well drained. Permeability of the subsoil is moderately slow. Runoff is slow to medium, and the available water holding capacity is moderate. Root penetration is deep. The soil has fair tilth, and cultivation is somewhat difficult. Fertility is low. The erosion hazard is slight to moderate when the soil is cultivated. The soil is used for dry-farmed grain, grain hay, pasture, and range. (Capability unit IVe–3)

Perkins loam, 45 to 75 percent slopes, eroded (PcF2).—Except for steeper slopes and a grayish-brown surface layer, this soil is similar to Perkins loam, 3 to 30 percent slopes. In some small areas, however, the surface layer is dark grayish brown and is abruptly underlain by brown, weakly cemented conglomerate bedrock.

This soil is somewhat excessively drained, and runoff is very rapid. The erosion hazard is very severe, and cultivation is very difficult. The soil is used for range. (Capability unit VIIe–3; Steep Upland Terraces range site)

Pescadero Series

The Pescadero series consists of imperfectly drained, gray, saline-alkali soils north of Livermore. They occur on nearly level basin rims and along the lower edge of the terraces. They have hog-wallowed microrelief. These

soils formed in alluvium from sandstone and shale. The vegetation is mainly annual grasses, saltgrass, and Australian saltbush. The Pescadero soils are in the same general area as the Clear Lake, Diablo, and Solano soils.

The surface layer is thin. It is gray, slightly acid clay loam that has platy structure. It is hard when dry. The subsoil is dark-gray, moderately alkaline clay. When dry, it breaks to prismatic structure. The substratum is light-gray to light olive-gray, massive, moderately alkaline clay that is underlain by clay loam.

Pescadero soils are used primarily for pasture.

Pescadero clay (Pd).—Most of this soil is in large, nearly level areas that have hog-wallowed, or hummocky, microrelief.

Representative profile:

0 to 2 inches, gray clay loam; platy structure; hard when dry, friable when moist, slightly plastic and sticky when wet; slightly acid.
2 to 20 inches, dark-gray clay; prismatic structure; very hard when dry, firm when moist, slightly sticky and plastic when wet; moderately alkaline.
20 to 72 inches, light-gray to light olive-gray calcareous clay underlain by clay loam; firm when moist, slightly sticky and plastic when wet; moderately alkaline.

The surface soil ranges in thickness from a few inches on the barren areas to 8 inches on the hummocks or mounds. In areas transitional to the Clear Lake soils, the effect of salt and alkali is slight and the hog-wallowed microrelief is not so strongly marked.

This soil is imperfectly drained and is very slowly permeable. Runoff is slow, and the available water holding capacity is low. Root penetration is moderately deep. The soil has poor tilth. It can be cultivated only within a narrow range of moisture content. Fertility is low, and the erosion hazard is slight when the soil is cultivated. Cultivation is difficult. The soil is usd for pasture. (Capability unit VIw–2)

Pleasanton Series

The Pleasanton series consists of very deep, well-drained, loamy soils on nearly level to strongly sloping low terraces and fans south of Livermore. These soils formed in alluvium from sedimentary rock. In areas that are not cultivated, the vegetation is mainly annual grasses and scattered oaks. The Pleasanton soils are in the same general area as the Livermore, Perkins, Rincon, and Positas soils.

The surface soil is grayish-brown, slightly acid to neutral gravelly loam. It is massive or has very weak granular structure. This layer grades to dark-brown, very hard, neutral gravelly clay loam. The substratum consists of yellowish-brown, mildly alkaline gravelly silt loam.

Pleasanton soils are used mainly for dry-farmed grain, grain hay, and wine grapes.

Pleasanton gravelly loam, 0 to 3 percent slopes (PgA).—Most of this soil is in large bodies on nearly level terraces or fans (fig. 10).

Representative profile:

0 to 21 inches, grayish-brown gravelly loam; massive or very weak granular structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; slighty acid to neutral.

Figure 10.—**Large, nearly level area of Pleasanton soils in foreground; Positas and Perkins soils in background.**

21 to 64 inches, dark-brown gravelly clay loam; moderate subangular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; neutral.
64 to 72 inches, yellowish-brown gravelly silt loam; massive or weak blocky structure; hard when dry, friable when moist, sticky and slightly plastic when wet; mildly alkaline.

The color of the surface soil is light brownish gray, grayish brown, pale brown, or yellowish brown. The texture ranges from gravelly loam or loam to light clay loam. In areas transitional to the Rincon soils, the substratum is slightly calcareous.

The permeability of the subsoil is moderately slow. Runoff is slow, and the available water holding capacity is moderate. Root penetration is very deep, and fertility is moderate. The soil has fair tilth and is somewhat difficult to work. If the soil is cultivated, the erosion hazard is slight. The soil is used for grapes, dry-farmed grain, and grain hay. (Capability unit IIs–3)

Pleasanton gravelly loam, 3 to 12 percent slopes (PgB).—Except for steeper slopes, this soil is similar to Pleasanton gravelly loam, 0 to 3 percent slopes. It is generally gently sloping to rolling, but in places it is moderately steep. Runoff is slow to medium, and the erosion hazard is slight to moderate. This soil is used primarily for dry-farmed grain and grain hay. (Capability unit IIIe–3)

Positas Series

The Positas series consists of well-drained to excessively drained, shallow to moderately deep gravelly loam soils on nearly level to very steep high terraces south of the Livermore Valley. These soils formed in poorly sorted clay, sand, and gravel that are weakly consolidated in places. The vegetation consists mainly of annual grasses and a few scattered oaks. The Positas soils are in the same general area as the Azule, Pleasanton, and Perkins soils.

The surface soil is brown, medium acid gravelly loam. It is massive and is hard when dry. It is abruptly un-

derlain by reddish-brown, medium acid to mildly alkaline clay subsoil. The subsoil has prismatic structure. It is very plastic when wet and extremely hard when dry. The lower part of the subsoil is brownish, blocky heavy loam that is very hard when dry.

The Positas soils are used for pasture, range, dry-farmed grain, and grain hay.

Positas gravelly loam, 2 to 20 percent slopes, eroded (PoC2).—Most of this soil is in large bodies on smooth, gently sloping to strongly sloping high terraces (fig 11).

Representative profile:

0 to 11 inches, brown gravelly loam; massive; hard when dry, friable when moist; medium acid.
11 to 29 inches, reddish-brown clay; strong prismatic structure; extremely hard when dry, extremely firm when moist, very plastic and sticky when wet; medium acid in upper part and mildly alkaline in lower part.
29 to 54 inches, brown heavy loam; strong, medium, blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; moderately alkaline.
54 inches +, light yellowish-brown gravelly sandy clay loam; massive; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; mildly alkaline.

In places the texture of the surface soil is gravelly sandy loam, gravelly loam, or loam. Some areas have coarse pebbles or cobbles throughout the profile. Although typically brown, this layer is reddish brown in places. In areas transitional to the Perkins soils, the subsoil is light clay. In some places the underlying material is weakly consolidated, yellowish calcareous silt.

Figure 11.—**Profile of Positas gravelly loam, 2 to 20 percent slopes, eroded.**

Figure 12.—**View of Positas gravelly loam, 40 to 60 percent slopes, eroded.**

This well-drained soil has a very slowly permeable subsoil. Before the surface soil is saturated, the soil absorbs water readily. Runoff is slow to medium, and the available water holding capacity is low. Root penetration is shallow. The soil has fair tilth, and cultivation is somewhat difficult. Fertility is low. The erosion hazard is slight to moderate on cultivated areas. This soil is used for pasture, range, dry-farmed grain, and grain hay. (Capability unit IVe–3)

Positas gravelly loam, 20 to 40 percent slopes, eroded (PoE2).—Except for steeper slopes, this soil is similar to Positas gravelly loam, 2 to 20 percent slopes, eroded. It occurs on hilly to steep terraces. The soil is well drained to somewhat excessively drained. The erosion hazard is severe, and tillage is difficult. Runoff is rapid. This soil is used mainly for pasture and range, although a few fields are used for dry-farmed grain and grain hay. (Capability unit VIe–3; Upland Terraces range and pasture site)

Positas gravelly loam, 40 to 60 percent slopes, eroded (PoF2).—Except for steeper slopes, this soil is similar to Positas gravelly loam, 2 to 20 percent slopes, eroded (fig. 12). It occurs on very steep terraces, and cultivation is therefore very difficult. The soil is excessively drained; runoff is rapid to very rapid. The erosion hazard is very severe. The soil is used only for grazing. (Capability unit VIIe–3; Steep Upland Terraces range site)

Positas gravelly loam, thick surface, 2 to 10 percent slopes, eroded (PtB2).—The surface layer of this soil is about 18 to 30 inches thick, and that of Positas gravelly loam, 2 to 20 percent slopes, eroded, is about 12 to 18. Otherwise, the two soils are similar. This soil is gently sloping to rolling. Runoff is slow to medium, and the available water holding capacity is low. Root penetration is moderately deep. Fertility is low. The soil has fair tilth and is somewhat difficult to work. If the soil is cultivated, the erosion hazard is slight to moderate. The

soil is used for pasture, range, dry-farmed grain, and grain hay. (Capability unit IIIe–3)

Rincon Series

The Rincon series consists of well-drained, deep, grayish-brown soils on nearly level valley floors and fans east of Livermore and north of Mountain House. These soils formed in alluvium from sandstone and shale under annual grasses and scattered oaks. The Rincon soils are in the same general areas as the San Ysidro and Pleasanton soils.

The surface soil is grayish-brown, very hard, neutral clay loam. The upper part of the subsoil is brown, neutral to mildly alkaline clay. When dry, this layer breaks to moderate blocky structure. The lower part is yellowish-brown, moderately alkaline clay loam that has seams of lime.

Rincon soils are used for irrigated pasture, alfalfa, row crops, dry-farmed grain, and grain hay.

Rincon clay loam, 0 to 3 percent slopes (RdA).—This soil occurs in large bodies on nearly level to very gently sloping valley floors and fans.

Representative profile:

0 to 16 inches, grayish-brown clay loam; massive; very hard when dry, friable when moist, plastic and sticky when wet; neutral.
16 to 52 inches, brown clay; moderate blocky structure; extremely hard when dry, firm when moist, very plastic and sticky when wet; neutral to mildly alkaline.
52 to 60 inches, yellowish-brown clay loam; lime seams; moderate blocky structure; extremely hard when dry, very firm when moist, very plastic and slightly sticky when wet; moderately alkaline.

The color of the surface soil ranges from grayish brown or dark brown to brown. The texture is light clay loam or heavy clay loam. In areas transitional to the Clear Lake soils, the subsoil is heavy clay loam.

This soil is well drained. It has a slowly permeable subsoil. Runoff is slow, and the available water holding capacity is high. Root penetration is very deep. The soil has good tilth, but it is best to cultivate it when the moisture content is about one-half field capacity. Fertility is moderate. The erosion hazard is slight when the soil is cultivated. This soil is somewhat difficult to work and is used for irrigated alfalfa and pasture. (Capability unit IIs–3)

Rincon loam, 0 to 3 percent slopes (Rc).—This soil has a brown surface soil and a dark-brown subsoil. The soil is easy to work. It is used mainly for dry-farmed grain and grain hay, and a few fields are irrigated (fig. 13). (Capability unit IIs–3)

Rincon clay loam, 3 to 7 percent slopes (RdB).—Except for steeper slopes, this soil is similar to Rincon clay loam, 0 to 3 percent slopes. It is on gently sloping fans. Runoff is slow to medium, and the erosion hazard is slight to moderate. This soil is used mainly for dry-farmed grain. (Capability unit IIIe–3)

Riverwash (Rh)

This land type occurs throughout the valleys. The areas are typically very gravelly or stony. The vegetation consists mainly of patches of annual grasses and scattered oaks. (Capability unit VIIIw–4)

Figure 13.—**Irrigated corn on right is on Rincon loam, 0 to 3 percent slopes. Soils in background are Altamont and Los Osos.**

Rock Land (RoF)

This land type occurs throughout the uplands. It consists of very steep, rocky areas (fig. 14). Because this land type has a thin surface layer, erosion is critical. The areas are generally well covered by woody plants and scattered patches of annual grass. They are used as watersheds. (Capability unit VIIIs–9)

San Ysidro Series

The San Ysidro series consists of moderately well drained, shallow soils developed on nearly level old valley fill northeast of Livermore. These soils formed in alluvium from sedimentary rock. Their vegetation consists of annual grasses. The San Ysidro soils are in

Figure 14.—**Rock land is in background; Altamont soils are in foreground.**

the same general area as the Rincon and Solano soils in valleys and the Altamont soils in uplands.

The surface soil is pale-brown loam that is massive. It is hard when dry and is medium acid. The upper part of the subsoil is brown clay that has strong columnar structure; it is extremely hard when dry and is neutral but becomes moderately alkaline with depth. The lower part is yellowish-brown, blocky, moderately alkaline silty clay. The San Ysidro soils are used mainly for dry-farmed grain, grain hay, pasture, and range.

San Ysidro loam (Sa).—This soil occurs mostly in large bodies in nearly level valleys.

Representative profile:

0 to 16 inches, pale-brown loam; massive; hard when dry, slightly plastic and slightly sticky when wet; medium acid.
16 to 34 inches, brown clay; strong columnar structure; extremely hard when dry, very firm when moist, very plastic and slightly sticky when wet; neutral, but becomes moderately alkaline with depth.
34 to 60 inches, yellowish-brown silty clay; moderate blocky structure; very hard when dry, firm when moist, very plastic and slightly sticky when wet; moderately alkaline.

The texture of the surface soil ranges from silt loam to fine sandy loam. The color ranges from pale brown or brown to grayish brown. In some areas, the subsoil is reddish brown. The lower part of the subsoil is clay, silty clay, or silty clay loam, and, in a few places, gravelly clay loam. In areas transitional to the Pescadero soils, the surface soil is dark gray.

This soil is moderately well drained. It has a very slowly permeable subsoil. Runoff is slow, and the available water holding capacity is low. Root penetration is shallow. The soil has fair tilth, and cultivation is easy. Fertility is low, and the erosion hazard is slight when the soil is cultivated. The soil is used for dry-farmed grain, grain hay, pasture, and range. (Capability unit IVe–3)

Shedd Series

The Shedd series consists of well-drained to somewhat excessively drained, moderately deep silt loam soils on hilly to very steep uplands southeast of the Livermore Valley. These soils formed in soft, pale-olive and olive, weakly consolidated, fine-grained sediments. The vegetation is mainly annual grasses and a few scattered oaks. The Shedd soils are in the same general area as the Positas soils.

The surface soil is light brownish-gray silt loam. It is soft to slightly hard and moderately calcareous. When dry, this layer breaks to moderately fine granular structure. The subsoil is similar to the surface soil, except that it is strongly calcareous. Depth to parent material ranges from 12 to 36 inches.

Shedd soils are used mainly for pasture, range, dry-farmed grain, and grain hay.

Shedd silt loam, 30 to 45 percent slopes, eroded (SdE2).—This soil is in small bodies on moderately steep uplands.

Representative profile:

0 to 12 inches, light brownish-gray silt loam; moderate to weak granular structure; soft to slightly hard when dry, very friable to friable when moist, slightly sticky and slightly plastic when wet; moderately calcareous.
12 to 32 inches, material similar to that in the surface soil except that it is strongly calcareous.
32 inches +, pale-olive to olive, weakly consolidated, fine-grained sediments.

The color of the surface soil is dark grayish brown, grayish brown, or light grayish brown. In some places lime concretions occur throughout the profile, and mycelialike lime is in the subsoil. A few fine quartz pebbles occur throughout the profile. In areas transitional to the Positas soils, the surface soil is brown and the subsoil is grayish brown.

This soil is well drained and moderately permeable. Runoff is rapid, and the available water holding capacity is moderate. Root penetration is moderately deep. The soil has very good tilth, but it is difficult to cultivate because of steepness. Fertility is moderate and the erosion hazard is severe. The soil is used for pasture and range. (Capability unit VIe–8; Loamy Uplands range and pasture site)

Shedd silt loam, 15 to 30 percent slopes, eroded (SdD2).—Except for slope, this soil is similar to Shedd silt loam, 30 to 45 percent slopes, eroded. Runoff is medium, and the erosion hazard is moderate. Cultivation is somewhat difficult. This soil is used for dry-farmed grain, grain hay, pasture, and range. (Capability unit IVe–3)

Shedd silt loam, 45 to 75 percent slopes, severely eroded (SdF3).—Except for steeper slopes and a greater degree of erosion, this soil is similar to Shedd silt loam, 30 to 45 percent slopes, eroded. Drainage is somewhat excessive, and runoff is very rapid. The available water holding capacity and fertility are moderate to low. Root penetration is moderately deep to shallow. Cultivation is very difficult, and the erosion hazard is very severe. The soil is used for pasture and range. (Capability unit VIIe–8; Steep Loamy Slopes range site)

Solano Series

The Solano series consists of imperfectly drained, shallow, slightly to strongly saline-alkali, very pale brown soils. These soils have hog-wallowed microrelief and occur on nearly level stream terraces and basin rims north and east of Livermore and in the northeast part of the Area. They formed in alluvium from sandstone and shale. The vegetation is mainly saltgrass, saltbush, iodine plant, and other salt-tolerant plants. The Solano soils are in the same general area as the San Ysidro, Rincon, and Pescadero soils in valleys, and the Altamont and Linne soils in uplands.

The surface soil is very pale brown, medium acid fine sandy loam. It is underlain by a thin layer of light-gray, medium acid fine sandy loam that has weak platy structure. The subsoil is pale-brown, neutral clay loam. When dry, this layer breaks to weak columnar structure. The substratum consists of a yellowish brown, massive, mildly alkaline clay loam or light clay loam. This layer becomes strongly alkaline with depth. Solano soils are used mainly for pasture.

Solano fine sandy loam (Sf).—Most of this soil is in small, nearly level areas that have hog-wallowed microrelief.

Representative profile:

0 to 4 inches, very pale brown fine sandy loam; massive; soft when dry, friable when moist, nonsticky and nonplastic when wet; medium acid.

4 to 6 inches, light-gray fine sandy loam; weak platy structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; medium acid.
6 to 13 inches, pale-brown clay loam; massive or weak columnar structure; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; neutral.
13 to 60 inches, yellowish-brown clay loam or light clay loam; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; mildly alkaline in upper part and strongly alkaline below a depth of 30 inches.

The thickness of the surface soil ranges from 0 on the barren alkali spots to 18 inches on the mounds. The texture ranges from sandy loam or fine sandy loam to loam. In some places, the subsoil is dark grayish brown, is clayey, and has strong columnar structure. The effects from salts and alkali range from slight to strong (fig. 15).

This soil is imperfectly drained. Permeability of the subsoil is moderately slow to slow. Runoff is slow, and the available water holding capacity is low. Root penetration is shallow. The soil has poor tilth and is somewhat difficult to work. Fertility is low, and the erosion hazard is slight. The soil is used for saltgrass pasture. (Capability unit VIw–2)

Sunnyvale Series

The Sunnyvale series consists of poorly drained, deep to very deep, calcareous soils on nearly level valley floors north of Pleasanton. The soils formed in fine-grained alluvium from sedimentary rock. The vegetation in uncultivated areas consists mainly of annual grasses and sedges. The Sunnyvale soils are in the same general area as the Clear Lake, Sycamore, Pescadero, and Yolo soils.

The surface soil is gray, granular, slightly calcareous heavy clay loam. The lower part is strongly calcareous silty clay. This part grades to a gray, granular, strongly calcareous silty clay layer that has rust-colored mottles and seams and nodules of lime. In places this layer has intermittent lenses of fine sandy loam. The underlying material is dark-gray, very hard, calcareous clay.

Sunnyvale soils are used for irrigated row crops and pasture and for dry-farmed grain.

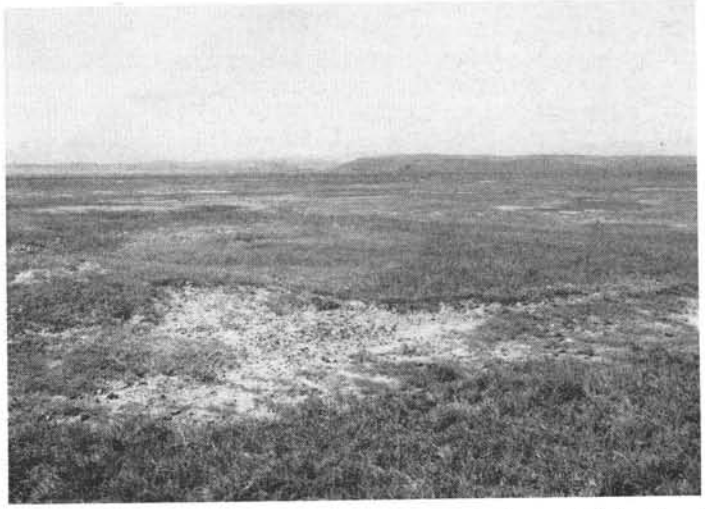

Figure 15.—**Typical field of Solano fine sandy loam; light-colored saline-alkali spot is in foreground.**

Sunnyvale clay loam over clay (Sm).—This soil occurs in large bodies on nearly level valley floors.

Representative profile:

0 to 18 inches, gray, slightly calcareous heavy clay loam; granular structure; hard when dry, friable when moist, plastic and sticky when wet; moderately alkaline; the lower part is strongly calcareous silty clay.
18 to 42 inches, gray, strongly calcareous silty clay; common, fine, rust-colored mottles; seams and nodules of lime; granular structure; hard when dry, friable when moist, plastic and sticky when wet; moderately alkaline.
42 to 66 inches, dark-gray clay, gray in the lower part; few nodules and seams of lime; strong, coarse, prismatic structure; very hard when dry, very firm when moist, very plastic and slightly sticky when wet; moderately alkaline.

The texture of surface soil ranges from silt loam to heavy clay loam or heavy silty clay loam. In some small areas the surface soil is strongly calcareous. The subsoil ranges from silt loam to silty clay in texture and has thin (2 to 3 inches), discontinuous lenses of fine sandy loam. Texture of the substratum ranges from light clay loam to clay. The depth to the substratum ranges from 36 to 60 inches. In places this soil has a sandy loam overwash 18 to 36 inches thick.

This soil is poorly drained and, in places, has an intermittent water table within a depth of 5 feet. It is subject to occasional flooding and to detrimental deposits. The permeability of the subsoil is moderately slow, and that of the substratum is slow. Runoff is slow, and the available water holding capacity is very high. Root penetration is deep. This soil has good tilth, but it can best be cultivated when the moisture content is about one-half field capacity. Fertility is high, and the hazard of erosion is slight. This soil is used for irrigated row crops, grain, and grain hay. (Capability unit IIw–3)

Sunnyvale clay loam (Sl).—This soil is poorly drained and has an intermittent water table within a depth of 5 feet. The substratum consists of dark-gray, granular, calcareous clay loam. Permeability of the subsoil is moderately slow. This soil has good tilth and is easy to work. It is used for irrigated pasture and row crops. (Capability unit IIw–2)

Sunnyvale clay loam, drained (Sn).—This soil formed in poorly drained areas. The drainage, however, has been improved by pumping; if pumping is continued, excess water is no longer a problem. The substratum consists of dark-gray, granular, calcareous clay loam. The available water holding capacity is high. This soil has good tilth and is easy to work. It is used for irrigated pasture and row crops. (Capability unit I–1)

Sycamore Series

The Sycamore series consists of moderately well drained, very deep, light brownish-gray, calcareous soils on nearly level valley floors north of Pleasanton. These soils formed in calcareous alluvium from sandstone and shale. They formed under grasses, sedges, and willows. The soils are in the same general area as the Yolo, Sunnyvale, and Clear Lake soils.

The surface soil is light brownish-gray, calcareous, moderately alkaline silt loam. It grades to a light olive-gray silt loam layer that has fine rust-colored mottles. This layer is strongly calcareous and has small, soft, whitish seams of lime. It is moderately alkaline.

Sycamore soils are used mainly for irrigated pasture, alfalfa, and row crops.

Sycamore silt loam (So).—This soil is mostly in large bodies on nearly level valley floors.

Representative profile:

0 to 18 inches, light brownish-gray silt loam; weak granular structure; slightly hard when dry, friable to very friable when moist, sticky and slightly plastic when wet; moderately calcareous; moderately alkaline.

18 to 60 inches, light olive-gray silt loam; common, fine, rust-colored mottles; soft whitish nodules and seams of lime; massive; friable when moist; strongly calcareous; moderately alkaline.

The texture of the surface soil ranges from gravelly loam or loam to silt loam. The color ranges from light brownish gray or grayish brown to light gray. Where this soil formed in moderately well drained areas, the mottles in the substratum are few and faint.

Drainage has been improved, and this soil is now moderately well drained. It is moderately permeable. Runoff is slow, and the available water holding capacity is high. Root penetration is very deep. The soil has good tilth and is easy to cultivate. Fertility is high. The erosion hazard is slight when the soil is cultivated. The soil is used for irrigated pasture, alfalfa, and row crops. (Capability unit I–1)

Sycamore silt loam over clay (Sy).—This soil is underlain by dark-gray calcareous clay at a depth of 36 to 48 inches. Included in mapping are a few small areas that are poorly drained and have an intermittent water table within a depth of 5 feet. The underlying clay is slowly permeable. Root penetration is deep. The available water holding capacity and fertility are moderate. The soil is used mainly for irrigated pasture. (Capability unit IIs–3)

Vallecitos Series

The Vallecitos series consists of well-drained to somewhat excessively drained shallow soils in the steep to very steep mountainous area south of Livermore Valley (fig. 16). These soils formed from hard shale and sandstone. The vegetation consists of annual grasses, brush, oaks, and some digger and Coulter pines. The Vallecitos soils are in the same general area as the Parrish, Henneke, and Gaviota soils and the Los Gatos-Los Osos complex of soils.

Figure 16.—**Typical landscape of Vallecitos soils.**

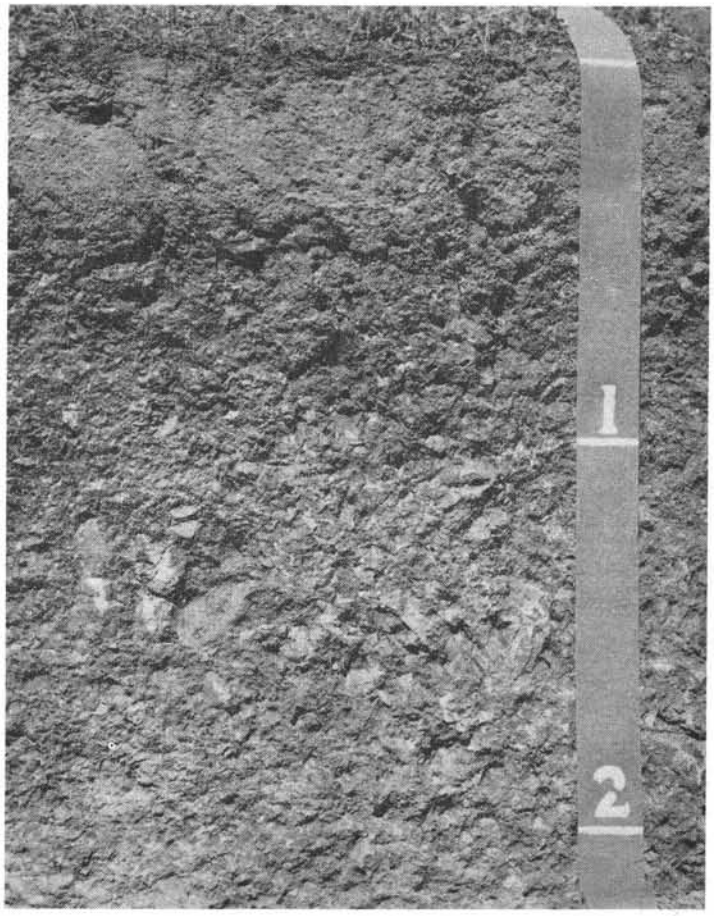

Figure 17.—**Profile of Vallecitos rocky loam, 30 to 45 percent slopes, eroded.**

The surface soil is brown, massive, slightly acid gravelly loam. It grades abruptly to reddish-brown, massive, neutral clay loam. Depth to bedrock ranges from 12 to 36 inches. Rock outcrops are frequent.

Vallecitos soils are used for pasture and range.

Vallecitos rocky loam, 30 to 45 percent slopes, eroded (VaE2).—This soil occurs in large bodies in moderately steep to steep mountainous areas. Rock outcrops are numerous (fig. 17).

Representative profile:

0 to 6 inches, brown gravelly loam; massive; hard when dry, friable when moist, plastic and slightly sticky when wet; slightly acid.

6 to 16 inches, reddish-brown clay loam; massive; very hard when dry, firm when moist, very plastic and slightly sticky when wet; neutral.

16 inches +, bluish-gray, metamorphosed, fine-grained sandstone.

Some areas of this soil are free of rock outcrops. The color of the surface soil ranges from brown or pale brown to light grayish brown. The texture ranges from sandy loam or loam to gravelly loam. On the steep, rocky ridges the subsoil may be only a few inches thick. In areas transitional to the Henneke soils, the surface soil is reddish brown.

This soil is well drained. Permeability of the subsoil is moderately slow. Runoff is rapid, and the available water holding capacity is low. Root penetration is shallow. The fertility is low, and the erosion hazard is severe. Tillage is difficult. The soil is used for pasture and range. (Capability unit VIe–8; Shallow Loamy Uplands range site)

Vallecitos rocky loam, 45 to 75 percent slopes, eroded (VaF2).—Except for steeper slopes, this soil is similar to Vallecitos rocky loam, 30 to 45 percent slopes, eroded. It occurs in very steep mountainous areas and has numerous rock outcrops. Drainage is somewhat excessive. Runoff is very rapid, and the erosion hazard is very severe. This soil is used for pasture and range. (Capability unit VIIe–1; Steep Shallow Loamy Uplands range site)

Yolo Series

The Yolo series consists of well-drained, moderately deep to very deep, loamy soils on nearly level valley floors west of Livermore and on the gently sloping to strongly sloping fans in small valleys east of Hayward. These soils formed under grasses and scattered oaks in alluvium from shale and sandstone. The Yolo soils are in the same general areas as the Sycamore, Sunnyvale, and Livermore soils.

The surface soil is grayish-brown, massive, mildly alkaline loam. The subsoil is brown very fine sandy loam and very dark grayish-brown fine sandy loam. It is moderately alkaline and very slightly calcareous. The substratum is dark-brown loam. It is moderately calcareous and is moderately alkaline.

The Yolo soils are used mainly for irrigated pasture, alfalfa, and row crops.

Yolo loam, 0 to 3 percent slopes (YmA).—This soil occurs mostly in large bodies on nearly level valley floors.

Representative profile:

0 to 16 inches, grayish-brown loam; massive; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; mildly alkaline.
16 to 46 inches, brown very fine sandy loam and very dark grayish-brown fine sandy loam; massive; soft when dry, friable when moist, nonsticky and nonplastic when wet; in places very slightly calcareous below 30 inches; moderately alkaline.
46 to 60 inches, dark-brown loam; massive; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; moderately calcareous; moderately alkaline.

The color of the surface soil ranges from dark grayish brown or grayish brown to brown. The texture ranges from fine sandy loam to light clay loam. The depth to lime ranges from 24 inches to 5 feet or more. A small area of this soil has a dark-gray, clayey substratum at 24 to 36 inches. Also, some small areas are gravelly throughout the profile. In a few places an intermittent water table is within a depth of 5 feet, and the substratum has common, fine, distinct, rust-colored mottles.

This soil is well drained and is moderately permeable. Runoff is very slow to slow, and the available water holding capacity is high. Root penetration is very deep. The soil has good tilth and can be cultivated easily. Fertility is moderate. The erosion hazard is slight in cultivated areas. The soil is used for irrigated pasture, alfalfa, and row crops. (Capability unit I–1)

Yolo loam, 3 to 10 percent slopes (YmB).—This soil occurs on gently sloping to moderately sloping alluvial fans. The soil is free of lime. Runoff is slow to medium, and the erosion hazard is slight to moderate if the soil is cultivated. This soil is used mainly for irrigated pasture and alfalfa. (Capability unit IIe–1)

Yolo sandy loam, 0 to 3 percent slopes (Ys).—Except for coarser texture, this soil is similar to Yolo loam, 0 to 3 percent slopes. Permeability is moderately rapid, and the available water holding capacity is moderate. This soil is used mainly for irrigated alfalfa and row crops. (Capability unit I–1)

Yolo gravelly loam, 0 to 3 percent slopes (Yr).—This soil is gravelly throughout the profile and is typically free of lime. The available water holding capacity is moderate, and the soil is easy to work. It is used mainly for irrigated pasture, alfalfa, and dry-farmed grain. (Capability unit IIs–4)

Yolo loam over gravel, 0 to 3 percent slopes (Yo).—This soil occurs in narrow stringers on nearly level valley floors. It is underlain by loose, porous gravelly sand at a depth of 24 to 36 inches. The available water holding capacity and fertility are moderate to low. A few small areas have a gravelly loam surface layer. This soil is used mainly for irrigated pasture, alfalfa, and row crops. (Capability unit IIIs–0)

Zamora Series

The Zamora series consists of well-drained, very deep, loamy soils on nearly level flood plains east of Livermore. The soils were formed in alluvium from sedimentary rock. The vegetation on uncultivated areas consists of annual grasses. The Zamora soils are in the same general area as the Rincon and Pleasanton soils.

The surface soil is grayish-brown light silty clay loam. When dry, it breaks to subangular blocky structure. This layer grades to a dark grayish-brown, moderately alkaline heavy clay loam subsoil. The substratum is massive, moderately alkaline clay loam.

Zamora soils are used mainly for roses, row crops, alfalfa, grain, and grain hay.

Zamora silty clay loam, 0 to 3 percent slopes (Zc).—This soil occurs mostly in large bodies on nearly level flood plains.

Representative profile:

0 to 18 inches, grayish-brown light silty clay loam, dark grayish brown in the lower part; moderate subangular blocky structure; hard when dry, friable when moist, sticky and slightly plastic when wet; mildly alkaline.
18 to 50 inches, dark grayish-brown heavy clay loam; medium blocky structure; hard when dry, friable when moist, sticky and plastic when wet; moderately alkaline.
50 to 60 inches, brown clay loam; massive; hard when dry, friable when moist, sticky and plastic when wet; slightly calcareous; moderately alkaline.

The surface soil ranges from grayish brown or dark grayish brown to dark brown. The texture ranges from heavy silt loam or silty clay loam to clay loam. In areas transitional to Rincon soils, the subsoil is more distinct and slightly finer textured. The substratum ranges from brown to yellowish brown in color. In some areas it is noncalcareous.

This soil is well drained. Permeability is moderately slow. Runoff is slow, and the available water holding capacity is high. Root penetration is very deep. The soil has good tilth, and cultivation is easy. Fertility is moderate. The erosion hazard is slight in cultivated

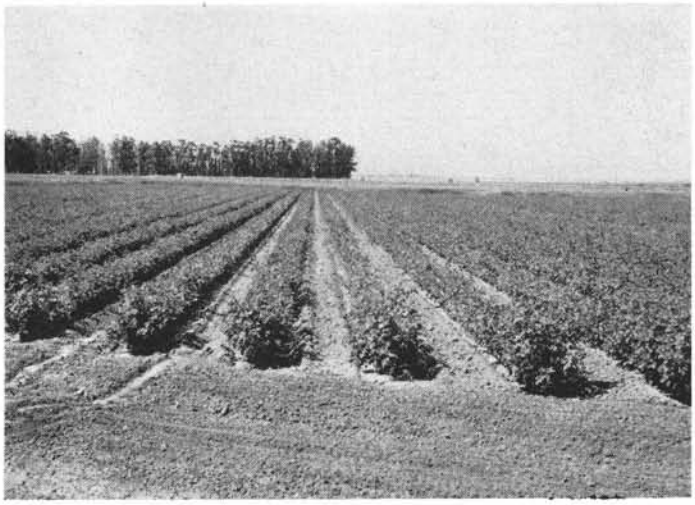

Figure 18.—**Roses on Zamora silty clay loam, 0 to 3 percent slopes.**

areas. The soil is used for irrigated roses (fig. 18), row crops, alfalfa, grain, and grain hay. (Capability unit I–1)

Zamora silt loam, 0 to 4 percent slopes (Za).—Except for coarser texture, this soil is similar to Zamora silty clay loam, 0 to 3 percent slopes. A few small areas have slopes steeper than 4 percent. The soil is used for irrigated row crops, alfalfa, grain, and grain hay. (Capability unit I–1)

Use, Management, and Productivity of Soils

Discussed in this section are general management practices, saline and alkali soils, capability groups, Storie index ratings, estimated yields, pasture and range, and engineering uses of the soils.

General Management Practices

Soils used for cultivated crops need management that maintains or improves their fertility, keeps them in good tilth, and helps control erosion. Cultivated crops grown on the soils of the Alameda Area are of four general types: (1) Dry-farmed grain, (2) irrigated pasture and alfalfa, (3) irrigated row crops, and (4) vineyards. The dry-farmed grain consists primarily of barley and some soft winter wheat. Irrigated pasture and alfalfa are used mainly as feed for dairy cattle, but some alfalfa is sold as hay. Row crops consist mainly of tomatoes, sugar beets, vegetables, and rose bushes. Grapes are used for making table wine. In some places the vineyards are irrigated by the sprinkler method late in winter and in spring. General management practices for the soils of the Area are discussed in the following paragraphs.

Fertility management.—Most soils in the Area do not have enough available phosphorus and nitrogen to produce high yields of crops. The amount of fertilizer needed depends upon the inherent fertility of the soil and the requirement of the crop. For example, the amounts differ for vineyards grown on the very gravelly Livermore soils and irrigated pasture grown on Clear Lake soils. The Livermore soils have low inherent fertility but require only moderate amounts of fertilizers to grow grapes of high quality for wine. On the other hand, the Clear Lake soils have high inherent fertility but require moderate to large amounts of phosphate to grow a large amount of forage.

Erosion control.—Accelerated erosion is a problem on many soils where dry-farmed grain is grown. It is the result of changes in the natural cover and in soil condition through use. The loss of surface soil caused by erosion reduces the supply of organic matter and plant nutrients and makes the soil less absorbent. Consequently, more water runs off, the rate of erosion increases, and the supply of available moisture decreases.

Accelerated erosion in the Alameda Area has been caused mainly by running water. Both sheet erosion and gully erosion occur. Sheet erosion—the removal of soil more or less uniformly in a thin layer—is more damaging and less obvious.

None of the upland soils of the Area, except the Positas soils, have inherent soil characteristics that make them highly erodible. However, most cultivated soils in the Area have eroded because of slope and the method in which they were used. The rate of erosion is probably less now than in the past. Much of the acreage of soils in the uplands now used for pasture and range was formerly cultivated for dry-farmed grain and grain hay. Removal of the protective plant cover by continuous overgrazing on most of the uncultivated soils has also caused erosion.

The Los Osos, Diablo, and some of the other upland soils are subject to small local landslides. It is common practice now to smooth these areas, to shape them so as to drain off excess water, and to seed them. This practice reduces gully erosion.

Saline-alkali soils in some of the small upland valleys are severely eroded and have deeply incised gullies. The soils on upland terraces are used mostly for pasture and range. These soils have been eroded, and fertility has been reduced.

Eroded soil material is carried by streams and is either deposited on lower lying and more nearly level areas or carried to San Francisco Bay. In the Alameda Area, material from eroded areas has been deposited over rather large areas of the Livermore and Amador Valleys. This recently deposited material makes up the soils of the Sunnyvale and Sycamore series. In many places along the larger creeks, the deposits are more than 5 feet deep, but the larger areas have an overwash less than 5 feet deep over basin clays. Soil material is still deposited along most of the streams at some time during each winter. In some places, the deposits ruin better farmland, break levees, and damage drainage ditches. Soils formerly shaped and leveled for irrigation often have to be releveled.

The control of erosion depends on many things, including slope, land area, climate, and soil type, and need for control usually varies from farm to farm. Practices generally used in the Area include one or more of the following:

1. Rotating grain with a pasture of volunteer annual grasses. The number of years the soil is left in pasture is determined by the degree of slope and the kind of soil.

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2. Tilling all fields on the contour, or across the slope.
3. Returning all crop residue to the soil. Adding nitrogen fertilizer is desirable to help decompose the residue and produce higher yields the following year.

Tillage practices.—Frequent tillage destroys the structure of the soil. This tillage produces a powdery surface layer that does not absorb water readily and makes irrigation difficult. It also speeds the decomposition of organic matter. Good tilth and a high rate of infiltration can be maintained by—

1. Returning all crop residue to the soil.
2. Adding organic matter by growing and turning under green-manure crops. This practice is particularly important if tree crops are grown and the soil is clean-cultivated throughout the summer.
3. Rotating row crops with irrigated pasture or alfalfa.
4. Using chemicals to control weeds and thus reduce tillage.
5. Tilling only enough to prepare a good seedbed and to control weeds and other volunteer plants.

A tillage pan, caused by a combination of factors, forms below the plow layer in some soils. If a soil is tilled to the same depth each time, the bottom of the furrow acquires a sheared, slick surface. Tractor wheels tend to compress the plow layer, particularly if it is moist. Clay moves down through the loose, plowed soil and fills the fine pores of the slick, compressed surface of the pan. As a result of these factors, the soil becomes compact and develops a platy structure just below the plow layer. The platy layer restricts the depth of root penetration and the movement of water.

To prevent the formation of a pan, vary the depth of plowing and other tillage operations and do not till when the top 12 inches of the soil is more than slightly moist. Growing grasses with legumes in irrigated pasture helps to prevent or to correct tillage pans.

Saline and Alkali Soils

The term "alkali," as commonly understood in the Area and used in this report, refers to soluble salts, either neutral or alkaline in reaction, that occur in soils in sufficient quantities to have a toxic or retarding effect on the growth of cultivated plants. The neutral salts consist of sodium chloride and sodium sulfate and are called white alkali. The true alkaline salts consist of sodium bicarbonate and sodium carbonate and are called black alkali.

Alkali soils in the Area were graded as *moderate* or *strong*. Soils moderately affected are marginal and produce poor to fair yields of tolerant crops. Soils strongly affected are difficult to reclaim, and the yield of salt-tolerant crops is low.

Alkali grades were established principally on the kind and percentage of salts and alkali in the soil. The grade is *moderate* if sodium makes up 15 to 20 percent of the exchangeable cations; it is *strong* if the percentage is more than 20. The exchangeable sodium percentage (ESP), which is the degree of saturation of the soil exchange complex with sodium, can be calculated by the formula:

$$\text{ESP}=\frac{\text{Exchangeable sodium (meq./100 gm. soil)}}{\text{Cation-exchange capacity (meq./100 gm. soil)}}\times 100$$

From three to five soil samples, from the surface to a depth of 5 feet, were collected at selected points to determine soil alkali. The percentage of salt was obtained by the electrical conductivity of the soil extract. Calcium and magnesium were determined by the Versenate method. The remaining cations were assumed to be sodium. A graph on page 73 of Agriculture Handbook No. 60 was used to determine the percentage of exchangeable sodium (*18*).[2]

Reclamation of saline-alkali soils depends on the type of soil. At the present time, the reclamation of most strong alkali soils and some moderate alkali soils is not feasible in the Area. In general, the following practices help to reclaim saline-alkali soils:

1. Providing adequate drainage.
2. Using a good method of irrigation.
3. Applying gypsum, sulfur, and other amendments.
4. Leaching with irrigation water of good quality.
5. Using salt-tolerant plants.

Capability Groups of Soils

The capability classification is a grouping that shows, in a general way, how suitable soils are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products. The Alameda Area has no soils in class V.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated 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* means that water in or on the soil will interfere 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 country, indicates 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 or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it are subject to little or no erosion but have other limitations that limit their use largely to pasture, range, woodland, or wildlife.

[2] Italic numbers in parentheses refer to Literature Cited, page 85.

Within the subclasses are the capability units, groups of soils 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 identified by numbers assigned locally, for example, IIe–1 or IIIe–3.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations; but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil; and without consideration of possible but unlikely major reclamation projects.

The classes and subclasses are subdivided into capability units, which are groups of soils that are similar in suitability for major crops in kind of management needed, and in kinds and amounts of crops produced. The capability unit shows the specific condition or conditions that limit the use of the soil. The kinds of soil within a capability unit, however, may differ slightly in the management practices they need and in the crop yields they produce.

In California the capability units are identified by numbers as follows:

0. Soils that generally are medium textured and are underlain by gravel or coarse sand that limits root penetration.
1. An erosion hazard, slope, or both.
2. A problem or limitation caused by wetness.
3. A problem or limitation caused by shallow depth of soil.
4. A problem or limitation caused by coarse soil texture, or excessive amounts of gravel.
5. A problem or limitation caused by fine soil texture.
6. A problem or limitation caused by salts or alkali.
7. A problem or limitation caused by cobblestones, rocks, or stones that interfere with cultivation. (None recognized in this Area.)
8. A problem or limitation caused by a shallow root zone (usually within 36 inches for class VI and 20 inches for class VII) because of an impermeable hardpan, bedrock, or other layer that limits available moisture.
9. A problem or limitation caused by very low fertility.

The eight classes in the capability system, and the subclasses and units in the Area are described in the following list.

Class I. Soils that have few limitations that restrict their use.
- Capability unit I–1.—Very deep, well drained and moderately well drained soils on alluvial fans and flood plains.

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

Subclass IIe. Soils that are likely to erode if they are not protected.
- Capability unit IIe–1.—Gently sloping, very deep, well-drained soils on recent alluvial fans.
- Capability unit IIe–3.—Gently sloping, very deep, well-drained soils that have a slowly permeable subsoil and are on alluvial fans.

Subclass IIs. Soils that have moderate limitations because of gravel or a compact subsoil.
- Capability unit IIs–3.—Nearly level, very deep, well drained and moderately well drained soils that have a dense subsoil and are on alluvial fans.
- Capability unit IIs–4.—Nearly level, very deep, well-drained and somewhat excessively drained soils that are gravelly and are on alluvial fans and low terraces.

Subclass IIw. Soils that have moderate limitations because of excess water.
- Capability unit IIw–2.—Very deep, nearly level soils that are on recent flood plains and basins and have a water table within 5 feet of the surface.
- Capability unit IIw–3.—Deep, nearly level soils that have a slowly permeable underlying layer, are in basins or on recent flood plains, and have a water table within 5 feet of the surface.

Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

Subclass IIIe. Soils subject to severe erosion if they are tilled and not protected.
- Capability unit IIIe–1.—Deep, imperfectly drained to moderately well drained, gently sloping to rolling soils in small upland valleys.
- Capability unit IIIe–3.—Moderately deep to deep, gently sloping to moderately sloping soils that have a dense subsoil and are on fans and terraces.
- Capability unit IIIe–5.—Very deep, deep, and moderately deep, clayey soils that are underlain by shale and sandstone.

Subclass IIIs. Soils that have severe limitations because of underlying gravel or a clayey texture.
- Capability unit IIIs–0.—Moderately deep soils that are underlain by gravel and are on flood plains.
- Capability unit IIIs–5.—Very deep, moderately well drained, clayey soils in basins.

Subclass IIIw. Soils that have severe limitations because of excess water.
- Capability unit IIIw–5.—Deep, imperfectly drained, clayey soils that are in nearly level basins and have a water table within 5 feet of the surface.

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

Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
- Capability unit IVe–3.—Nearly level to hilly, shallow to deep soils.
- Capability unit IVe–5.—Gently sloping to hilly, shallow to deep, moderately fine and fine textured soils.

Subclass IVs. Soils that have very severe limitations because of low moisture capacity.

Capability unit IVs–4.—Very deep, very gravelly soils on recent flood plains.

Class V. Soils not likely to erode that have other limitations, impractical to remove without major reclamation, that limit their use largely to pasture or range, woodland, or wildlife food and cover.

No soils or landforms of class V were mapped in the Alameda Area.

Class VI. Soils that have severe limitations that make them generally unsuited to cultivation and that limit their use largely to pasture or range, woodland, or wildlife food and cover.

Subclass VIe. Soils severely limited, chiefly by the hazard of erosion if protective cover is not maintained.

Capability unit VIe–3.—Shallow, hilly to steep soils on terraces.

Capability unit VIe–5.—Moderately fine and fine textured, steep soils on uplands.

Capability unit VIe–8.—Very shallow to moderately deep, loamy, very steep soils.

Subclass VIw. Soils unsuitable for cultivation because of excess water.

Capability unit VIw–2.—Soils on basin rims and low terraces limited chiefly by excess water; saline-alkali soils.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation, and that restrict their use largely to grazing, woodland, or wildlife.

Subclass VIIe. Soils very severely limited, chiefly by risk of erosion if not protected.

Capability unit VIIe–1.— Shallow to moderately deep, very steep soils on north-facing slopes.

Capability unit VIIe–3.—Shallow to deep, very steep soils on terraces.

Capability unit VIIe–5.—Moderately fine and fine textured, very steep soils on uplands.

Capability unit VIIe–8.—Very shallow to moderately deep, loamy, very steep soils.

Class VIII. Soils and landforms that, without major reclamation, have limitations that preclude their use for commercial production of plants; and that restrict their use to recreation, wildlife, water supply, or esthetic purposes.

Subclass VIIIs. Soils or land types that support very little vegetation.

Capability unit VIIIs–9.—Shallow, infertile soils and land types.

Subclass VIIIw. Land types that have excess water.

Capability unit VIIIw–4.—Coarse-textured material in stream channels and gravel pits.

Management by capability units

The capability units are described in the following pages. The soils in each unit are listed, and management suitable for all the soils in the unit is discussed. The soils in each capability unit have about the same limitations and similar risks of damage. The soils in one unit, therefore, need about the same kind of management.

CAPABILITY UNIT I–1

This capability unit consists of very deep, nearly level, well drained and moderately well drained soils on recent alluvial fans and flood plains. They are permeable and have no features that limit penetration of roots and moisture. The profile is fairly uniform throughout. Stratification in the subsoil is not sufficient to cause serious management problems. The soils are fairly easy to till and moderately to highly retentive of moisture. Texture ranges from sandy loam to silty clay loam. Slopes are very gentle, and erosion is seldom a problem. The soils are—

(Sn)	Sunnyvale clay loam, drained.
(So)	Sycamore silt loam.
(YmA)	Yolo loam, 0 to 3 percent slopes.
(Ys)	Yolo sandy loam, 0 to 3 percent slopes.
(Za)	Zamora silt loam, 0 to 4 percent slopes.
(Zc)	Zamora silty clay loam, 0 to 3 percent slopes.

Use and management.—The soils of this unit are well suited to a wide range of crops, including irrigated pasture, tomatoes, sugar beets, and various specialty crops, such as roses. Good yields of all crops can be expected, although good management practices, including fertilizing, are needed to produce the best yields and to maintain a high level of production.

The organic-matter content can be maintained by including a green-manure crop in the rotation every 3 to 5 years, rotating row crops with irrigated pasture or alfalfa, and returning all crop residue to the soil. These practices also help to control diseases, insects, and other pests.

Rotation grazing, clipping to eliminate the bunching of grasses and weeds, and scattering the droppings of animals are good practices for irrigated pasture. Grazing the forage below a height of 3 to 4 inches and grazing when the soils are wet should be avoided. The soils generally respond to nitrogen and phosphorus fertilizer.

These soils may be irrigated by the furrow, border, contour-basin, or sprinkler system. The length of runs for furrows, borders, or basins and the rate of application by sprinklers will vary with the soil texture, the head of water, and the slope. The soils are very deep and can be leveled for irrigation without difficulty.

CAPABILITY UNIT IIe–1

The one soil in this capability unit, (YmB) Yolo loam, 3 to 10 percent slopes, is well drained and is more than 5 feet deep. It is gently sloping and is on recent alluvial fans. Permeability is moderate.

This soil is similar to the soils in capability unit I–1 but more sloping. Also, runoff is slow to medium, and the erosion hazard is slight to moderate. Droughtiness, moisture penetration, and drainage are not problems. This soil occurs primarily in small upland valleys in the western part of the Area.

Use and management.—The soil of this capability unit is suitable for a wide range of crops; but because of the shortage of irrigation water, it is used primarily for dry-farmed grain, grain hay, and pasture. The soil has moderate fertility, and good yields can be expected. Crops on this soil respond to nitrogen and phosphorus fertilizer.

Erosion can be controlled by tilling across the slope, stubble mulching, and rotating crops with pasture every

3 to 5 years. These practices also help to maintain good tilth and soil structure.

CAPABILITY UNIT IIe-3

The one soil in this capability unit, (DaB) Danville silty clay loam, 3 to 10 percent slopes, is well drained, moderately fine textured, and very deep. It is gently sloping and occurs on alluvial fans. Permeability of the subsoil is slow.

Use and management.—This soil is well suited to tomatoes and sugar beets; but because of the lack of irrigation water, it is used primarily for dry-farmed grain, grain hay, and pasture. The soil has high fertility, and good yields can be expected. Increased yields can be expected from the addition of nitrogen and phosphorus fertilizer.

Erosion can be controlled by tilling across the slope, stubble mulching, and rotating crops with native pasture every 3 to 5 years. These practices also help to maintain soil structure and good tilth.

CAPABILITY UNIT IIs-3

This capability unit consists of nearly level, well drained and moderately well drained soils on low terraces and alluvial fans. These soils are more than 5 feet deep. Their texture ranges from loam to silty clay loam. Permeability is moderately slow to slow. These soils have a dense subsoil that slightly restricts their use. The soils are—

(DaA) Danville silty clay loam, 0 to 3 percent slopes.
(PgA) Pleasanton gravelly loam, 0 to 3 percent slopes.
(RdA) Rincon clay loam, 0 to 3 percent slopes.
(Rc) Rincon loam, 0 to 3 percent slopes.
(Sy) Sycamore silt loam over clay.

Use and management.—These soils are suitable for irrigated pasture, row crops, and grain. Although alfalfa is grown on these soils, it is short-lived, and irrigation has to be carefully controlled because permeability of the subsoil is moderately slow to slow.

Management practices are needed that maintain soil structure and soil fertility. A green-manure crop every 2 to 4 years is advisable in crop rotations. Other methods for soil improvement include the use of a grass-legume crop or a hay crop in the rotation and the return of all crop residue to the soil.

CAPABILITY UNIT IIs-4

This capability unit consists of nearly level to gently sloping, very deep, well-drained and somewhat excessively drained soils on alluvial fans and low terraces. The soils are gravelly and are more than 5 feet deep. Permeability is moderate. The water-holding capacity and fertility of the soils are low to moderate, but are less favorable in areas that have a higher content of gravel. In some places gravel is only in the surface soil, but in others it occurs throughout the profile. Also in places the soils, particularly the Yolo soil, contain layers of sand and gravel throughout the profile. Roots and water penetrate these soils to a great depth. The soils are—

(Lg) Livermore gravelly loam.
(Yr) Yolo gravelly loam, 0 to 3 percent slopes.

Use and management.—The soils of this capability unit are suited to a wide range of crops. Dry-farmed crops, however, may not produce good yields because of the low moisture-holding capacity of the soils. Under irrigation, good yields are obtained with moderate applications of nitrogen and phosphorus. Light and frequent applications of irrigation water reduce the loss of water caused by deep percolation. Water can best be applied by a sprinkler system. If furrow or border irrigation is used, short runs will reduce excessive percolation and leaching.

All crops respond to nitrogen fertilizer, and many respond to phosphorus. Cover crops and green-manure crops help to maintain good soil structure and fertility and to increase the response of crops to fertilizer. All crop residue should be returned to the soil.

CAPABILITY UNIT IIw-2

The one soil in this capability unit, (Sl) Sunnyvale clay loam, is nearly level and more than 5 feet deep. It is on flood plains and in basins and has an intermittent water table within a depth of 5 feet. Permeability of the subsoil is moderately slow.

This soil has developed under slow to very slow runoff and a high water table. It is now considerably better drained, however, because drains have been installed and a large volume of water is pumped for irrigation in the area.

Use and management.—Crops best suited to this soil are irrigated tomatoes, pasture, sugar beets, hay, and dry-farmed grain. Delayed tillage is a minor problem. There are also some minor problems on water disposal and irrigation. If drainage is provided, the soil is suitable for deep-rooted crops. This soil is productive, and good yields can be expected. Drainage is needed, and irrigation must be carefully controlled.

A crop rotation that include a grass-legume crop every 3 or 4 years is needed to maintain fertility and soil structure. A green-manure crop adds needed organic matter. Subsoiling improves permeability in areas where there is a tillage pan.

CAPABILITY UNIT IIw-3

The one soil in this capability unit, (Sm) Sunnyvale clay loam over clay, is deep and nearly level. It is in basins and on recent flood plains and has an intermittent water table within a depth of 5 feet. The clay loam surface layer is underlain at a depth of 3 to 4 feet by a layer of slowly permeable clay.

This soil developed under slow to very slow runoff and a high water table. However, drains have been installed and natural channels deepened and a large volume of water is pumped for irrigation; consequently, most areas of this soil are now considerably better drained.

Use and management.—This soil is best suited to irrigated pasture, sugar beets, hay, and dry-farmed grain. In a few areas the content of lime is high enough to cause chlorosis in tomatoes. Delayed tillage and a restrictive subsoil are minor problems on this soil. There are also some minor problems connected with water disposal and irrigation. Surface drainage is needed, and irrigation must be carefully controlled. This soil is not suitable for deep drains.

A crop rotation that includes a grass-legume crop every 3 to 5 years is needed to maintain soil fertility and soil structure. A green-manure crop adds needed organic

matter. Even though drained, this soil, because of the underlying clay, is not well suited to deep-rooted crops.

CAPABILITY UNIT IIIe-1

The one soil in this capability unit, (LsC) Los Osos loam, seeped variant, 3 to 15 percent slopes, is deep and is imperfectly drained to moderately well drained. It is gently sloping to rolling and formed from soft sedimentary rock in small upland valleys east of Hayward. Permeability is moderately slow.

This soil ranges from 36 to 60 inches in depth to sandstone bedrock. The water-holding capacity is moderate. This soil is subject to severe erosion if it is left bare during the rainy season.

Use and management.—The soil of this capability unit is best suited to pasture, range, dry-farmed grain, and grain hay. If water is available, this soil is suitable for irrigated pasture. Fertilizer that contains nitrogen and phosphorus is beneficial.

Major conservation practices are needed to control sheet and gully erosion. All tillage and planting should be on the contour or across the slope. On soil used for dry-farmed grain or grain hay, a green-manure crop is needed every 3 or 4 years. All crop residue should be returned to the soil. Grain and hay stubble, if allowed to remain on the surface, greatly aids in reducing sheet erosion.

If irrigation is practiced, a sprinkler system is best because the soil is sloping. Waterways and protected outlets should be provided. Subsoiling on the contour when the soil is dry helps to increase the intake of water. Seepage may cause a temporarily high water table during winter and early in summer. The soil is too steep for artificial drainage, but gullies provide drainage in some areas.

CAPABILITY UNIT IIIe-3

This capability unit consists of moderately deep to deep, gently sloping to moderately sloping soils on fans and terraces. These soils have a dense subsoil. The texture of the surface layer ranges from gravelly loam to clay loam, and permeability ranges from slow to very slow.

The surface layer of the soils of this unit is readily penetrated by roots and water, but the dense subsoil restricts both. If the soils are left bare during the rainy season, severe erosion will result. In the Positas soil, a tight claypan is at a depth of 18 to 30 inches. Irrigation water or rainfall that exceeds the water-holding capacity of the surface layer of Positas soils causes rapid runoff and temporary waterlogging. The soils in this unit are—

(PgB) Pleasanton gravelly loam, 3 to 12 percent slopes.
(PtB2) Positas gravelly loam, thick surface, 2 to 10 percent slopes, eroded.
(RdB) Rincon clay loam, 3 to 7 percent slopes.

Use and management.—The soils of this unit present a major problem in use because of slope and limited depth. Crops best suited are irrigated pasture, dry-farmed grain, and hay. Deep-rooted trees are not suited. Winter-growing crops, such as grain and hay, make the best use of the available moisture.

Irrigation must be carefully controlled to avoid saturation of the soil above the subsoils. Saturation causes root rot in plants and leaching of plant nutrients. The Positas soils are best suited to sprinkler irrigation.

Major conservation practices are needed to control sheet and gully erosion. All tillage and planting should be on the contour or across the slope. On soils used for grain or hay, a green-manure crop is needed every 3 or 4 years. All crop residue should be returned to the soil. Grain and hay stubble, if allowed to remain on the surface, aids in controlling sheet erosion. Cultivated crops should be alternated with grasses and legumes every 3 to 5 years.

CAPABILITY UNIT IIIe-5

This capability unit consists of very deep to moderately deep clayey soils that are underlain by shale and sandstone.

These soils are 20 inches deep or more. The texture ranges from clay loam to clay. Permeability ranges from moderately slow to slow, and the water-holding capacity from moderate to high. The clay soils tend to form large cracks when they dry. The soils of this unit are relatively stable against sheet erosion. They are on moderately sloping uplands. Except the Clear Lake soil, which is on fans, the soils are underlain by slightly consolidated rock. The soils are—

(AaC) Altamont clay, 3 to 15 percent slopes.
(CdB) Clear Lake clay, drained, 3 to 7 percent slopes.
(DbC) Diablo clay, 7 to 15 percent slopes.
(DvC) Diablo clay, very deep, 3 to 15 percent slopes.
(LaC) Linne clay loam, 3 to 15 percent slopes.

Use and management.—Dry-farmed grain and grain hay are well suited to the soils of this capability unit. Tillage practices should be on the contour or across the slope to help control erosion. When the soils are used for grain or hay, a green-manure crop is needed every 3 to 4 years. All crop residue should be returned to the soil. Grain and hay stubble, if allowed to remain on the surface, helps control sheet erosion. Stubble mulching also helps to control erosion. Some of the soils are in areas of extensive grassland and are used for grazing.

CAPABILITY UNIT IIIs-0

The one soil in this capability unit, (Yo) Yolo loam over gravel, 0 to 3 percent slopes, is moderately deep and is underlain by loose gravel at a depth of 2 to 3 feet. The soil is on recent fans and flood plains. In most places the texture of the surface layer is loam, but it is gravelly loam in a few small areas. Permeability of the surface layer is moderate, but that of the underlying gravel is very rapid.

Use and management.—The soil in this unit is suited to irrigated row crops, pasture, grain, and hay. Dry-farmed crops, however, do not produce well. If the soil is irrigated and moderately fertilized, good yields are obtained. The application of irrigation water must be light and frequent to prevent the loss of water by deep percolation. Water can best be applied by a sprinkler system. If furrow or border irrigation is used, short runs should be used to prevent excessive percolation and leaching.

All crops respond well to nitrogen and phosphorus fertilizer. Cover crops and green-manure crops help to maintain good soil structure and fertility. All crop residue should be returned to the soil.

CAPABILITY UNIT IIIs-5

The one soil in this capability unit, (CdA) Clear Lake clay, drained, 0 to 3 percent slopes, is a very deep, moderately well drained, clayey soil in nearly level basins. The soil

is slowly permeable. Because of the development of large-scale pumping operations and the deepening of stream channels by erosion, most areas of this soil are now considerably better drained.

Use and management.—The soil in this unit is suited to irrigated tomatoes, pasture, and sugar beets, and to dry-farmed grain and grain hay. On fields used for grain or hay, a green-manure crop is needed every 3 to 5 years. All crop residue should be returned to the soil. Cover crops add needed organic matter and improve tilth and soil structure. If water is available, cover crops should be irrigated to start early growth.

CAPABILITY UNIT IIIw-5

The one soil in this capability unit, (Cc) Clear Lake clay, 0 to 3 percent slopes, is a deep, imperfectly drained clayey soil in nearly level basins. An intermittent water table is within a depth of 5 feet. This soil is slowly permeable. The water-holding capacity and fertility are high. A general lowering of the water table of this soil has improved drainage and resulted in a wider suitability of crops.

Use and management.—The soil in this unit is best suited to irrigated pasture, hay, and grain. It is also suited to some row crops and truck crops. Drainage can be improved by diverting runoff from higher soils, and by avoiding overirrigation. Because the soil is slowly permeable, internal drainage by ditches or by tile is difficult.

On fields used for grain or hay, a green-manure crop is needed every 3 to 4 years. All crop residue should be returned to the soil to help maintain good tilth and good structure.

CAPABILITY UNIT IVe-3

This capability unit consists of nearly level to hilly, shallow and moderately deep soils. These soils range from 10 to 60 inches in depth.

The texture of the surface layer ranges from fine sandy loam or gravelly loam to silt loam. The texture of the subsoil ranges from silt loam to clay. Permeability ranges from moderate to very slow.

The Positas soil has gravel throughout the profile; it is droughty and has lower fertility than the other soils. The San Ysidro soil is nearly level, but it is placed in this unit because it is only moderately deep. The soils are—

(CoC2) Cotati fine sandy loam, eroded.
(LuD) Los Osos and Millsholm soils, 7 to 30 percent slopes (Los Osos silt loam and Millsholm silt loam).
(PcD) Perkins loam, 3 to 30 percent slopes.
(PoC2) Positas gravelly loam, 2 to 20 percent slopes, eroded.
(Sa) San Ysidro loam.
(SdD2) Shedd silt loam, 15 to 30 percent slopes, eroded.

Use and management.—The soils in this unit are best suited to grazing. They can be used for dry-farmed grain and grain hay, if they are handled with care. If they are used for hay or grain, a grass-legume crop is needed 4 years in 5 to help control erosion. All crop residue should be returned to the soil. Tillage should be on the contour or across the slope. Grain and hay stubble, if allowed to remain on the surface, greatly aids in controlling sheet erosion. These soils respond well to nitrogen and phosphorus fertilizer.

When the soils are used for pasture and range, good management practices are needed to provide more forage and to protect the soils from erosion. Suitable practices are discussed in the subsection "Use of Soils for Pasture and Range."

CAPABILITY UNIT IVe-5

This capability unit consists of gently sloping to hilly, shallow to deep, moderately fine and fine textured soils.

These soils range from 20 to 60 inches in depth. They are underlain by soft sedimentary rock or semiconsolidated material. The texture of the surface soil ranges from silty clay loam to clay. Permeability ranges from moderately slow to slow. The water-holding capacity ranges from low to high, and runoff is medium. The soils are relatively stable, but because the slopes are moderately steep, there is a moderate erosion hazard. The soils are—

(AaD) Altamont clay, 15 to 30 percent slopes.
(AzD) Azule clay loam, 3 to 30 percent slopes.
(DbD) Diablo clay, 15 to 30 percent slopes.
(DvD2) Diablo clay, very deep, 15 to 30 percent slopes, eroded.
(LaD) Linne clay loam, 15 to 30 percent slopes.
(LtD) Los Osos silty clay loam, 7 to 30 percent slopes.

Use and management.—These soils are best suited to dry-farmed grain, grain hay, and grazing. If the soils are used for hay and grain, a grass-legume crop is needed 3 years in 5 to help maintain good structure and tilth. All crop residue should be returned to the soil. Tillage should be on the contour or across the slope. Adding moderate amounts of nitrogen and phosphorus to the soils increases yields.

When the soils are used for pasture or range, good management practices are needed to produce more and better plants for forage and continuous protection of the soils. Suitable practices are discussed in the subsection "Use of Soils for Pasture and Range".

CAPABILITY UNIT IVs-4

The one soil in this capability unit, (Lm) Livermore very gravelly coarse sandy loam, is a very deep, very gravelly soil on flood plains. It is 5 feet deep or more. The texture of the surface layer is very gravelly sandy loam. Permeability is rapid. The water-holding capacity is very low, and natural fertility is low.

Use and management.—Use of this soil is limited to vineyards and pasture. Where water is available, the vineyards are irrigated early in spring, particularly if the winter has been dry. The applications of irrigation water must be light and frequent to prevent loss of water by deep percolation. Water should be applied by the sprinkler system.

All crop residue should be returned to the soil. A green-manure crop improves tilth and infiltration and increases fertility. These soils respond to the addition of nitrogen and phosphorus.

CAPABILITY UNIT VIe-3

The one soil in this capability unit, (PoE2) Positas gravelly loam, 20 to 40 percent slopes, eroded, is a shallow, hilly to steep soil on terraces. It has a gravelly loam surface layer and a claypan subsoil. It is from 10 to 20 inches deep to the claypan. The water-holding capacity is low, and fertility is low. This soil has a moderately high potential for forage production. It is covered mainly by grasses. Forage production is about the same on all slopes.

Use and management.—This soil is well suited to pasture and range. Management practices are discussed in the subsection "Use of Soils for Pasture and Range."

CAPABILITY UNIT VIe-5

This capability unit consists of moderately fine and fine textured, steep soils on uplands. The texture of the surface layer ranges from silty clay loam to clay, but in one soil it is rocky clay. These soils are 18 inches deep or more to bedrock or semiconsolidated material. They are relatively stable and have moderately slow to slow permeability. The water-holding capacity and inherent fertility are low to high. The soils in this capability unit have a high potential for forage production. They are covered mainly by grasses, but there are a few scattered oaks and some brush. Forage production is about the same on all slopes. The soils are—

(AmE2) Altamont clay, moderately deep, 30 to 45 percent slopes, eroded.
(ArD) Altamont rocky clay, moderately deep, 7 to 30 percent slopes.
(AzE2) Azule clay loam, 30 to 45 percent slopes, eroded.
(DbE2) Diablo clay, 30 to 45 percent slopes, eroded.
(DvE2) Diablo clay, very deep, 30 to 45 percent slopes, eroded.
(LaE2) Linne clay loam, 30 to 45 percent slopes, eroded.
(LpE2) Los Gatos-Los Osos complex, 30 to 45 percent slopes, eroded (Los Osos silty clay loam part).
(LtE2) Los Osos silty clay loam, 30 to 45 percent slopes, eroded.

Use and management.—The soils in this capability unit are well suited to pasture and range. Management of the soils is discussed in the subsection "Use of Soils for Pasture and Range."

CAPABILITY UNIT VIe-8

This capability unit consists of shallow to moderately deep, loamy, very steep soils. The texture ranges from sandy loam to silt loam. Some of these soils are rocky, some are gravelly, and some are shaly. Depth to bedrock ranges from 10 to 48 inches. In some places bedrock crops out. The soils are stable and have moderately rapid to slow permeability. The water-holding capacity is very low to moderate, and the inherent fertility is low to moderate. The soils in this capability unit have a moderate potential for forage production. The present cover consists of grasses, scattered oaks, and brush. Forage production is about the same on all slopes. The soils are—

(GaE2) Gaviota rocky sandy loam, 5 to 40 percent slopes, eroded.
(LoE2) Lobitos shaly loam, eroded.
(LpE2) Los Gatos-Los Osos complex, 30 to 45 percent slopes, eroded (Los Gatos loam part).
(LuE2) Los Osos and Millsholm soils, 30 to 45 percent slopes, eroded (Los Osos silt loam and Millsholm silt loam).
(MhE2) Millsholm silt loam, 30 to 45 percent slopes, eroded.
(PaE2) Parrish gravelly loam, 30 to 45 percent slopes, eroded.
(SdE2) Shedd silt loam, 30 to 45 percent slopes, eroded.
(VaE2) Vallecitos rocky loam, 30 to 45 percent slopes, eroded.

Use and management.—The soils in this capability unit are best suited to pasture and range. Management of the soils is discussed in the subsection "Use of Soils for Pasture and Range."

CAPABILITY UNIT VIw-2

In this capability unit are nearly level to very gently sloping, saline-alkali soils. They occur along the lower basin rims and on low terraces. The texture of the surface layer is fine sandy loam or clay. These soils are flooded periodically. The vegetation consists of salt-tolerant plants. The soils are—

(Pd) Pescadero clay.
(Sf) Solano fine sandy loam.

Use and management.—The soils of this unit are used principally for grazing. The vegetation normally consists of saltbush, saltgrass, foxtail, and other annual plants. Forage production is very low. Reclamation is not feasible because of the high cost. Fencing, development of watering places, and proper use of forage are the main management practices needed.

CAPABILITY UNIT VIIe-1

This capability unit consists of moderately deep, very steep soils on north-facing slopes.

The soils have a loam, gravelly loam, or rocky loam surface layer and a clay loam to clay subsoil. Depth to bedrock ranges from 10 to 36 inches. The water-holding capacity and inherent fertility are low to moderate. The soils in this unit have a low to moderately low potential for forage production.

The vegetation consists of hardwoods and conifers, and an understory of brush, grasses, and forbs. Forage production is about the same on all slopes. The soils are—

(LpF2) Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded (Los Gatos loam part).
(PaF2) Parrish gravelly loam, 45 to 75 percent slopes, eroded.
(VaF2) Vallecitos rocky loam, 45 to 75 percent slopes, eroded.

Use and management.—These soils are best suited to pasture and range. Management practices are discussed in the subsection "Use of Soils for Pasture and Range."

CAPABILITY UNIT VIIe-3

This capability unit consists of shallow to deep, very steep soils on terraces. The soils have a gravelly loam or loam surface layer and a clay loam or clay subsoil. They range from 10 to 36 inches in depth. The water-holding capacity and inherent fertility are very low to moderate. The soils in this capability unit have a moderate potential for forage production. The vegetation is mainly grasses and scattered oaks. Forage production is about the same on all slopes. The soils are—

(PcF2) Perkins loam, 45 to 75 percent slopes, eroded.
(PoF2) Positas gravelly loam, 40 to 60 percent slopes, eroded.

Use and management.—These soils are best suited to pasture and range. Management practices are discussed in the subsection "Use of Soils for Pasture and Range."

CAPABILITY UNIT VIIe-5

This capability unit consists of moderately fine and fine textured, very steep soils on uplands.

These soils have a clay loam, clay, or silty clay loam surface layer. Depth to bedrock or semiconsolidated material is 18 inches or more. The soils are stable and have moderately slow to slow permeability. The water-holding capacity and inherent fertility range from low to high. The soils in this capability unit have a high potential for forage production.

The cover is mainly grasses, a few scattered oaks, and brush. Forage production is about the same on all slopes.

The soils are—

(AmF2) Altamont clay, moderately deep, 45 to 75 percent slopes, eroded.
(AzF2) Azule clay loam, 45 to 60 percent slopes, eroded.
(DmF2) Diablo clay, moderately deep, 45 to 60 percent slopes, eroded.
(DvF2) Diablo clay, very deep, 45 to 60 percent slopes, eroded.
(LcF2) Linne clay loam, shallow, 45 to 75 percent slopes, eroded.
(LpF2) Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded (Los Osos silty clay loam part).
(LtF2) Los Osos silty clay loam, 45 to 75 percent slopes, eroded.

Use and management.—These soils are best suited to pasture and range. Management practices are discussed in the subsection "Use of Soils for Pasture and Range."

CAPABILITY UNIT VIIe-8

This capability unit consists of shallow to moderately deep, loamy, very steep soils.

These soils have a silt loam, sandy loam, or rocky sandy loam surface layer. They are 10 to 36 inches deep to bedrock. The soils have moderately rapid to moderate permeability and low to moderate water-holding capacity and inherent fertility. They have a moderately low potential for forage production. The vegetation consists of grasses, scattered oaks, and brush. Forage production is about the same on all slopes. The soils are—

(GaF2) Gaviota rocky sandy loam, 40 to 75 percent slopes, eroded.
(MhF2) Millsholm silt loam, 45 to 75 percent slopes, eroded.
(SdF3) Shedd silt loam, 45 to 75 percent slopes, severely eroded.

Use and management.—These soils are best suited to pasture and range. Management practices are discussed in the subsection "Use of Soils for Pasture and Range."

CAPABILITY UNIT VIIIs-9

This capability unit consists of a shallow to very shallow, infertile soil and a rocky land type.

The land type, Rock land, comprises areas that have little or no soil, and very steep, rough, mountainous areas. It is scattered throughout the Area. In this unit are—

(HnF2) Henneke rocky loam, eroded.
(RoF) Rock land.

Use and management.—The Henneke soils and Rock land are mostly in brush. The soils are very infertile and are too steep and too shallow to permit any extensive improvement in cover. The present cover, however, provides valuable protection to watersheds and forage for wildlife, and for this reason should be protected from fire. Burned places should be seeded, because runoff from fire-denuded slopes is a serious threat to good soils in the valleys. Fencing the critically eroded areas is also desirable.

CAPABILITY UNIT VIIIw-4

In this capability unit are land types that have coarse and very coarse material and are in stream channels and gravel pits. They are not suited to the commercial production of plants. The land types are—

(Gp) Gravel pit.
(Rh) Riverwash.

Use and management.—These land types should be managed for wildlife habitats and as recreational areas. Some areas are a source of material for highway and other construction. Other areas have a plant cover and should be protected from fire. Protection of stream channels is needed.

772-162—66——4

Storie Index Rating

The soils of the Area are arranged in alphabetic order in table 8 and are rated according to the Storie index (*2*, *14*). This index expresses numerically the relative degree of suitability, or value, of a soil for general intensive agriculture. The rating is based on soil characteristics only and is obtained by evaluating such factors as depth, texture of the surface soil, density of subsoil, drainage, salts and alkali, and relief. Other factors, such as availability of water for irrigation, climate, and distance from markets, that might determine the desirability of growing certain plants in a given locality, are not considered. Therefore, in itself the index cannot be considered as an index of land value.

Four general factors are considered in the index rating. These factors are (A) the characteristics of the soil profile and soil depth; (B) the texture of the surface soil; (C) slope; and (X) other factors, such as drainage, salts and alkali, and erosion. Each of these four general factors is evaluated on the basis of 100 percent. A rating of 100 percent expresses the most favorable, or ideal, condition, and lower percentage ratings are given for conditions that are less favorable for crop production.

The index rating for a soil is obtained by multiplying the four factors, A, B, C, and X; thus, any one factor may dominate or control the final rating. For example, a soil may have an excellent profile justifying a rating of 100 percent for factor A, excellent texture of the surface soil justifying 100 percent for factor B, a smooth, nearly level surface justifying 100 percent for factor C, but a high accumulation of salts or alkali that would give a rating of 10 percent for factor X. Multiplying these four ratings gives an index rating of 10 for this soil. The high accumulation of salts or alkali would dominate the quality of the soil, render it unproductive for crops, and justify the low index rating of 10.

Soils are placed in grades according to their suitability for general intensive agriculture as shown by their Storie index ratings. The six grades and their range in index ratings are:

	Index rating
Grade 1	80 to 100
Grade 2	60 to 80
Grade 3	40 to 60
Grade 4	20 to 40
Grade 5	10 to 20
Grade 6	Less than 10

Soils of grade 1 are excellent, or well suited to general intensive agriculture. Grade 2 soils are good and are also well suited to agriculture, although they are not so desirable as soils of grade 1. Grade 3 soils are only fairly well suited, grade 4 soils are poorly suited, and grade 5 soils are very poorly suited. Grade 6 consists of soils and land types that are not suited to agriculture.

Estimated Yields

The soils are listed in table 9, and the relative suitability of each for the principal crops grown in the Area is estimated. In estimating the suitability of a soil for

TABLE 8.—*Storie index rating for soils of the Alameda Area, Calif.*

Map symbol	Soil	Soil rating factors				Index rating	Grade
		A (profile)	B (texture)	C (slope)	X (other conditions)		
						Percent	
AaC	Altamont clay, 3 to 15 percent slopes	80	60	90	95	41	3
AaD	Altamont clay, 15 to 30 percent slopes	80	60	70	95	32	4
AmE2	Altamont clay, moderately deep, 30 to 45 percent slopes, eroded	60	60	40	90	13	5
ArD	Altamont rocky clay, moderately deep, 7 to 30 percent slopes	60	40	75	90	16	5
AmF2	Altamont clay, moderately deep, 45 to 75 percent slopes, eroded	50	60	20	90	5	6
AzD	Azule clay loam, 3 to 30 percent slopes	60	85	80	95	39	4
AzE2	Azule clay loam, 30 to 45 percent slopes, eroded	60	85	40	90	18	5
AzF2	Azule clay loam, 45 to 60 percent slopes, eroded	60	85	20	90	9	6
CdA	Clear Lake clay, drained, 0 to 3 percent slopes	90	60	100	90	49	3
CdB	Clear Lake clay, drained, 3 to 7 percent slopes	90	60	95	90	46	3
Cc	Clear Lake clay, 0 to 3 percent slopes	90	60	100	80	43	3
CoC2	Cotati fine sandy loam, eroded	40	100	80	90	29	4
DaA	Danville silty clay loam, 0 to 3 percent slopes	95	90	100	100	86	1
DaB	Danville silty clay loam, 3 to 10 percent slopes	95	90	95	100	81	1
DbC	Diablo clay, 7 to 15 percent slopes	90	60	85	95	44	3
DbD	Diablo clay, 15 to 30 percent slopes	90	60	70	95	36	4
DbE2	Diablo clay, 30 to 45 percent slopes, eroded	90	60	40	90	19	5
DmF2	Diablo clay, moderately deep, 45 to 60 percent slopes, eroded	70	60	20	90	8	6
DvC	Diablo clay, very deep, 3 to 15 percent slopes	80	60	90	100	43	3
DvD2	Diablo clay, very deep, 15 to 30 percent slopes, eroded	80	60	70	95	34	4
DvE2	Diablo clay, very deep, 30 to 45 percent slopes, eroded	80	60	40	95	18	5
DvF2	Diablo clay, very deep, 45 to 60 percent slopes, eroded	60	60	20	95	7	6
GaE2	Gaviota rocky sandy loam, 5 to 40 percent slopes, eroded	40	60	70	95	16	5
GaF2	Gaviota rocky sandy loam, 40 to 75 percent slopes, eroded	40	60	20	95	5	6
Gp	Gravel pit [1]						
HnF2	Henneke rocky loam, eroded	50	60	20	80	5	6
LaC	Linne clay loam, 3 to 15 percent slopes	70	85	90	95	51	3
LaD	Linne clay loam, 15 to 30 percent slopes	70	85	70	95	40	4
LaE2	Linne clay loam, 30 to 45 percent slopes, eroded	60	85	40	90	18	5
LcF2	Linne clay loam, shallow, 45 to 75 percent slopes, eroded	40	85	20	90	6	6
Lg	Livermore gravelly loam	100	70	100	90	63	2
Lm	Livermore very gravelly coarse sandy loam	100	40	100	90	36	4
LoE2	Lobitos shaly loam, eroded	50	75	50	90	17	5
LpE2	Los Gatos loam,[2] 30 to 45 percent slopes, eroded	40	95	40	90	14	5
LpF2	Los Gatos loam,[2] 45 to 75 percent slopes, eroded	40	95	20	90	7	6
LsC	Los Osos loam, seeped variant, 3 to 15 percent slopes	70	100	90	80	50	3
LtD	Los Osos silty clay loam, 7 to 30 percent slopes	50	90	75	90	30	4
LtE2	Los Osos silty clay loam, 30 to 45 percent slopes, eroded	50	90	40	90	16	5
LtF2	Los Osos silty clay loam, 45 to 75 percent slopes, eroded	50	90	20	90	8	6
LuD	Los Osos silt loam,[3] 7 to 30 percent slopes	50	100	75	90	34	4
LuE2	Los Osos silt loam,[3] 30 to 45 percent slopes, eroded	50	100	40	90	18	5
MhE2	Millsholm silt loam, 30 to 45 percent slopes, eroded	40	100	40	90	14	5
MhF2	Millsholm silt loam, 45 to 75 percent slopes, eroded	40	100	20	90	7	6
PaE2	Parrish gravelly loam, 30 to 45 percent slopes, eroded	50	70	40	90	13	5
PaF2	Parrish gravelly loam, 45 to 75 percent slopes, eroded	50	70	20	90	6	6
PcD	Perkins loam, 3 to 30 percent slopes	85	100	80	70	48	3
PcF2	Perkins loam, 45 to 75 percent slopes, eroded	85	100	20	70	12	5
Pd	Pescadero clay	80	50	100	40	16	5
PgA	Pleasanton gravelly loam, 0 to 3 percent slopes	85	80	100	100	68	2
PgB	Pleasanton gravelly loam, 3 to 12 percent slopes	85	80	85	100	58	3
PoC2	Positas gravelly loam, 2 to 20 percent slopes, eroded	40	80	75	90	22	4
PoE2	Positas gravelly loam, 20 to 40 percent slopes, eroded	40	80	40	90	12	5
PoF2	Positas gravelly loam, 40 to 60 percent slopes, eroded	40	80	20	90	6	6
PtB2	Positas gravelly loam, thick surface, 2 to 10 percent slopes, eroded	60	80	95	90	41	3
Rc	Rincon loam, 0 to 3 percent slopes	80	100	100	100	80	1
RdA	Rincon clay loam, 0 to 3 percent slopes	80	85	100	100	68	2
RdB	Rincon clay loam, 3 to 7 percent slopes	80	85	95	100	65	2
Rh	Riverwash					[4]2	6
RoF	Rock land					[4]1	6
Sa	San Ysidro loam	50	100	100	90	45	3
SdD2	Shedd silt loam, 15 to 30 percent slopes, eroded	50	100	70	90	32	4
SdE2	Shedd silt loam, 30 to 45 percent slopes, eroded	50	100	40	90	18	5
SdF3	Shedd silt loam, 45 to 75 percent slopes, severely eroded	50	100	20	70	7	6
Sf	Solano fine sandy loam	40	100	100	40	16	5
Sl	Sunnyvale clay loam	95	85	100	80	65	2
Sm	Sunnyvale clay loam over clay	90	85	100	80	61	2
Sn	Sunnyvale clay loam, drained	95	85	100	100	81	1
So	Sycamore silt loam	100	100	100	100	100	1

See footnotes at end of table.

TABLE 8.—*Storie index rating for soils of the Alameda Area, Calif.*—Continued

Map symbol	Soil	Soil rating factors				Index rating	Grade
		A (profile)	B (texture)	C (slope)	X (other conditions)		
						Percent	
Sy	Sycamore silt loam over clay	80	100	100	90	72	2
VaE2	Vallecitos rocky loam, 30 to 45 percent slopes, eroded	50	60	40	90	11	5
VaF2	Vallecitos rocky loam, 45 to 75 percent slopes, eroded	50	60	20	90	5	6
YmA	Yolo loam, 0 to 3 percent slopes	100	100	100	100	100	1
YmB	Yolo loam, 3 to 10 percent slopes	100	100	90	100	90	1
Yo	Yolo loam over gravel, 0 to 3 percent slopes	80	100	100	100	80	1
Yr	Yolo gravelly loam, 0 to 3 percent slopes	100	75	100	100	75	2
Ys	Yolo sandy loam, 0 to 3 percent slopes	100	95	100	100	95	1
Za	Zamora silt loam, 0 to 4 percent slopes	95	100	100	100	95	1
Zc	Zamora silty loam clay, 0 to 3 percent slopes	95	90	100	100	86	1

[1] Not rated for suitability.
[2] Los Gatos loam part of the Los Gatos-Los Osos complex.
[3] Los Osos silt loam part of the Los Osos and Millsholm soils.
[4] Index rating estimated; rating factors not determined.

a particular crop, the following were considered: (1) The soil and climatic requirements of the crop; (2) the probable yield and quality of the crop under management commonly practiced in the Area; (3) the feasibility of irrigation; and (4) the probable productive life of the crop if it is a perennial.

Although yield is not the only factor considered in estimating suitability, it is a major factor. Table 10 shows range in estimated average yields of principal crops for the soils variously rated in table 9 as *very poor*, *poor*, *fair*, *good*, and *very good*. No attempt should be made to grow a crop on soils rated very poor for that crop, as a profitable yield is unlikely. A crop may succeed on soils rated as poor, provided very special management such as that used in a noncommercial home garden is practiced.

Yield of a specified crop under common management practices on a soil of fair suitability for that crop is about the present average yield of the crop in the Area. Under crop and farm management commonly practiced in the Area, and with normal prices, farming on soils of good or very good suitability is likely to be successful.

Use of Soils for Pasture and Range [3]

Livestock production is the largest agricultural enterprise in the Alameda Area. About 315,000 acres is used for the production of forage and supplemental feed. Most beef cattle producers use the cow and calf plan. Other producers purchase stocker cattle in the fall and sell them as feeders at the end of the green-feed period the following spring. There are a few sheep producers in the Area.

General management of grasslands

Forage, like any other crop, responds to good care and management. Pasture and range that are dominated by annual grasses and forbs respond to management that provides for (1) the proper number of livestock, (2) the proper distribution of grazing, (3) the proper season of use, (4) the proper kind of livestock, and (5) forage improvement through seeding and fertilizing. Such management will produce the maximum amount of annual plants and maintain the remaining perennial plants.

Proper number of livestock.—The number of livestock grazed should be balanced with the amount of available forage and the length of time it will be grazed. If the balance is correct, the right amount of forage will be left on the ground as residue at the end of the grazing period. This residue left on the ground does these things:

1. Protects the soil from erosion because grass is the best kind of cover.
2. Serves as litter that increases the intake and storage of moisture.
3. Brings earlier growth because the litter serves as a heat blanket.
4. Results in maximum production because a properly used range produces much more forage than an overgrazed range.
5. Reduces seasonal fluctuation of growth.
6. Permits a supply of seed to be produced.
7. Discourages invasion by less desirable plants.
8. Enables remaining perennial plants to store food in their roots for growth the following season.

In order to maintain an adequate amount of residue, it is necessary to leave from 700 to 1,000 pounds of the current year's growth ungrazed. On steep slopes and on unstable soils, 1,200 to 1,500 pounds per acre of new plant materials are needed each year to protect the soils.

The forage can be used to the better advantage if a small number of animals is grazed for a longer period rather than a large number for a shorter period.

Proper distribution of grazing.—Many areas are overgrazed, and other parts are undergrazed or not grazed at all. Changing the location of salt, developing other watering places, or properly located fences will help to obtain uniform grazing.

Salt should be placed in lightly used or unused areas and located so that it is available from several directions. If it is possible, watering places should be at intervals

[3] By C. V. JENSEN, range conservationist, Soil Conservation Service.

TABLE 9.—*Relative suitability of soils for general agriculture and for principal crops in the Alameda Area, Calif.*[1]

[Ratings for suitability are very poor (VP), poor (P), fair (F), good (G), and very good (VG)]

Symbol	Mapping unit name	Barley (grain)	Grain hay (barley or oats)	Irrigated pasture	Sugar beets	Tomatoes	Grapes	Roses	Range pasture	
									Unfertilized	Fertilized
AaC	Altamont clay, 3 to 15 percent slopes	VG	VG	G	VP	VP	F	P	VG	VG
AaD	Altamont clay, 15 to 30 percent slopes	G	G	F	VP	VP	F	VP	VG	VG
AmE2	Altamont clay, moderately deep, 30 to 45 percent slopes, eroded	P	P	P	VP	VP	VP	VP	VG	VG
ArD	Altamont rocky clay, moderately deep, 7 to 30 percent slopes	VP	VP	VP	VP	VP	VP	VP	VG	VG
AmF2	Altamont clay, moderately deep, 45 to 75 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	G	VP
AzD	Azule clay loam, 3 to 30 percent slopes	G	G	G	VP	VP	VP	VP	VG	VG
AzE2	Azule clay loam, 30 to 45 percent slopes, eroded	P	P	P	VP	VP	VP	VP	VG	VG
AzF2	Azule clay loam, 45 to 60 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	G	VP
CdA	Clear Lake clay, drained, 0 to 3 percent slopes	G	G	VG	G	G	VP	VP	VG	VG
Cc	Clear Lake clay, 0 to 3 percent slopes	G	G	VG	G	G	VP	VP	VG	VG
CdB	Clear Lake clay, drained, 3 to 7 percent slopes	G	G	VG	F	F	VP	VP	VG	VG
CoC2	Cotati fine sandy loam, eroded	F	F	G	VP	VP	VP	VP	F	F
DaA	Danville silty clay loam, 0 to 3 percent slopes	VG	VG	VG	VG	VG	G	VG	VG	VG
DaB	Danville silty clay loam, 3 to 10 percent slopes	VG	VG	G	F	F	F	F	VG	VG
DbC	Diablo clay, 7 to 15 percent slopes	VG	VG	G	VP	VP	F	P	VG	VG
DbD	Diablo clay, 15 to 30 percent slopes	G	G	G	VP	VP	F	P	VG	VG
DbE2	Diablo clay, 30 to 45 percent slopes, eroded	P	P	P	VP	VP	VP	VP	VG	VG
DmF2	Diablo clay, moderately deep, 45 to 60 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	G	VP
DvC	Diablo clay, very deep, 3 to 15 percent slopes	VG	VG	G	VP	VP	F	P	VG	VG
DvD2	Diablo clay, very deep, 15 to 30 percent slopes, eroded	G	G	F	VP	VP	F	P	VG	VG
DvE2	Diablo clay, very deep, 30 to 45 percent slopes, eroded	P	P	P	VP	VP	VP	VP	G	VG
DvF2	Diablo clay, very deep, 45 to 60 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	G	VP
GaE2	Gaviota rocky sandy loam, 5 to 40 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	G	G
GaF2	Gaviota rocky sandy loam, 40 to 75 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	F	VP
Gp	Gravel pit	VP	VP	VP	VP	VP	VP	VP	VP	VP
HnF2	Henneke rocky loam, eroded	VP	VP	VP	VP	VP	VP	VP	VP	VP
LaC	Linne clay loam, 3 to 15 percent slopes	VG	VG	VG	[2] F	VP	VP	VP	VG	VG
LaD	Linne clay loam, 15 to 30 percent slopes	G	G	VP	VP	VP	VP	VP	VG	VG
LaE2	Linne clay loam, 30 to 45 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	VG	VG
LcF2	Linne clay loam, shallow, 45 to 75 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	G	VP
Lg	Livermore gravelly loam	G	G	G	G	G	G	G	G	G
Lm	Livermore very gravelly coarse sandy loam	VP	VP	VP	VP	VP	G	VP	VP	VP
LoE2	Lobitos shaly loam, eroded	VP	VP	VP	VP	VP	VP	VP	G	G
LpE2	Los Gatos-Los Osos complex, 30 to 45 percent slopes, eroded (Los Gatos loam part)	VP	VP	VP	VP	VP	VP	VP	VG	VG
LpF2	Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded (Los Gatos loam part)	VP	VP	VP	VP	VP	VP	VP	G	VP
LsC	Los Osos loam, seeped variant, 3 to 15 percent slopes	F	F	G	F	F	VP	VP	VG	VG
LtD	Los Osos silty clay loam, 7 to 30 percent slopes	VG	VG	F	VP	VP	F	VP	VG	VG
LtE2	Los Osos silty clay loam, 30 to 45 percent slopes, eroded	P	P	P	VP	VP	VP	VP	VG	VG

See footnotes at end of table.

TABLE 9.—*Relative suitability of soils for general agriculture and for principal crops in the Alameda Area, Calif.*[1]—Con.

[Ratings for suitability are very poor (VP), poor (P), fair (F), good (G), and very good (VG)]

Symbol	Mapping unit name	Barley (grain)	Grain hay (barley or oats)	Irrigated pasture	Sugar beets	Tomatoes	Grapes	Roses	Range pasture	
									Unfertilized	Fertilized
LtF2	Los Osos silty clay loam, 45 to 75 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	G	VP
LuD	Los Osos and Millsholm soils, 7 to 30 cent slopes (both soils)	G	G	F	VP	VP	F	VP	VG	VG
LuE2	Los Osos and Millsholm soils, 30 to 45 slopes, eroded (both soils)	P	P	VP	VP	VP	VP	VP	VG	VG
MhE2	Millsholm silt loam, 30 to 45 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	G	G
MhF2	Millsholm silt loam, 45 to 75 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	F	VP
PaE2	Parrish gravelly loam, 30 to 45 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	VG	F
PaF2	Parrish gravelly loam, 45 to 75 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	G	VP
PcD	Perkins loam, 3 to 30 percent slopes	F	F	G	VP	VP	F	VP	F	F
PcF2	Perkins loam, 45 to 75 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	F	VP
Pd	Pescadero clay	VP	VP	P	VP	VP	VP	VP	VP	VP
PgA	Pleasanton gravelly loam, 0 to 3 percent slopes	G	G	VG	VG	VG	VG	VG	G	G
PgB	Pleasanton gravelly loam, 3 to 12 percent slopes	G	G	VG	G	G	VG	VG	G	G
PoC2	Positas gravelly loam, 2 to 20 percent slopes, eroded	P	P	F	VP	VP	VP	VP	F	F
PoE2	Positas gravelly loam, 20 to 40 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	F	F
PoF2	Positas gravelly loam, 40 to 60 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	F	VP
PtB2	Positas gravelly loam, thick surface, 2 to 10 percent slopes, eroded	F	F	G	VP	VP	F	VP	G	G
Rc	Rincon loam, 0 to 3 percent slopes	VG	VG	VG	VG	VG	VG	VG	VG	VG
RdA	Rincon clay loam, 0 to 3 percent slopes	VG	VG	VG	VG	VG	VG	VG	VG	VG
RdB	Rincon clay loam, 3 to 7 percent slopes	VG	VG	G	G	G	VG	VG	VG	VG
Rh	Riverwash	VP	VP	VP	VP	VP	VP	VP	VP	VP
RoF	Rock land	VP	VP	VP	VP	VP	VP	VP	VP	VP
Sa	San Ysidro loam	F	F	G	P	P	P	P	F	F
SdD2	Shedd silt loam, 15 to 30 percent slopes, eroded	F	F	P	VP	VP	VP	VP	VG	VG
SdE2	Shedd silt loam, 30 to 45 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	VG	VG
SdF3	Shedd silt loam, 45 to 75 percent slopes, severely eroded	VP	VP	VP	VP	VP	VP	VP	F	VP
Sf	Solano fine sandy loam	VP	VP	VP	VP	VP	VP	VP	VP	VP
Sn	Sunnyvale clay loam, drained	VG	VG	VG	VG	VG	VG	VG	VG	VG
Sl	Sunnyvale clay loam	VG	VG	VG	VG	VG	VG	G	VG	VG
Sm	Sunnyvale clay loam over clay	VG	VG	VG	VG	VG	VG	G	VG	VG
So	Sycamore silt loam	VG	VG	VG	VG	VG	VG	VG	VG	VG
Sy	Sycamore silt loam over clay	VG	VG	VG	VG	VG	VG	VG	VG	VG
YmA	Yolo loam, 0 to 3 percent slopes	VG	VG	VG	VG	VG	VG	VG	VG	VG
YmB	Yolo loam, 3 to 10 percent slopes	VG	VG	G	G	G	VG	F	VG	VG
Yo	Yolo loam over gravel, 0 to 3 percent slopes	F	F	F	F	G	G	G	G	G
Yr	Yolo gravelly loam, 0 to 3 percent slopes	G	G	VG	VG	VG	VG	VG	G	G
Ys	Yolo sandy loam, 0 to 3 percent slopes	VG	VG	VG	VG	VG	VG	VG	VG	VG
VaE2	Vallecitos rocky loam, 30 to 45 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	G	G
VaF2	Vallecitos rocky loam, 45 to 75 percent slopes, eroded	VP	VP	VP	VP	VP	VP	VP	F	VP
Za	Zamora silt loam, 0 to 4 percent slopes	VG	VG	VG	VG	VG	VG	VG	VG	VG
Zc	Zamora silty clay loam, 0 to 3 percent slopes	VG	VG	VG	VG	VG	VG	VG	VG	VG

[1] Care must be used in applying the ratings in this table to specific sites. Past management affects fertility, the rate at which water enters the soil, soil structure, and other features. The mapping unit and capability unit descriptions should be studied carefully. These suitability ratings are representative of the most extensive areas of the listed soil.

[2] Sugar beets suitable on the soil only if grown on the contour on areas with slopes of 3 to 5 percent.

TABLE 10.—*Estimated range in average acre yields for crops on soils with specified ratings*

Crop	Range in yields for soils rated in table 9 as—				
	Very poor	Poor	Fair	Good	Very good
Barley (grain)_100 lb. sacks__	(1)	5	5–12	19–25	>25
Sugar beets_____tons__	(1)	<18	18–25	25–35	>35
Tomatoes_____tons__	(1)	<8	<15	>20	>25
Grapes_____tons__	(1)	<¾	¾–1½	1½–2	>2
Roses					
1,000 plants per acre [2]__	(1)	(1)	(1)	15–18	18–20
Hay (barley, oats)_____tons__	(1)	<¾	¾–1½	1½–2	>2
Pasture (irrigated) [3]					
animal unit months [4]__	(1)	<8	8–15	15–20	>20
Pasture and range:					
Nonfertilized [5]					
animal unit months__	(1)	<½	½–¾	¾–1	>1
Fertilized [6]					
animal unit months__	(1)	<2	2–3	3–4	>4

[1] Crops not suited, yields very low, yields not of commercial importance, or management not appropriate to use specified.

[2] About 60 or 70 percent of flowers are first grade; culls are sold locally.

[3] Irrigated pasture rated under these conditions: (1) 8-month grazing season; (2) nitrogen and phosphate applied during year, according to recommended local practices; (3) no grazing when soil is wet; (4) grazing rotated; (5) mowed as necessary to kill weeds and prevent bunching of grass; and (6) dragging used to spread manure.

[4] The term "animal unit month" is used to express the carrying capacity of pasture or range. It equals the number of animal units per acre multiplied by the number of months of grazing. One animal unit is one cow, steer, horse, or five sheep.

[5] Nonfertilized pasture and range rated under these conditions: (1) Grazing season about 6 months long (from about the end of January to early in July with the equivalent of 1 month of dry forage in fall); (2) no fertilizer added; and (3) no rotation, deferred grazing, or control of weeds and woody plants.

[6] Fertilized pasture and range rated under these conditions: (1) Grazing season about 7½ months long (from about the middle of December to the middle of July with the equivalent of 1 month of dry forage in fall); (2) nitrogen and phosphate, as recommended, broadcast in fall; (3) rotational grazing practiced; and (4) weeds and woody plants controlled.

of 1 to 1½ miles. Improper water development and poor distribution of watering places are major causes of poor distribution of grazing.

Fences should be located in a way that prevents livestock from congregating. Where it is possible, fences should be on the boundary between range sites and on contour intervals, so that the season of use can be controlled.

Proper season of use.—Grazing at the correct seasons is most significant for plant establishment, for maintenance, and for maximum forage production. The major growing period usually is in March and April. Grazing should be started after the new grass is vigorous and capable of making maximum growth under moderate grazing. Animals grazed on range when the feed is dry need a protein supplement. During winter, hay or other roughage must also be fed.

Proper kinds of livestock.—The animals grazed should be suited to the topography, forage, site, water supply, and climate. They should also be suitable for the operator's purposes.

Forage improvement through seeding and fertilizing.—The amount of vegetation for erosion control and for livestock feed and forage can be improved by seeding perennial or annual grasses and annual legumes on soils that are suitable.

Seeding hardinggrass on selected soils that receive more than 16 inches of rainfall annually provides high protein green feed approximately from December 15 through June 15. Compatible annual legumes, such as subterranean clover and Lana vetch, are seeded with the hardinggrass. Good seedbed preparation and seeding methods are essential for establishment.

Seeding of annual grasses and legumes is often desirable on suitable soils where the better plant species have been depleted or where increased production is desired. Blando brome with Lana vetch or subterranean clover is a satisfactory combination. Establishment of these plants is most successful if a seedbed is prepared and the mixture is drilled. On nontillable sites the mixtures can be broadcast. On suitable soils that have adequate moisture and a desirable composition of annual grasses and legumes, production can be materially increased by seeding Lana vetch. Soil erosion will be minimized, a desirable composition of plants will be maintained, and maximum yields will be produced if the seeding is properly managed and the range is carefully used.

Although the fertility of many soils in the Alameda Area is moderate to high, the yield of forage is increased by applying ammonium phosphate sulphate fertilizer to selected soils that receive 12 inches or more of precipitation annually. A fertilized and properly managed pasture can produce up to four times as much forage as an unfertilized pasture. This is true for both hardinggrass and annual grass and legume pastures. A large amount of fertilizer should be applied the first year and a moderate amount each year thereafter. Fertilizer should be applied before the first fall rain. The phosphate increases winter hardiness of the forage plants. Because soil temperature is low during the early part of the growing season, the soils do not release enough nitrogen at the time without an additional application. Legumes respond to small amounts of sulfur if other fertilizers are not used. If the soil is fertilized, the production, the nutritive value, and the palatability of the forage are increased. Maximum benefits are obtained if the fertilized soil is managed well.

On ranches that have suitable soils, production can be increase at least 50 percent by working out a good balance of fertilized hardinggrass pasture, fertilized annual pasture, and unfertilized annual range. The success of this plan requires that each kind of pasture be grazed when the grasses are ready, and that hardinggrass be grazed early and then not grazed during the time when annual plants are green and are furnishing nutritious forage.

Range and pasture sites

Range and pasture sites are groups of soils that have the ability to produce a significantly different kind or amount of vegetation. A significant difference in kind or amount means one large enough that different grazing use or management is required.

The soils in the Alameda Area have been grouped into eight range and pasture sites. The sites are (1) Upland

Terraces, (2) Clayey Hills, (3) Shallow Loamy Uplands, (4) Steep Shallow Loamy Uplands, (5) Steep Upland Terraces, (6) Steep Clayey Slopes, (7) Loamy Uplands, and (8) Steep Loamy Slopes.

In some places the soils have been mapped in a complex involving two sites. When two sites occur in a complex, refer to the appropriate site description of each component in the complex.

Each site is discussed in the following pages. The soils in each site are listed and briefly described, plants growing on the site when it is at maximum production are listed, and some practices of use and management are discussed.

UPLAND TERRACES RANGE AND PASTURE SITE

The one soil in this site (PoE2) Positas gravelly loam, 20 to 40 percent slopes, eroded, has a gravelly loam surface layer. It is 10 to 20 inches deep to a claypan, which is underlain by semiconsolidated material or bedrock. The soil is moderately steep, and its water-holding capacity and fertility are low.

When this site is at maximum production, about 70 percent of the vegetation consists of desirable plants, such as soft chess, needlegrass, filaree, and small amounts of wild oats and tomcat clover; about 20 percent consists of ripgut brome, annual fescue, Mediterranean barley, lupine, and other less desirable plants; and about 10 percent consists of fiddleneck, owls-clover, tarweed, mustard nitgrass, and other undesirable plants. The surface soil should be well protected by partly decomposed litter.

Use and management.—This soil is best suited to grazing. Proper grazing management is essential for the control of erosion and for maximum forage production.

Forage that is used during the green-feed period (usually March and April) should not be grazed until the better grasses are 4 to 6 inches high. Mechanical damage results if the plants are grazed when the soil is too wet. Livestock that are grazed during the rest of the year need supplemental protein feed to keep them in good condition when the forage is dry or before the forage is ready.

Stubble 2 or 3 inches high should be left at the end of the grazing period, and the forage should have a patchy appearance. These results can be accomplished more easily if a small number of animals is grazed for a long period rather than a large number for a short period. Livestock should be removed at the end of the green-feed period if the site is to be used the following fall or early in winter. Where possible, livestock watering places should be developed at intervals of 1 to 1½ miles. Placing salt away from the watering places and in the less used areas helps to distribute livestock. Salt should be moved when the forage has been properly grazed. The number of animals grazed and the season and degree of use can be controlled by fences.

Seeding is often desirable in areas where the better forage species have been depleted or where increased production is desired. Seeding of hardinggrass on selected sites that receive 16 inches or more of rainfall annually can lengthen the green-feed period. Annuals, such as subterranean clover, Lana vetch, or Blando brome, are satisfactory plants for seeding.

The fertility of this soil is low. Yields of forage are increased by adding a large amount of ammonium phosphate sulphate fertilizer in areas that receive 12 inches or more of rainfall annually. Fertilizer should be applied before the first fall rains; a moderate amount should be applied each year to maintain high production. The phosphate increases winter hardiness of the forage plants. Because soil temperature is low during the early part of the growing season, not enough nitrogen is released for plants unless additional amounts are applied. Legumes respond to small amounts of sulfur if other fertilizer is not used. If fertilizer is applied, earlier forage readiness results and the productivity, nutritive value, and palatability of the forage are increased. Maximum benefits are attained if the fertilizer plants are properly grazed.

CLAYEY HILLS RANGE AND PASTURE SITE

The steep soils that make up this site are clay loams and clays 18 inches or more deep to bedrock. The soils are stable and have moderately slow to slow permeability. Their water-holding capacity and fertility are moderate to high. This site has a very high potential for forage production. The soils are—

(AmE2) Altamont clay, moderately deep, 30 to 45 percent slopes, eroded.
(ArD) Altamont rocky clay, moderately deep, 7 to 30 percent slopes.
(AzE2) Azule clay loam, 30 to 45 percent slopes, eroded.
(DbE2) Diablo clay, 30 to 45 percent slopes, eroded.
(DvE2) Diablo clay, very deep, 30 to 45 percent slopes, eroded.
(LaE2) Linne clay loam, 30 to 45 percent slopes, eroded.

When this site is at maximum production, about 70 percent of the vegetation consists of needlegrass, pine bluegrass, creeping wildrye, dryland sedge, soft chess, ryegrass, wild oats, filaree, burclover, tomcat clover, cow clover, Spanish clover, and other desirable plants; about 20 percent consists of squirreltail, red brome, ripgut brome, annual fescue, mouse barley, lupine, poison-oak, and other less desirable plants; and about 10 percent consists of nitgrass, medusahead, popcornflower, fiddleneck, tarweed, gumweed, wild mustard, thistle, and other undesirable plants. Excellent stands of burclover occur on this site during good clover years. The surface soil should be well protected by partly decomposed vegetation.

Use and management.—The soils in this site are best suited to grazing. Proper grazing management is essential for the control of erosion and for maximum production of forage.

Forage that is used during the green-feed period (usually March and April) should not be grazed until the better grasses are 4 to 6 inches high. Mechanical damage results if the plants are grazed when the soil is too wet. Livestock that are grazed during the rest of the year need supplemental protein feed to keep them in good condition when the feed is dry or before forage is ready.

Stubble 2 to 3 inches high should be left at the end of the grazing period, and the forage should have a patchy appearance. These results can be accomplished more easily if a small number of animals is grazed for a long period rather than a large number for a short period. Livestock should be removed at the end of the

green-feed period if the site is to be used the following fall or early in winter. Where possible, livestock watering places should be developed at intervals of 1 to 1½ miles. Placing salt away from the watering places and in the less frequented areas helps to distribute livestock. Salt should be moved when the forage has been properly grazed. The number of animals grazed and the season and degree of use can be controlled by fences.

Seeding annual grasses and legumes is often desirable in areas where the better forage species have been depleted or where increased production is desired. The seeding of hardinggrass on selected sites that receive 16 inches or more of rainfall annually lengthens the green-feed period. Subterranean clover, Lana vetch, Blando brome, and other annuals are satisfactory plants for seeding.

The fertility of these soils is moderate to high. Yields of forage are increased, however, by applying large amounts of ammonium phosphate sulphate fertilizer in areas that receive 12 inches or more of rainfall annually. Fertilizer should be applied before the first fall rains; moderate amounts should be applied each year to maintain high production. The phosphate increases the winter hardiness of forage plants. Because soil temperature is low during the early part of the growing season, not enough nitrogen is released for plants unless additional amounts are applied. Legumes respond to small amounts of sulfur if other fertilizer is not used. If fertilizer is applied, earlier forage readiness results and the production, nutritive value, and palatability of the forage are increased. Maximum benefits are attained if the fertilized plants are properly grazed.

SHALLOW LOAMY UPLANDS RANGE AND PASTURE SITE

The soils that make up this site range from sandy loam to silt loam in texture and from 10 to 20 inches in depth to bedrock. The Parrish soils are somewhat deeper than the other soils but have comparable productivity. The soils in this site are hilly to steep. Some of them are rocky, some are gravelly, and some have rock outcrops. These soils are stable and have moderately rapid to moderately slow permeability. The water-holding capacity and fertility are moderate to low. The site has a moderate potential for forage production. The soils are—

(GaE2) Gaviota rocky sandy loam, 5 to 40 percent slopes, eroded.
(LpE2) Los Gatos-Los Osos complex, 30 to 45 percent slopes, eroded. (Los Gatos loam part.)
(PaE2) Parrish gravelly loam, 30 to 45 percent slopes, eroded.
(VaE2) Vallecitos rocky loam, 30 to 45 percent slopes, eroded.

When this site is at maximum production, about 70 percent of the vegetation consists of soft chess, wild oats, needlegrass, pine bluegrass, filaree, Spanish clover, burclover, tomcat clover, and other desirable plants; about 20 percent consists of wild barley, ripgut brome, annual fescue, lupine, wild carrot, soapplant, and other less desirable plants; and about 10 percent consists of fiddleneck, tarweed, thistle, wild mustard, and other undesirable plants. The surface soil should be protected by partly decomposed vegetation.

Use and management.—The soils in this site are best suited to grazing. Proper grazing management, however, is essential for the control of erosion and for the maximum production of forage.

Forage that is used during the green-feed period (usually March and April) should not be grazed until the better grasses are 4 to 6 inches high. Mechanical damage results if plants are grazed when the soil is too wet. Livestock that are grazed during the rest of the year need supplemental protein feed to keep them in good condition when the forage is dry or before it is ready.

Stubble 2 to 3 inches high should be left at the end of the grazing period, and the forage should have a patchy appearance. These results can be accomplished more easily if a small number of animals is grazed for a long period rather than a large number for a short period. Livestock should be removed at the end of the green-feed period if the site is to be used the following fall or early in winter. Where possible, livestock watering places should be developed at intervals of 1 to 1½ miles. Placing salt away from the watering places and in the less frequented areas helps to distribute livestock. Salt should be moved when the forage has been properly grazed. The number of animals grazed and the season and degree of use can be controlled by fences.

Seeding annual grasses and legumes is often desirable in areas where the better forage species have been depleted or where increased production is desired. Subterranean clover, Lana vetch, Blando brome, and other annuals are satisfactory plants for seeding.

The fertility of these soils is moderate to high. Yields of forage are increased, however, by applying large amounts of ammonium phosphate sulphate fertilizer in areas that receive 12 inches or more of rainfall annually. Fertilizer should be applied before the first fall rains; moderate amounts should be applied each year to maintain high production. The phosphate increases the winter hardiness of forage plants. Because soil temperature is low during the early part of the growing season, not enough nitrogen is released for plants unless additional amounts are applied. Legumes respond to small amounts of sulfur if other fertilizer is not used. If fertilizer is applied, earlier forage readiness results and the production, nutritive value, and palatability of the forage are increased. Maximum benefits are attained if the fertilized plants are properly grazed.

STEEP SHALLOW LOAMY UPLANDS RANGE SITE

The very steep soils in this site are rocky sandy loams, gravelly loams, and rocky loams. Their subsoil is clay loam or clay. The depth to bedrock is between 10 and 20 inches. The Parrish soils are somewhat deeper than the other soils but have comparable productivity. The water-holding capacity and fertility of the soils of this site are low to moderate. The potential for forage production is low to moderately low. The soils are—

(GaF2) Gaviota rocky sandy loam, 40 to 75 percent slopes, eroded.
(LpF2) Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded. (Los Gatos loam part)
(PaF2) Parrish gravelly loam, 45 to 75 percent slopes, eroded.
(VaF2) Vallecitos rocky loam, 45 to 75 percent slopes, eroded.

When this site is at maximum production, about 40 percent of the vegetation consists of California brome,

blue wildrye, soft chess, needlegrass, California fescue, pine bluegrass, wild pea, deer vetch, and other desirable plants; about 30 percent consists of lupine, blue-eyed-grass, poison-oak, California sagebrush, snowberry, and other less desirable plants; and about 30 percent consists of chamise, wedgeleaf ceanothus, rabbitbrush, shrubby monkeyflower, coyotebrush, California coffeeberry, California buckeye, and other undesirable plants. There are many ungrazed and partly grazed desirable plants left after grazing.

Much of this site has a dense cover of brush. Oak and digger pine also occur at some higher elevations.

Use and management.—The soils in this site are best suited to grazing. Proper grazing management, however, is essential for the control of erosion and for maximum forage production.

Forage should not be grazed until the better grasses are 4 to 6 inches high.

Stubble 3 to 4 inches high should be left at the end of the grazing period, and the forage should have a lightly grazed appearance. These results can be accomplished more easily if a small number of animals is grazed for a long period rather than a large number for a short period. Where possible, livestock watering places should be developed at intervals of 1 mile. Placing salt away from the watering places and in the less frequented areas helps to distribute livestock. Salt should be moved when the forage has been properly grazed. The number of animals and the season and degree of use can be controlled by fences.

Seeding is often desirable in areas that are accidentally burned over. Annuals, such as Lana vetch and Blando brome, have been proved satisfactory for seeding. Fertilizing is not advisable on this site.

STEEP UPLAND TERRACES RANGE SITE

The very steep soils in this site are gravelly loam and loam. The subsoil is clay loam or clay. The soils range from 10 to 36 inches in depth. The water-holding capacity and fertility are low to moderate. The soils in this site have a moderate potential for forage production. The soils are—

(PcF2) Perkins loam, 45 to 75 percent slopes, eroded.
(PoF2) Positas gravelly loam, 40 to 60 percent slopes, eroded.

When this site is at maximum production, desirable plants make up about 70 percent of the vegetation. These are mostly soft chess, needlegrass, and filaree, but small amounts of wild oats and tomcat clover, ripgut brome, annual fescue, Mediterranean barley, lupine, and other less desirable plants make up about 20 percent; and fiddleneck, owls-clover, tarweed, mustard, nitgrass, and other undesirable plants make up about 10 percent. The surface soil should be well protected by partly decomposed vegetation.

Use and management.—The soils in this site are best suited to grazing. Proper grazing management, however, is essential for the control of erosion and for maximum forage production.

Forage that is used during the green-feed period (usually March and April) should not be grazed until the better grasses are 4 to 6 inches high. Livestock that are grazed during the rest of the year need supplemental protein feed to keep them in good condition when the forage is dry or before it is ready for grazing. Mechanical damage results if the soils are grazed when too wet.

Stubble 3 to 4 inches high should be left at the end of the grazing period, and the forage should have a lightly grazed appearance. These results can be accomplished more easily if a small number of animals is grazed for a long period rather than a large number for short periods. Livestock should be removed at the end of the green-feed period if the site is to be used the following fall or early in winter. Where possible, livestock watering places should be developed at intervals of 1 to 1½ miles. Placing salt away from watering places and in the less frequented areas helps to distribute livestock. Salt should be moved when the forage has been properly grazed. The number of animals grazed and the season and degree of use can be controlled by fences.

Seeding is often desirable in areas where the better forage species have been depleted or in areas that have been accidentally burned over. Annuals, such as Lana vetch and Blando brome, are satisfactory plants for seeding. Fertilizing is not advisable on this site.

STEEP CLAYEY SLOPES RANGE SITE

The very steep soils in this site range from silty clay loam to clay in texture. Depth to bedrock is 18 inches or more. The soils are stable and have moderately slow to slow permeability. The water-holding capacity and fertility are moderate to high. This site has a high potential for forage production. The soils are—

(AmF2) Altamont clay, moderately deep, 45 to 75 percent slopes, eroded.
(AzF2) Azule clay loam, 45 to 60 percent slopes, eroded.
(DmF2) Diablo clay, moderately deep, 45 to 60 percent slopes, eroded.
(DvF2) Diablo clay, very deep, 45 to 60 percent slopes, eroded.
(LcF2) Linne clay loam, shallow, 45 to 75 percent slopes, eroded.

When this site is at maximum production, about 70 percent of the vegetation consists of needlegrass, pine bluegrass, creeping wildrye, dryland sedge, soft chess, ryegrass, wild oats, filaree, burclover, tomcat clover, cow clover, Spanish clover, and other desirable plants; about 20 percent consists of squirreltail, red brome, ripgut brome, annual fescue, mouse barley, lupine, poison-oak, and other less desirable plants; about 10 percent consists of nitgrass, medusahead, popcornflower, fiddleneck, tarweed, gumweed, wild mustard, thistle, and other undesirable plants. The surface soil is well protected with partly decomposed vegetation, and there are many ungrazed and partly grazed plants.

Use and management.—The soils in this site are best suited to grazing (fig. 19). Proper grazing management, however, is essential for the control of erosion and for maximum production of forage.

Forage that is used during the green-feed period (usually March and April) should not be grazed until the better grasses are 4 to 6 inches high. Mechanical damage results if plants are grazed when the soil is too wet. Livestock require a protein supplement if they graze when the forage is dry or at other times when the protein content of the forage is low.

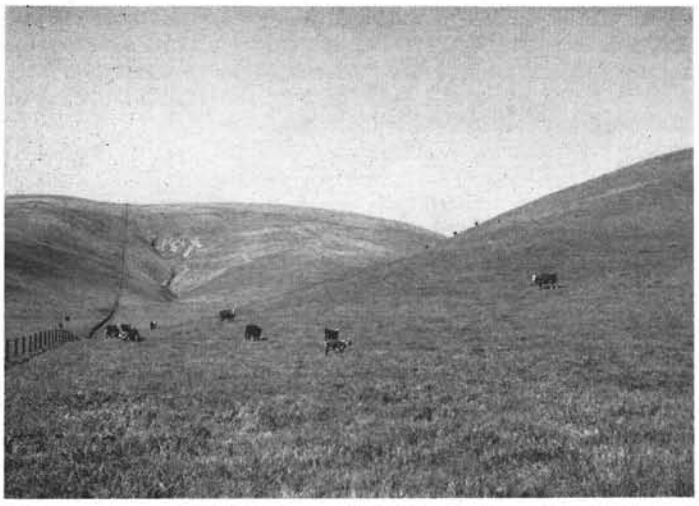

Figure 19.—**Altamont and Linne soils used for grazing.**

Stubble 3 to 4 inches high should be left at the end of the grazing period, and the forage should have a lightly grazed appearance. These results can be accomplished more easily if a small number of animals is grazed for a long period rather than a large number for a short period. Livestock should be removed at the end of the green-feed period if the site is to be used the following fall or early in winter. Where possible, livestock watering places should be developed at intervals of 1 to 1½ miles. Placing salt away from watering places and in the less frequented areas helps to distribute livestock. Salt should be moved when the forage has been properly grazed. The number of animals and the season and degree of use can be controlled by fences.

Seeding is often desirable in areas where the better forage species have been depleted or in areas that have been accidentally burned over. Annuals, such as Lana vetch and Blando brome, are satisfactory plants for seeding. Fertilizing is not advisable on this site.

LOAMY UPLANDS RANGE AND PASTURE SITE

The soils that make up this site are silt loams, silty clay loams, and shaly loams. They are between 20 and 36 inches deep. The Millsholm soils are slightly shallower but have comparable productivity. These soils have moderate to moderately slow permeability. The water-holding capacity and fertility are moderate. This site has a high potential for forage production. The soils are—

(LtE2)	Los Osos silty clay loam, 30 to 45 percent slopes, eroded.
(LpE2)	Los Gatos-Los Osos complex, 30 to 45 percent slopes, eroded. (Los Osos silty clay loam part)
(LoE2)	Lobitos shaly loam, eroded.
(LuE2)	Los Osos and Millsholm soils, 30 to 45 percent slopes, eroded. (Both soils)
(MhE2)	Millsholm silt loam, 30 to 45 percent slopes, eroded.
(SdE2)	Shedd silt loam, 30 to 45 percent slopes, eroded.

When this site is at maximum production, about 70 percent of the vegetation consists of soft chess, wild oats, needlegrass, pine bluegrass, Spanish clover, burclover, tomcat clover, filaree, and other desirable plants; about 20 percent consists of wild barley, ripgut brome, annual fescue, lupine, wild carrot, soapplant, and other less desirable plants; and about 10 percent consists of fiddleneck, tarweed, thistle, wild mustard, and other undesirable plants. The surface soil is protected well by partly decomposed vegetation.

Use and management.—The soils in this site are best suited to grazing. Proper grazing management is essential for the control of erosion and for maximum production of forage.

Forage that is used during the green-feed period (usually March and April) should not be grazed until the better grasses are 4 to 6 inches high. Mechanical damage results if the plants are grazed when the soils are wet. Livestock that are grazed during the rest of the year need supplemental protein feed to keep them in good condition when the forage is dry or before it is ready.

Stubble 2 to 3 inches high should be left at the end of the grazing period, and the forage should have a lightly grazed appearance. These results can be accomplished more easily if a small number of animals is grazed for a long period rather than a large number for a short period. Livestock should be removed at the end of the green-feed period if the site is to be used the following fall or early in winter. When possible, livestock watering places should be developed at intervals of 1 to 1½ miles. Placing salt away from the watering places and in less frequented areas helps to distribute livestock. Salt should be removed when the forage has been properly grazed. The number of animals grazed in an area and the season and degree of use can be controlled by fences.

Seeding annual grasses and legumes is often desirable in areas where the better forage species have been depleted or when increased production is desired. The seeding of hardinggrass on selected areas that receive 16 or more inches of rainfall annually lengthens the green-feed period. Subterranean clover, Lana vetch, Blando brome, and other annual plants are satisfactory for seeding.

The fertility of these soils is moderate to high. Yields of forage are increased by applying large amounts of ammonium phosphate sulphate fertilizer in areas that receive 12 inches or more of rainfall annually. Fertilizer should be applied before the first fall rains, and moderate amounts should be applied each year to maintain high production. The phosphate increases the winter hardiness of forage plants. Because soil temperature is low during the early part of the growing season, not enough nitrogen is released for plants unless additional amounts are applied. Legumes respond to small amounts of sulfur if other fertilizer is not used. If fertilizer is applied, earlier forage readiness results, and the production, nutritive value, and palatability of the forage are increased. Maximum benefits are obtained if the fertilized plants are properly grazed.

STEEP LOAMY SLOPES RANGE SITE

The very steep soils in this site have silt loam or silty clay loam texture. Bedrock is at a depth of 20 to 36 inches. The Millsholm soils are slightly shallower but have comparable productivity. The soils have moderate to moderately slow permeability. The water-holding

capacity and fertility are moderate. This site has a moderate potential for forage production. The soils are—

(LpF2) Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded. (Los Osos silty clay loam part.)
(LtF2) Los Osos silty clay loam, 45 to 75 percent slopes, eroded.
(MhF2) Millsholm silt loam, 45 to 75 percent slopes, eroded.
(SdF3) Shedd silt loam, 45 to 75 percent slopes, severely eroded.

When this site is at maximum production, about 70 percent of the vegetation consists of soft chess, wild oats, needlegrass, pine bluegrass, filaree (not more than 30 percent), burclover, Spanish clover, tomcat clover, and other desirable plants; about 20 percent consists of wild barley, ripgut brome, annual fescue, lupine, wild carrot, soapplant, and other less desirable plants; and about 10 percent consists of fiddleneck, tarweed, thistle, wild mustard, and other undesirable plants. The surface soil is protected with partly decomposed vegetation, and there are many ungrazed and partly grazed plants left after the grazing season.

Use and management.—The soils in this site are best suited to grazing. Proper grazing management, however, is essential for the control of erosion and for maximum forage production.

Forage that is used during the green-feed period (usually March and April) should not be grazed until the better grasses are 4 to 6 inches high. Mechanical damage results if plants are grazed when the soil is too wet. Livestock that are grazed during the rest of the year need supplemental protein feed to keep them in good condition when the forage is dry or not ready for grazing.

Stubble 3 to 4 inches high should be left at the end of the grazing period, and the forage should have a lightly grazed appearance. These results can be accomplished more easily if a small number of animals is grazed for a long period rather than a large number of animals for a short period. Livestock should be removed at the end of the green-feed period if the site is to be used the following fall or early in winter. Where possible, livestock watering places should be developed at intervals of 1 to 1½ miles. Placing salt away from the watering places and in the less frequented areas helps to distribute livestock. Salt should be moved when the forage has been properly grazed. The number of animals and the season and degree of use can be controlled by fences.

Seeding is desirable in areas where the better forage species have been depleted or in areas that have been accidentally burned over. Annuals, such as Lana vetch and Blando brome, are satisfactory plants for seeding. Fertilizing is not advisable on this site.

Estimated yields on range and pasture sites

Estimated potential production of herbage for range and pasture sites, in favorable and less favorable years, are given in table 11. The estimates represent the air-dry weight of herbage from unfertilized range and pasture. They are based on studies of a limited number of clippings made during favorable and less favorable years and on knowledge of the site. Extremes in weather conditions can cause even greater fluctuation in yields than are shown in the table.

TABLE 11.—*Estimated potential production of unfertilized air-dry herbage*

Site	Favorable years	Less favorable years
	Lb.	*Lb.*
Upland Terraces	2, 400	1, 200
Clayey Hills	3, 400	2, 000
Shallow Loamy Uplands	2, 400	1, 200
Steep Shallow Loamy Uplands	2, 000	1, 000
Steep Upland Terraces	2, 200	1, 200
Steep Clayey Slopes	3, 200	1, 800
Loamy Uplands	3, 000	1, 600
Steep Loamy Slopes	2, 600	1, 300

Engineering Interpretations of Soils [4]

This subsection presents soil information useful to engineers. Much of the information is in tables 12, 13, and 14. These tables are based on fieldwork done by soil scientists of the Soil Conservation Service. The primary emphasis during fieldwork was on soil characteristics important to agriculture, but many soil features important in agriculture are also important in engineering. For this reason, the soil survey report is useful to engineers, architects, contractors, and other nonagricultural users. Some of the terms used by soil scientists, however, differ from those used by engineers. These terms are defined in the Glossary.

The engineering interpretations in tables 12, 13, and 14 do not eliminate the need for sampling and testing at sites selected for specific engineering works that involve heavy loads and require excavation to depths greater than reported in this survey. Soil data in this report apply to the developed soil and the underlying layers to a depth, as a rule, of about 5 feet. Also, the laboratory tests were made on only a few soil samples (see table 14). Nevertheless, the soil map and report are useful in planning more detailed field investigations and in indicating kinds of problems that can be expected. Some examples will illustrate.

When road construction is planned, various soil features must be considered. Millsholm soils, for example, are gently rolling to very steep and are usually less than 20 inches deep to shale bedrock. For these soils, the engineer can anticipate a need for excavating rock and probably a need for large cuts and fills. The Pescadero soil, in contrast, is in basins, is subject to a seasonal high water table, and in some areas is ponded during the wet season. Also, this soil is high in montmorillonite clays and has a high shrink-swell potential. The engineer knows that he faces a drainage problem on the Pescadero soil, particularly during the wet season, and also that he has a highly expansive clay as building material.

For the Shedd soils, there is a possibility that loss of water will be large in reservoirs if the underlying bedrock is fractured. If an embankment is to be built on these soils, it is important to know that they have low

[4] This subsection was prepared by R. S. MILLER, assistant State conservation engineer, Soil Conservation Service.

TABLE 12.—*Brief description of the soils and*

[Typical profile described is from

Soil symbol	Soil [1]	Description of soil and site	Depth from surface
			Inches
AaC	Altamont clay, 3 to 15 percent slopes.	About 2 feet of clay over 2 feet of calcareous silty clay underlain by fine-grained sandstone and shale; drainage good; depth to bedrock ranges from 1½ to 5 feet; occur on rolling to steep uplands.	0–28
AaD	Altamont clay, 15 to 30 percent slopes.*		28–50
AmE2	Altamont clay, moderately deep, 30 to 45 percent slopes, eroded.		50+
AmF2	Altamont clay, moderately deep, 45 to 75 percent slopes, eroded.		
ArD	Altamont rocky clay, moderately deep, 7 to 30 percent slopes.		
AzD	Azule clay loam, 3 to 30 percent slopes.*	About 2 feet of clay over moderately fine textured terrace material; drainage good; occur on gently rolling to very steep terraces.	0–25
AzE2	Azule clay loam, 30 to 45 percent slopes, eroded.		25+
AzF2	Azule clay loam, 45 to 60 percent slopes, eroded.		
Cc	Clear Lake clay, 0 to 3 percent slopes.	About 3 feet of clay over 1 foot of calcareous clay underlain by calcareous silty clay; drainage moderately good to imperfect; occur in nearly level to gently sloping basins; subsoil contains gypsum seams.	0–36
CdA	Clear Lake clay, drained, 0 to 3 percent slopes.*		36–48
CdB	Clear Lake clay, drained, 3 to 7 percent slopes.		48–65+
CoC2	Cotati fine sandy loam, eroded.*	About 1 foot of fine sandy loam over 1 foot of loam underlain by 2 feet of clay on shattered sandstone; drainage imperfect; occurs on moderate to strong slopes.	0–27
			27–49
			49+
DaA	Danville silty clay loam, 0 to 3 percent slopes.	More than 6 feet of well-drained silty clay loam; occur on nearly level to moderately sloping alluvial fans and low terraces.	0–80+
DaB	Danville silty clay loam, 3 to 10 percent slopes.*		
DbC	Diablo clay, 7 to 15 percent slopes.	About 2½ feet of silty clay over 2 feet of calcareous silty clay loam underlain by fine-grained sandstone and shale; drainage is good; occur on gently rolling to steep uplands; depth to rock ranges from 1½ to 5 feet.	0–6
DbD	Diablo clay, 15 to 30 percent slopes.		6–32
DbE2	Diablo clay, 30 to 45 percent slopes, eroded.*		32–50
DmF2	Diablo clay, moderately deep, 45 to 60 percent slopes, eroded.		50+
DvC	Diablo clay, very deep, 3 to 15 percent slopes.		
DvD2	Diablo clay, very deep, 15 to 30 percent slopes, eroded.		
DvE2	Diablo clay, very deep, 30 to 45 percent slopes, eroded.		
DvF2	Diablo clay, very deep, 45 to 60 percent slopes, eroded.		
GaE2	Gaviota rocky sandy loam, 5 to 40 percent slopes, eroded.*	About 1 foot of rocky sandy loam underlain by hard sandstone; drainage somewhat excessive; occur on strongly sloping to very steep uplands; depth to rock ranges from ½ foot to 2 feet.	0–11
GaF2	Gaviota rocky sandy loam, 40 to 75 percent slopes, eroded.		11+
HnF2	Hennecke rocky loam, eroded.*	About 1 foot of rocky loam underlain by weathered serpentine; drainage somewhat excessive; occurs on very steep uplands; depth to rock ranges from a few inches to several feet.	0–15
			15+
LaC	Linne clay loam, 3 to 15 percent slopes.	About 3 feet of calcareous clay loam underlain by calcareous sandstone; drainage good; occur on gently sloping to very steep uplands; depth to rock ranges from 1 to 4 feet.	0–36
LaD	Linne clay loam, 15 to 30 percent slopes.*		
LaE2	Linne clay loam, 30 to 45 percent slopes, eroded.		36+
LcF2	Linne clay loam, shallow, 45 to 75 percent slopes, eroded.		
Lg	Livermore gravelly loam.	About 2½ feet of gravelly loam on 2½ feet of very gravelly loamy coarse sand; drainage somewhat excessive; occurs on nearly level to gently sloping fans and low terraces; gravel makes up 20 to 40 percent of the soil.	0–30
			30–60+
Lm	Livermore very gravelly coarse sandy loam.*	About 3 feet of very gravelly coarse sandy loam; otherwise similar to Livermore gravelly loam; gravel makes up 40 to 75 percent of the soil.	0–34
			34–60+

See footnote at end of table.

their estimated physical and chemical properties

the soil marked by an asterisk]

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	*Inches per hour*	*Inches per inch of depth*	*pH*	
Clay	CH	A–7	98–100	98–100	90–95	0. 05–0. 2	0. 167	6. 5–7. 8	High.
Silty clay	CH	A–7	98–100	98–100	90–95	0. 05–0. 2	. 167	7. 4–8. 5	High.
Sandstone and shale									
Clay	CL–1	A–6	95–100	80–90	70–80	0. 05–0. 2	. 167	6. 1–6. 5	High.
Gravelly clay loam	CL–1	A–4	70–80	60–70	50–60	0. 2–0. 8	. 150	6. 1–6. 5	Moderate.
Clay	CH	A–7	98–100	98–100	90–100	0. 05–0. 2	. 183	6. 5–7. 8	High.
Clay	CH	A–7	90–100	80–90	70–80	0. 05–0. 2	. 167	7. 8–8. 2	High.
Silty clay	CH	A–7	95–100	95–100	60–80	0. 05–0. 2	. 150	7. 8–8. 2	High.
Fine sandy loam and loam.	ML	A–4	98–100	90–98	50–60	0. 8–2. 5	. 125	5. 6–6. 0	Low.
Clay	CH	A–7	98–100	98–100	90–100	<0. 05	. 167	5. 6–6. 0	High.
Shattered sandstone									
Silty clay loam	CL–2	A–6	98–100	98–100	90–95	0. 05–0. 2	. 167	6. 1–7. 4	Moderate.
Clay	CH	A–7	100	100	90–100	0. 05–0. 2	. 167	6. 1–7. 4	High.
Silty clay	CH	A–7	100	100	90–100	0. 05–0. 2	. 167	7. 4–7. 8	High.
Silty clay loam	CL	A–7	100	100	90–100	0. 2–0. 8	. 150	7. 8–8. 2	Moderate.
Sandstone and shale									
Sandy loam	SW	A–1	60–100	50–80	15–25	2. 5–5. 0	. 083	6. 0–6. 5	Low.
Sandstone									
Loam	ML	A–4	80–90	70–80	60–70	0. 8–2. 5	. 125	7. 9–8. 2	Low.
Weathered serpentine									
Clay loam	CL	A–6	98–100	98–100	80–90	0. 2–0. 8	. 167	7. 9–8. 2	Low.
Sandstone									
Gravelly loam	GM	A–1	30–50	20–50	10–25	2. 5–5. 0	. 104	6. 1–7. 4	Low.
Very gravelly loamy coarse sand.	SW or GW	A–1	60–70	20–50	0–10	5. 0–10. 0	. 083	6. 1–7. 4	Low.
Very gravelly coarse sandy loam.	GM	A–1	30–50	20–50	10–25	5. 0–10. 0	. 083	6. 1–7. 4	Low.
Gravelly loamy coarse sand.	SW or GW	A–1	60–70	20–50	0–10	5. 0–10. 0	. 083	6. 1–7. 4	Low.

TABLE 12.—*Brief description of the soils and their*

Soil symbol	Soil [1]	Description of soil and site	Depth from surface
			Inches
LoE2	Lobitos shaly loam, eroded.*	About 1 foot of shaly loam over 2 feet of shaly light clay loam underlain by shattered diatomaceous shale; drainage is good; occurs on rolling to steep uplands; depth to rock varies considerably in short distances.	0–24 24–38 38+
LpE2	Los Gatos-Los Osos complex, 30 to 45 percent slopes, eroded.*	The Los Gatos soils consist of about 1 foot of loam over 2½ feet of heavy loam underlain by hard sandstone; drainage good to somewhat excessive; on steep and very steep uplands; depth to rock from 1 to 4 feet. For Los Osos soils, see Los Osos silty clay loam.	0–11 11–42 42+
LpF2	Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded.		
LsC	Los Osos loam, seeped variant, 3 to 15 percent slopes.*	About 2 feet of loam on 1½ feet of sandy clay loam underlain by sandstone; drainage is imperfect to moderately good; occurs in gently to strongly sloping upland valleys; depth to rock ranges from 3 to 6 feet; subject to high water table.	0–20 20–41 41+
LtD	Los Osos silty clay loam, 7 to 30 percent slopes.*	About 2½ feet of well-drained silty clay loam underlain by shale; drainage good to somewhat excessive; occur on rolling to very steep uplands; depth to rock ranges from 18 to 48 inches.	0–30 30+
LtE2	Los Osos silty clay loam, 30 to 45 percent slopes, eroded.		
LtF2	Los Osos silty clay loam, 45 to 75 percent slopes, eroded.		
LuD	Los Osos and Millsholm soils, 7 to 30 percent slopes.	For Los Osos soils, see Los Osos silty clay loam. For Millsholm soils, see Millsholm silt loam.	
LuE2	Los Osos and Millsholm soils, 30 to 45 percent slopes, eroded.		
MhE2	Millsholm silt loam, 30 to 45 percent slopes, eroded.*	About 2 feet of silt loam on shale; drainage good to somewhat excessive; on gently rolling to very steep uplands.	0–20 20+
MhF2	Millsholm silt loam, 45 to 75 percent slopes, eroded.		
PaE2	Parrish gravelly loam, 30 to 45 percent slopes, eroded.*	About 1 foot of gravelly loam on 2 feet of gravelly clay loam underlain by shattered shale; drainage good; occur on steep to very steep uplands; depth to rock ranges from 1 to 4 feet.	0–13 13–36 36+
PaF2	Parrish gravelly loam, 45 to 75 percent slopes, eroded.		
PcD	Perkins loam, 3 to 30 percent slopes.*	About 1 foot of loam over 2 feet of gravelly clay loam underlain by 2 feet of very gravelly clay loam; drainage good to somewhat excessive; occur on strongly sloping to very steep high terraces.	0–10 10–33 33–65+
PcF2	Perkins loam, 45 to 75 percent slopes, eroded.		
Pd	Pescadero clay.*	About 2½ feet of clay on 3½ feet of calcareous clay loam; drainage imperfect; occurs on nearly level basin rims; subject to high water table and some ponding during wet season; saline-alkali soil.	0–30 30–72+
PgA	Pleasanton gravelly loam, 0 to 3 percent slopes.*	About 2 feet of gravelly loam over 3 feet of gravelly clay loam underlain by 1 foot or more of gravelly silt loam; drainage good; occur on nearly level to moderately sloping fans and terraces.	0–21 21–64 64–72+
PgB	Pleasanton gravelly loam, 3 to 12 percent slopes.		
PoC2	Positas gravelly loam, 2 to 20 percent slopes, eroded.*	About 1 foot of gravelly loam over 1½ feet of clay over 2 feet of heavy loam underlain by many feet of gravelly sandy clay loam; drainage good to excessive; occur on nearly level to steep uplands; coarse gravel and cobbles throughout the soil profile.	0–11 11–29 29–54 54+
PoE2	Positas gravelly loam, 20 to 40 percent slopes, eroded.		
PoF2	Positas gravelly loam, 40 to 60 percent slopes, eroded.		
PtB2	Positas gravelly loam, thick surface, 2 to 10 percent slopes, eroded.		
Rc	Rincon loam, 0 to 3 percent slopes.	About 1 foot of clay loam over 3 feet of clay over clay loam many feet deep; drainage good; occur on nearly level to gently sloping broad alluvial fans.	0–16 16–52 52–60+
RdA	Rincon clay loam, 0 to 3 percent slopes.*		
RdB	Rincon clay loam, 3 to 7 percent slopes.		
Rh	Riverwash.	Very gravelly or stony material along water courses; nearly level to gently sloping.	----------

See footnote at end of table.

estimated physical and chemical properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
						Inches per hour	*Inches per inch of depth*	*pH*	
Shaly loam	ML	A–4	95–100	95–100	50–60	0. 8–2. 5	0. 150	5. 1–5. 5	Low.
Shaly light clay loam	ML	A–4	98–100	95–100	70–80	0. 8–2. 5	. 150	5. 1–5. 5	Low.
Diatomaceous shale									
Loam	ML–CL	A–4	98–100	90–100	70–80	0. 8–2. 5	. 167	6. 1–7. 4	Low.
Heavy loam	CL	A–6	98–100	95–100	70–90	0. 8–2. 5	. 175	6. 1–7. 4	Low.
Sandstone									
Loam	ML	A–4	98–100	90–100	50–60	0. 8–2. 5	. 167	5. 5–6. 0	Low.
Sandy clay loam	CL	A–6	98–100	98–100	70–90	0. 2–0. 8	. 175	5. 1–6. 0	Moderate.
Sandstone									
Silty clay loam	ML–CL	A–6	98–100	98–100	70–90	0. 2–0. 8	. 167	5. 5–6. 5	Moderate.
Shale									
Silt loam	ML–CL	A–6	100	98–100	70–90	0. 8–2. 5	. 150	5. 6–6. 0	Moderate.
Shale									
Gravelly loam	SC	A–2	95–100	80–90	25–35	0. 8–2. 5	. 125	5. 5–6. 5	Low.
Gravelly clay loam	SC or CL	A–6	85–100	75–100	40–60	0. 05–0. 2	. 150	4. 6–5. 5	Moderate.
Shattered shale									
Loam	ML	A–4	95–100	95–100	50–65	0. 8–2. 5	. 167	5. 5–6. 0	Low.
Gravelly clay loam and clay	SC	A–4	60–90	50–80	35–50	0. 2–0. 8	. 150	6. 1–6. 5	Moderate.
Very gravelly clay loam	GC	A–2	50–80	30–50	15–30	0. 2–0. 8	. 125	7. 4–7. 8	Low.
Clay	CH	A–7	95–100	95–100	80–95	<0. 5	. 150	7. 9–8. 2	High.
Clay loam	CL	A–4	98–100	95–100	70–80	0. 05–0. 2	. 150	7. 9–8. 2	Moderate.
Gravelly loam	SC	A–2	70–80	60–70	25–30	0. 8–2. 50	. 150	6. 1–7. 4	Low.
Gravelly clay loam	SC	A–2	65–75	50–60	20–30	0. 2–0. 8	. 167	6. 6–7. 4	Moderate.
Gravelly silt loam	SC	A–2	75–85	65–75	20–30	0. 2–0. 8	. 167	7. 4–7. 8	Low.
Gravelly loam	ML or CL	A–6	90–100	85–90	70–80	0. 8–2. 5	. 083	5. 5–6. 0	Low.
Clay	CH	A–7	90–100	90–100	70–90	<0. 05	. 150	5. 5–7. 8	High.
Heavy loam	CL or ML	A–6	98–100	95–100	70–85	0. 2–0. 8	. 150	7. 8–8. 2	Moderate.
Gravelly sandy clay loam	GM	A–2	40–50	30–45	20–30	0. 05–0. 2	. 125	7. 4–7. 8	Low.
Clay loam	ML or CL	A–4	98–100	95–100	70–80	0. 2–0. 8	. 150	7. 0	Moderate.
Clay	CH	A–7	90–100	85–100	70–90	0. 05–0. 2	. 167	7. 0–7. 5	High.
Clay loam	ML or CL	A–4	98–100	95–100	70–80	0. 2–0. 8	. 167	7. 8–8. 2	Moderate.
Sand and gravel	GP	A–1	10–25	0–5	0–2	10. 0	<. 042	6. 6–7. 3	Low.

TABLE 12.—*Brief description of the soils and their*

Soil symbol	Soil [1]	Description of soil and site	Depth from surface
			Inches
Sa	San Ysidro loam.*	About a foot of loam or silt loam over 2 feet of clay over 3 feet or more of silty clay; drainage moderately good; occurs on nearly level to undulating valley floors and old fans.	0–16 16–34 34–60+
SdD2 SdE2 SdF3	Shedd silt loam, 15 to 30 percent slopes, eroded. Shedd silt loam, 30 to 45 percent slopes, eroded.* Shedd silt loam, 45 to 75 percent slopes, severely eroded.	About 2½ feet of calcareous silt loam derived from weakly cemented, fine-grained lacustrine sediments; drainage good to somewhat excessive; occur on strongly sloping to steep uplands; depth to cemented material ranges from 1 to 3 feet.	0–32 32+
Sf	Solano fine sandy loam.*	About ½ foot of fine sandy loam over 5 feet and more of clay loam; drainage imperfect; occurs on nearly level to gently sloping basin rims and stream terraces; slightly to strongly saline-alkali.	0–6 6–60+
Sl Sm Sn	Sunnyvale clay loam. Sunnyvale clay loam over clay.* Sunnyvale clay loam, drained.	About 1½ feet of clay loam over 2 feet of silty clay underlain by clay; drainage poor to imperfect; occur on level to gently sloping flood plains; highly calcareous; Sunnyvale clay loam subject to intermittent high water table.	0–18 18–42 42–66+
So	Sycamore silt loam.*	More than 5 feet of calcareous silt loam; occurs on nearly level to gently sloping alluvial fans and valley floors; drainage moderately good.	0–60+
Sy	Sycamore silt loam over clay.*	Same as Sycamore silt loam but underlain by clay at a depth of about 3 feet; subject to intermittent high water table.	0–36 36–60+
VaE2 VaF2	Vallecitos rocky loam, 30 to 45 percent slopes, eroded.* Vallecitos rocky loam, 45 to 75 percent slopes, eroded.	About ½ foot of gravelly loam over 1 foot of clay loam derived from fine-grained sandstone; drainage good to somewhat excessive; occur on steep to very steep uplands.	0–6 6–16 16+
YmA YmB Yr Ys	Yolo loam, 0 to 3 percent slopes.* Yolo loam, 3 to 10 percent slopes. Yolo gravelly loam, 0 to 3 percent slopes. Yolo sandy loam, 0 to 3 percent slopes.	About 1½ feet of loam on 2½ feet of fine sandy loam and very fine sandy loam over many feet of loam; drainage good; occur on nearly level to moderately sloping valley floors and fans.	0–16 16–46 46–60+
Yo	Yolo loam over gravel, 0 to 3 percent slopes.	Same as Yolo loam, 0 to 3 percent slopes, but is underlain by gravel at a depth of 2 to 3 feet.	0–24 24+
Za Zc	Zamora silt loam, 0 to 4 percent slopes. Zamora silty clay loam, 0 to 3 percent slopes.*	About 1½ feet of silty clay loam over 2½ feet of heavy clay loam over clay loam; drainage good; occur on nearly level to gently sloping alluvial fans.	0–18 18–50 50–60

[1] Because Gravel pit (Gp) and Rock land (RoF) are variable, their properties were not estimated.

estimated physical and chemical properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
						Inches per hour	*Inches per inch of depth*	*pH*	
Loam to silt loam	ML or CL	A–4	98–100	95–100	60–70	0. 8–2. 5	0. 125	5. 5–6. 0	Low.
Clay	CH	A–7	90–100	85–100	70–90	<0. 05	. 150	7. 0–8. 2	High.
Silty clay	CH	A–7	95–100	95–100	60–70	0. 05–0. 20	. 167	7. 8–8. 2	High.
Silt loam	ML or CL	A–4	98–100	95–100	75–85	0. 8–2. 5	. 125	7. 9–8. 2	Low.
Cemented sediments									
Fine sandy loam	SC	A–4	95–100	90–95	40–50	0. 8–2. 5	. 083	5. 6–6. 0	Low.
Clay loam	ML or CL	A–6 or A–7	98–100	95–100	80–90	0. 5–0. 8	. 083	7. 0–9. 0	Moderate.
Clay loam	ML or CL	A–6	98–100	95–100	80–90	0. 8–2. 5	. 150	7. 9–8. 2	Moderate.
Silty clay	CH	A–7	80–90	60–70	60–70	0. 2–0. 8	. 167	7. 9–8. 2	High.
Clay	CH	A–7	95–100	95–100	80–90	0. 05–0. 2	. 167	7. 9–8. 2	High.
Silt loam	ML or CL	A–4	98–100	95–100	80–90	0. 8–2. 5	. 150	7. 9–8. 2	Low.
Silt loam	ML or CL	A–4	98–100	95–100	80–90	0. 8–2. 5	. 150	7. 9–8. 2	Low.
Clay	CH	A–7	95–100	95–100	80–95	0. 05–0. 2	. 167	7. 9–8. 2	High.
Gravelly loam	GM	A–2	40–50	20–35	10–25	0. 8–2. 5	. 125	6. 1–6. 6	Low.
Clay loam	CL or ML	A–6	80–90	60–95	50–65	0. 2–0. 8	. 125	6. 6–7. 3	Low.
Sandstone									
Loam	CL or CL-ML	A–4	98–100	95–100	60–75	0. 8–2. 5	. 167	7. 4–7. 8	Low.
Fine sandy loam	SM	A–4	90–100	65–85	35–50	0. 8–2. 5	. 142	7. 8–8. 2	Low.
Loam	ML or CL	A–4	98–100	95–100	60–75	0. 8–2. 5	. 167	7. 8–8. 2	Low.
Loam	ML	A–4	98–100	95–100	70–80	0. 8–2. 5	. 167	7. 4–7. 8	Low.
Gravel	SM	A–1	35–50	25–40	15–25	>10. 0	. 042	7. 4–7. 8	Low.
Silty clay loam	CL	A–4	98–100	95–100	80–90	0. 2–0. 8	. 167	7. 4–7. 8	Moderate.
Heavy clay loam	CL	A–6	95–100	95–100	85–95	0. 2–0. 8	. 175	7. 9–8. 2	Moderate to high.
Clay loam	CL	A–6	90–100	80–90	70–80	0. 2–0. 8	. 183	7. 9–8. 2	Moderate.

TABLE 13.—*Interpretation of*

Soil series	Soil features affecting engineering practices	
	Road location	Farm ponds and reservoirs
		Reservoir area
Altamont (AaC, AaD, AmE2, AmF2, ArD).	Steep, hilly, mountainous to rolling relief; underlying bedrock is shale and fine-grained sandstone; rock outcrops are common.	Moderate seepage can be expected; particularly if reservoirs are located on the shallow phase.
Azule (AzD, AzE2, AzF2)	Gently rolling to very steep terraces; formed in moderately fine-textured semiconsolidated material.	Moderate seepage rate
Clear Lake (Cc, CdA, CdB)	Nearly level basin areas formed in fine-grained alluvium from sedimentary rock.	Low seepage rates
Cotati (CoC2)	Moderately sloping to strongly sloping mountainous relief; bedrock is soft sandstone and shale.	Seepage losses should be moderate to high; bedrock is shattered.
Danville (DaA, DaB)	On nearly level to slightly sloping fans and terraces; substratum consists of grayish brown, neutral silty clay.	Low seepage rates
Diablo (DbC, DbD, DbE2, DmF2, DvC, DvD2, DvE2, DvF2).	Rolling to very steep mountainous relief; formed in soft interbedded shale and fine-grained sandstone; subject to local landslips.	Low to moderate seepage rates; shale and sandstone bedrock at depth of 18 to 60 inches.
Gaviota (GaE2, GaF2)	Steep, mountainous relief; very shallow to hard sandstone bedrock; frequent outcrops of parent rock.	Moderate seepage rate
Gravel pit (Gp)	Not suitable for road location; subject to flooding from overflow.	High seepage rate
Henneke (HnF2)	Steep, hilly to mountainous relief; much severe erosion	Low seepage rate
Linne (LaC, LaD, LaE2, LcF2)	Hilly relief; underlying materials are usually soft; steeper slopes may be unstable; some areas of landslips.	Low seepage rate
Livermore (Lg, Lm)	Nearly level to sloping relief; moderately steep slopes in places; somewhat excessively drained; some cobbles and stones throughout the profile in places.	High seepage rate
Lobitos (LoE2)	Rolling to steep, mountainous relief; very shallow to bedrock in some areas; underlying material may be highly fractured; bankslopes are highly susceptible to erosion.	Moderate seepage rate; bedrock is shattered shale.
Los Gatos (LpE2,[1] LpF2,[1])	On very steep mountainous uplands; sandstone bedrock at depth of 12 to 48 inches.	High seepage rate
Los Osos (LtD, LtE2, LtF2, LpE2,[2] LpF2,[2] LuD,[3] LuE2[3]).	Strongly sloping to very steep mountainous uplands; grayish-brown shale bedrock at depth of 18 to 48 inches.	Moderate seepage rate
Los Osos, seeped variant (LsC)	In gently to strongly sloping upland valleys; soft sandstone bedrock at depth of 41 inches; may have high water table in winter through early summer.	Moderate seepage rate
Millsholm (MhE2, MhF2, LuD,[4] LuE2[4])	Gently rolling to very steep mountainous uplands; 12 to 26 inches to shale bedrock.	Moderate seepage rate
Parrish (PaE2, PaF2)	Steep to very steep mountainous relief; shallow over shattered shales and fine-grained sandstone bedrock; frequent rock outcrops.	Moderate to low seepage rate; shattered shale and sandstone.
Perkins (PcD, PcF2)	Gently sloping to very steep relief; deep gravelly clay loam soils.	Moderately low seepage rate
Pescadero (Pd)	Nearly level relief; consists of clay that is high in montmorillonite; basin soils that are subject to seasonal or perched high water table; ponded areas in wet seasons.	Low seepage rate
Pleasanton (PgA, PgB)	Nearly level to sloping relief on low terraces and fans	Moderate to moderately low seepage rate.

See footnotes at end of table.

engineering properties of soils

Soil features affecting engineering practices—Continued	Hydrologic soil group	Remarks
Farm ponds and reservoirs—Continued		
Embankments		
Moderate to high resistance to settlement cracking; high post-construction settlement and high deformability; high resistance to piping.	D	In some areas the surface soil may be slightly calcareous; severe limitations for septic tank leach lines.
Moderate resistance to settlement cracking; moderate resistance to piping; moisture-density control is important.	C	Surface soils are slightly acid; subsurface material may be calcareous in some areas; severe limitations for septic tank leach lines.
High resistance to settlement cracking; high post-construction settlement but high deformability; high resistance to piping.	D	Subsoil is highly calcareous; severe limitations for septic tank leach lines.
Moderate to high resistance to settlement cracking; moderate resistance to piping.	C	Severe limitations for septic tank leach lines.
Moderate to high resistance to settlement cracking; moderate resistance to piping; high post-construction settlement.	C	The parent material is slightly calcareous in some areas; severe limitations for septic tank leach lines.
High resistance to settlement cracking; high resistance to piping; high post-construction settlement; high deformability.	D	Calcareous; severe limitations for septic tank leach lines.
Low resistance to settlement cracking; very susceptible to piping; moisture-density control very important.	B	These soils are generally shallow and rocky; severe limitations for septic tank leach lines.
Susceptible to piping; material would bulk from bank yardage to fill yardage.	A	Suitable as a source of sand and gravel.
Susceptible to piping and to settlement cracking; moisture-density control is important.	D	These soils provide a moderate to large amount of silt if allowed to erode; severe limitations for septic tank leach lines.
High resistance to piping and settlement cracking; high post-construction settlement; material is deformable.	C	Severe limitations for septic tank leach lines.
Low resistance to settlement cracking; susceptible to piping; moisture-density control is important; may bulk from bank yardage to fill yardage.	B	May be slightly acid in places; contains 20 to 60 percent gravel; slight limitations for septic tank leach lines; the texture ranges from very gravelly sandy loam to very gravelly loam; suitable as a source of sand and gravel but material may need crushing and washing.
Low resistance to settlement cracking; moisture-density control is important; low resistance to piping.	C	Strongly acid; severe limitations for septic tank leach lines; moderate in silt production.
Moisture-density control is important; low resistance to settlement cracking; susceptible to piping.	C	Soil is acid throughout; severe limitations for septic tank leach lines.
Low resistance to settlement cracking; susceptible to piping; moisture-density control is important.	C	Severe limitations for septic tank leach lines.
Low resistance to settlement cracking; susceptible to piping; moisture-density control is important.	C	Soil becomes more acid with depth; severe limitations for septic tank leach lines.
Low resistance to settlement cracking; susceptible to piping; moisture-density control is important.	D	Severe limitations for septic tank leach lines.
Moderate resistance to settlement cracking and piping; moisture-density control is important.	C	Acid in the subsoil; severe limitations for septic tank leach lines.
Moderate to high resistance to settlement cracking and piping; moisture-density control is important.	C	Acid in the upper profile; severe limitations for septic tank leach lines.
High resistance to settlement cracking and piping; material has high deformability; moisture-density control is moderately important.	D	Salt and alkali content moderate to high in most soils; severe limitations for septic tank leach lines.
Moderate resistance to settlement cracking; susceptible to piping; moisture-density control important.	B	Slightly acid to mildly alkaline; severe limitations for septic tank leach lines.

TABLE 13.—*Interpretation of engineering*

Soil series	Soil features affecting engineering practices	
	Road location	Farm ponds and reservoirs
		Reservoir area
Positas (PoC2, PoE2, PoF2, PtB2)	Nearly level to very steep high terraces	Very low seepage rate
Rincon (Rc, RdA, RdB)	On nearly level valley floors; the finer textured soils may contain some montmorillonite clays.	Low seepage rate
Riverwash (Rh)	Subject to stream action in wet season	High seepage rate
Rock land (RoF)	Consists of steep, eroding, rocky slopes	
San Ysidro (Sa)	On nearly level valley floor; deep clay to silty clay soil	Low seepage rate
Shedd (SdD2, SdE2, SdF3)	Steep, hilly relief; soils are generally shallow and eroded; steeper slopes are somewhat unstable; some areas susceptible to landslips.	Moderate to high seepage rate; underlying material may be fractured and porous.
Solano (Sf)	Nearly level relief; some areas hog-wallowed microrelief	Moderately slow to low seepage rate.
Sunnyvale (Sl, Sm, Sn)	Nearly level relief; some areas have an intermittent high water table; subject to occasional flooding.	Low to moderately low seepage rate.
Sycamore (So, Sy)	In nearly level flood plains; usually has seasonal high water table; finer textured soils contains moderate amounts of montmorillonite clays.	Low seepage rate; coarser textured soils underlain by sandy materials in places.
Vallecitos (VaE2, VaF2)	Steep, hilly to mountainous relief; steeper slopes are somewhat unstable and are susceptible to landslips.	Low seepage rate
Yolo (YmA, YmB, Yo, Yr, Ys)	Nearly level to sloping; consist of flood-plain and valley fill.	Low seepage rate
Zamora (Za, Zc)	In nearly level flood plains	Low seepage rate

[1] Los Gatos part of Los Gatos-Los Osos complex.
[2] Los Osos part of Los Gatos-Los Osos complex.
[3] Los Osos part of Los Osos and Millsholm soils.
[4] Millsholm part of Los Osos and Millsholm soils.

properties of soils—Continued

Soil features affecting engineering practices—Continued	Hydrologic soil group	Remarks
Farm ponds and reservoirs—Continued		
Embankments		
Moderate to high resistance to settlement cracking and piping; moisture-density control important.	D	Medium acid to moderately alkaline; severe limitations for septic tank leach lines.
Has intermediate resistance to piping and is susceptible to settlement cracking; moisture-density control important.	C	These soils have slow permeability; severe limitations for septic tank leach lines.
Susceptible to piping; material would bulk from bank yardage to fill yardage.	A	Suitable as a source of sand and gravel.
	D	Usually produce moderate amounts of silt if unprotected.
Very high resistance to settlement cracking and to piping; high post-construction settlement and deformability.	D	Medium acid to moderately alkaline; severe limitations for septic tank leach lines.
Has low piping resistance and high susceptibility to settlement cracking; moisture-density control important.	C	Steeper, severely eroded areas of these soils produce a moderate amount of silt if they are allowed to erode; severe limitations for septic tank leach lines.
Has low piping resistance and high susceptibility to settlement cracking; moisture-density control is important.	C	Slight erosion hazard; some areas are saline-alkali; severe limitations for septic tank leach lines.
The material in the upper 18 inches has low piping resistance and high susceptibility to settlement cracking; moisture-density control is important; material below 18 inches has high piping resistance and low susceptibility to settlement cracking.	C	Moderately alkaline; severe limitations for septic tank leach lines.
Intermediate susceptibility to piping and settlement cracking; moisture-density control important.	D	Concentrations of alkali moderate to severe in some areas; moderate to severe limitations for septic tank leach lines.
High resistance to piping and settlement cracking; material is very deformable.	C	Some areas of these soils may be rocky and have numerous rock outcrops; soils are generally shallow; severe limitations for septic tank leach lines.
Material in the upper 54 inches is susceptible to piping and settlement cracking; moisture-density control important; material below 54 inches might bulk from bank yardage to fill yardage.	A	Some areas of these soils are gravelly; subsoils extremely gravelly in some places; slight limitations for septic tank leach lines.
Material in the upper 30 inches susceptible to piping and settlement cracking; moisture-density control is important; material below 30 inches has high resistance to piping and settlement cracking.	A	Severe limitations for septic tank leach lines.

TABLE 14.—*Engineering*

[Tests performed by the California Division of Highways with procedures given

Soil name and location	Parent material	California report No.	Depth	Horizon	Moisture-density [1]	
					Maximum dry density	Optimum moisture
			Inches		*Lb. per cu. ft.*	*Percent*
Altamont clay:						
750 feet E. and 2,250 feet S. of NW cor. of sec. 19, R. 3 E., T. 2 S.	Interbedded fine-grained sandstone and shale.	60–566	0–7	A11	111	15
		60–560	19–28	A13	106	17
		60–563	37–50	Cca	109	18
Diablo clay:						
1,325 feet E. and 275 feet N. of SW cor. of sec. 25, R. 1 E., T. 2 S.	Interbedded fine-grained sandstone and shale.	60–564	0–6	A11	105	18
		60–559	26–32	A14ca	109	16
		60–561	42–50	Cca	117	14
Millsholm silt loam:						
SW¼SE¼NW¼ of sec. 7, T. 3 S., R. 1 W.	Shale.	60–562	0–6	A11	108	15
		60–558	13–20	B2t	116	13
		60–565	20–60	R	118	10
Positas gravelly loam:						
216 feet W. and 168 feet S. of NE cor. of sec. 25, T. 3 S., R. 2 E.	Old terrace deposits.	60–567	0–8	Ap	130	8
		60–577	11–20	B21t	104	20
		60–568	54+	IIC	140	5

[1] Maximum dry density and optimum moisture by California Division of Highways 5-layer procedure usually differ from values obtained in 3-layer procedure of AASHO Designation: T 99–57.

[2] Mechanical analyses by the California Division of Highways procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the procedure used (AASHO) (*1*), the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this

resistance to piping and high susceptibility to settlement and cracking. Additional tests at the site are advisable in such a situation. Or perhaps a site can be found on a more suitable kind of soil.

On Positas soils, installing septic tank leach lines will present a serious problem because these soils have very low permeability. Because they range from acid to alkaline, a corrosion problem is also likely.

Interpretations such as the foregoing can be made mainly by referring to the tables in this section, particularly tables 12 and 13. Table 12 contains a brief description of the soils in the survey area and estimates of their physical and chemical properties, by layers in the soil profile. The data on a few soil profiles are from laboratory analyses of soil samples. For most profiles, however, the data are estimated. The soil material in the various layers of the soil profiles has been classified according to the USDA, the Unified (*19*), and the AASHO (*1*) systems.

The USDA system is the textural classification used by the Soil Conservation Service in soil surveys.

The Unified classification was developed at the Vicksburg Waterways Experiment Station by the Corps of Engineers, U.S. Army. In this system soil materials are placed in 15 classes that are designated by pairs of letters. These classes range from GW, which consists of well-graded gravel, gravel and sand mixtures, and a little fine material, to Pt, which consists of peat and other highly organic material.

Many highway engineers classify soil material according to the AASHO method (*1*). This method was approved by the American Association of State Highway Officials. In this system soil materials are classed in seven principal groups. The groups range from A–1, consisting of soils that have high bearing capacity, to A–7, consisting of clayey soils having low strength when wet. Within each group the relative engineering value of the soil material is indicated by a group index number. These numbers range from 0 for the best materials to 20 for the poorest. The group index number is shown in parentheses following the group symbol in table 14.

Shrink-swell potential shown in table 12 indicates the change in soil volume that can be expected with change in moisture content. It is estimated primarily on the basis of the amount and type of clay in the soil. In general, soils classified as CH and A–7 have a "High" shrink-swell potential. Sands having only small amounts of slightly plastic fines, as well as most other nonplastic soil materials, have a "Low" shrink-swell potential.

In table 13 are listed characteristics of the soils that affect their suitability as sites for roads and farm ponds or reservoirs.

Of particular interest to hydrologists are the hydrologic groups given in table 13. Engineers and soil scien-

test data [1]

in California Materials Manual for Testing and Control Procedures (*3*)]

Mechanical analysis [2]								Liquid limit	Plasticity index	Classification	
Percentage passing sieve—						Percentage smaller than—					
No. 4 (4.76 mm.)	No. 8 (2.38 mm.)	No. 16 (1.19 mm.)	No. 30 (0.59 mm.)	No. 50 (0.297 mm.)	No. 200 (0.074 mm.)	0.005 mm.	0.001 mm.			AASHO	Unified
			100	97	89	50	30	45	19	A–7–6(13)	ML or CL.[3]
				100	90	68	(4)	45	19	A–7–6(13)	ML or CL.[3]
	100	99	98	97	91	51	(4)	47	25	A–7–6)15)	CL.[3]
				100	93	54	32	45	19	A–7–6(13)	ML or CL.[3]
				100	96	64	(4)	49	24	A–7–6(15)	CL.[3]
			100	98	96	65	(4)	48	21	A–7–6(14)	ML or CL.
100	99	98	97	96	92	44	16	34	11	A–6(8)	ML–CL.
	100	99	98	97	94	46	24	35	12	A–6(9)	ML–CL.
100	95	86	80	75	67	29	15	41	13	A–7–6(8)	ML.
[5] 93	90	86	83	78	64	20	9	21	4	A–4(6)	ML–CL.
100	99	97	95	93	85	57	47	53	26	A–7–6(17)	MH–CH.
[6] 59	50	44	41	37	21	11	6	28	10	A–2–4(0)	GC.

table are not suitable for use in naming textural classes for soils.

[3] Field experience indicates soils behave as CH material, but laboratory data given here do not support this classification.

[4] The percentage of the material smaller than 0.001 millimeter could not be determined by hydrometer analysis because of flocculation due to the presence of lime. The percentage of material smaller than 0.005 millimeter may be slightly influenced because of flocculation.

[5] 100 percent passes a 1½-inch sieve; 96 percent passes a ¾-inch sieve; and 96 percent passes a ⅜-inch sieve.

[6] 100 percent passes a 2-inch sieve; 92 percent passes a 1-inch sieve; and 78 percent passes a ½-inch sieve.

tists of the Soil Conservation Service have classified the major soil series in the county into four hydrologic groups—A, B, C, and D. The grouping is based on estimates of the intake of water during the latter part of a storm of long duration. The estimate is made of the intake of water in a soil without protective vegetation after it has been made wet and has swelled. This value is similar to the basic intake rate of an irrigated soil. The hydrologic soil groups shown in table 13 are tentative and may change as more data are obtained and evaluated. The four groups are described as follows:

Group A consists of soils that have a high infiltration rate even when thoroughly wet. These soils are primarily deep, well-drained sandy and gravelly soils that contain very little silt or clay. They have a rapid to very rapid rate of water transmission.

Group B consists of soils that have an above-average infiltration rate even when thoroughly wet. These are usually moderately deep to deep, moderately well drained or well drained soils with moderately coarse to moderately fine texture. The soils in this group have a moderate rate of water transmission.

Group C consists of soils that have a below-average infiltration rate when thoroughly wet. Most of the soils contain a layer that impedes the downward movement of water. The soils in this group are mostly moderately fine to fine textured. They have a slow rate of water transmission.

Group D consists of soils that have a very slow infiltration rate when thoroughly wet. The soils in this group are primarily clays with a high shrink-swell potential. Some soils with a permanently high water table are included. Also some of the soils in this group have a very shallow depth to a restrictive layer that impedes the downward movement of water. The soils of group D have a very slow rate of water transmission.

A summary of laboratory test data for four of the major soils in the survey area is given in table 14. Tests were performed by the California Division of Highways through an agreement with the United States Bureau of Public Roads and the Soil Conservation Service. Each major horizon in the profile was tested. The test data include mechanical analysis, liquid limit, plasticity index, and moisture-density relationships.

The liquid limit is the moisture content at which the soil material passes from a plastic to a liquid state. The plastic limit is the moisture content, expressed as a percentage of the oven-dry weight of the soil, at which the soil material passes from a semisolid to a plastic state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the

range of moisture content within which the soil material is in a plastic condition.

The test procedures are described in "Standard Specifications for Highway Materials and Methods of Sampling and Testing," American Association of State Highway Officials (AASHO). The moisture-density data were obtained in accordance with AASHO Designation: T 99–57, Method A. See, however, footnote 1, table 14.

Formation and Classification of Soils

This section consists of four main parts. In the first part, the important factors of soil formation are discussed. In the second part, the major processes of soil formation are described. In the third part, the soil series in the Area are placed in great soil groups and a profile typical of each great soil group is described. Unless otherwise stated, the description is for a dry soil. In the fourth part, the results of chemical and mechanical analyses of seven selected soils are given.

Factors of Soil Formation

Soil has been defined as a dynamic natural body on the surface of the earth in which plants grow; it is composed of mineral and organic materials and living forms (*16*). Soils differ in their appearance, composition, management requirements, and productivity within short distances. The factors that influence soil development are (1) climate, (2) living organisms, (3) parent material, (4) relief, and (5) time. Every soil is affected to some extent by all five factors, but the relative importance of each factor in soil development varies from one soil to another.

In the Alameda Area, the factors of soil formation have a fairly wide range, and therefore a large number of soils have formed. Also, because the soil-forming factors vary within short distances, the soil pattern is rather complex.

Climate.—The climate of the Alameda Area is of two main types—oceanic and subhumid mesothermal. The oceanic type is characterized by cool, moist winters and cool summers with frequent sea breezes and early morning fog. The subhumid mesothermal type is characterized by cool, moist winters and hot dry summers. The boundary between the two types runs roughly in a southeast-northwest direction from the Calaveras Dam to Dublin. Differences in annual rainfall are associated with differences in relief and vary widely over short distances. For example, annual rainfall ranges from 8 inches in the northeastern corner of the Area to 25 inches at a point in the uplands 15 miles farther south.

In the sections of low rainfall, many of the soils are calcareous and alkaline in reaction. In the sections of high rainfall, the soils are slightly acid to strongly acid. Soils formed under the oceanic climate are darker in most places and contain more organic matter than soils formed in similar material under the subhumid mesothermal climate. Also, soils that developed under low rainfall have accumulated carbonates in the lower part of their solum, whereas the soils that developed under high rainfall have been leached of carbonates.

Living organisms.—The vegetation of the Area was the most important part of the complex of living organisms that affected soil development. The activities of animals were of minor importance. Earthworms, insects, and bacteria were most active in soils containing a large amount of organic matter. In such soils they break down plant and animal remains to humus.

The influence of native vegetation was greatest in the dark Clear Lake soils in the northern part of the Livermore Valley and in the basin areas. In the uplands this vegetation consisted of thick stands of perennial grasses, such as needlegrass, and of scattered oaks; in the basin areas it consisted of perennial grasses, sedges, and willows. The Linne soils also exemplify the influence of native vegetation. They developed under thick stands of perennial grasses and scattered oaks. These soils are dark gray and contain a relatively large amount of organic matter. In contrast, the Gaviota soils developed under a sparse stand of grasses, rabbitbrush, and California sage and contain a small amount of organic matter. The Vallecitos soils have accumulated even a smaller amount of organic matter under a combined woodland-grassland type of vegetation. The percentage of woodland varied, but it consisted primarily of blue oak, California live oak, black oak, laurel, California buckeye, and other woody plants. Some scattered digger pine and Coulter pine were on higher elevations and on the sheltered north-facing slopes of these soils. The understory consisted of California fescue, needlegrass, blue wildrye, and mellicgrass. This kind of vegetation did not favor the accumulation of large amounts of organic matter.

The vegetation in the brush-covered areas consisted of chamise, manzanita, ceanothus, rabbitbrush, California sage, and a sparse stand of grasses. Little organic matter has accumulated in the soils and land types in these areas.

Farming in the area has affected and will affect the direction and rate of development of the soils. The soil-forming processes changed most by man's activities are the accumulation of organic matter and the leaching of soluble salts. The rate of accumulation of organic matter has been reduced, and in some soils, the organic matter has been depleted. Cultivation and grazing have almost eliminated the native perennial grasses, and annual grasses, forbs, and weeds have been introduced by settlers. The forage produced is removed continuously by grazing and by burning residue from dry-farmed grain. Artificial drainage of the basin areas has reduced the amount of organic matter in the soils by improving aeration and thus increasing the oxidation of the organic matter. In the well-drained soils in the valleys, the amount of organic matter may have been increased by the continual use of irrigated pasture. Even though the forage is removed, the root system is extensive and tends to increase the amount of organic matter in the soil. Also, soluble salts and some of the carbonates are leached from these soils by irrigation water and through improved drainage.

Parent material.—The parent material of soils in the uplands consists of sedimentary and metasedimentary

rocks of different composition and different geologic ages, intruded in some places by basic and ultrabasic igneous rocks. The sedimentary and metasedimentary rocks contain folds and faults in a very complex system. The sharp differences in the parent rocks tend to produce distinctive differences in soils.

In areas where the parent material consisted of the hard, metasedimentary rocks, the soils are shallow, have a low content of organic matter, and contain gravel or chert fragments that weather slowly. The Vallecitos soils are an example.

In areas where the parent material was interbedded sedimentary rock, the minerals weather easily because calcium carbonate is the principal cementing agent. In these areas the soils are usually deep, are fine textured, and have a calcareous subsoil. The Diablo soils are typical of this group.

In areas where serpentine, the predominant intrusive rock, was the parent material, the Henneke soils developed. They are reddish brown throughout, are shallow, and have low fertility.

The high terraces south of the Livermore Valley consists of poorly sorted gravel, sand, and clay that were deposited by fresh water. The deposits have a smooth surface that has a gentle incline of 10 to 30 degrees toward the valley. The Positas soils, which are low in fertility and have distinct B horizons, occur in this area.

The parent material of soils in the valleys consists predominantly of recent alluvium. In the southern part of Livermore Valley, the alluvium is typically medium textured and contains variable amounts of gravel. The gravel is predominantly quartz and is strongly resistant to weathering. The Livermore soils that developed in this alluvium have faint horizons. In the northern part of the Livermore Valley and in the Amador Valley, the soils developed from fine-textured alluvium. The streams are small, and they flow from areas that have fine-textured soils.

Relief.—The Alameda Area consists primarily of gently sloping to very steep uplands of the Mt. Diablo Range and of intermountain valleys. The northeastern corner of the Area is in the San Joaquin Valley. The slope and the size of the streams largely determine the texture of the soils in the valley. In areas adjacent to the larger streams, coarse-textured and gravelly soils, such as the Livermore and Pleasanton, have developed. The Pescadero and Solano soils formed on low terraces along the basins and basin rims. They have hog-wallowed microrelief and an accumulation of salts and alkali. Soils, such as Gaviota, formed on the very steep slopes. They are shallow, and their horizons are faint. The Los Osos and Diablo soils occur in other upland areas and have characteristic landslide and seep areas formed at times when the soils were saturated.

Time.—The soils of the Alameda Area range from young to very old. The Yolo and Sycamore soils are adjacent to the larger streams. They are young and show little horizon differentiation. These soils receive new sediments from floods that occur at frequent intervals. On the terraces and alluvial fans, the soils, such as Positas, are older. Their surface layer is leached of bases, and the B2t horizons have had a distinct increase in the content of clay. The soils in the uplands, such as the Vallecitos, also reflect greater age by their distinct horizon differentiation.

Major Processes of Soil Formation

Several processes take place in the formation of soil horizons. The differentiation of horizons in most soils is the result of two or more of the following processes: (1) Accumulation of organic matter; (2) leaching of carbonates and soluble salts; (3) translocation of silicate clay materials; (4) reduction and transfer of iron; (5) accumulation of soluble salts and alkali.

Organic matter has accumulated in the A horizon of all soils in the Alameda Area. Most of the organic matter is in the form of humus. The quantity is small in some soils but is fairly large in others. In such soils as Livermore very gravelly coarse sandy loam, the faint A horizon has a small amount of organic matter. In such soils as Clear Lake clay, the thick A horizon contains a fairly large amount of organic matter.

Leaching of carbonates and salts has occurred in most of the soils in the Area. In some soils, the carbonates have been leached out of the solum; in other soils, the carbonates and salts have been leached only from the A horizon. Leaching has had little effect in the removal of carbonates from soils that are strongly calcareous throughout, and the calcium content has kept the clays flocculated.

Translocation of silicate clay minerals has occurred in some soils in the Area. The clay films on ped faces and in root channels, as well as colloidal bridges between the sand grains, indicate the movement of silicate clay minerals from the A horizon. These soils have B horizons that range from faint to distinct.

Reduction and transfer of iron has occurred in all of the poorly drained and imperfectly drained soils. This process, called gleying, has been important in horizon differentiation in the poorly drained Clear Lake clay soils. The gray colors in the deeper horizons of the wet soils indicate a reduction of iron oxide. The reduction is commonly accompanied by the transfer of iron. In some of the well-drained soils, iron has been transferred from the A horizon to the B and C horizons where it has been deposited, has been oxidized, and has given these horizons a reddish-brown color. In other soils, iron has been segregated within the deeper horizons and occurs as yellowish-red or reddish-brown mottles. These soils were formed under moderately good drainage. Drainage of soils in valleys and basins has been improved either by stream cutting, by artificial drainage, or by pumping water for irrigation or domestic use.

Soluble salts accumulate in some soils or on the surface when water evaporates. Thus, salty soils commonly occur in low areas, and many have a periodically high or permanently high water table. A high water table or a perched water table exists naturally above an underlying, impervious stratum.

Many different kinds of salt occur in saline soils. The normally neutral, or nearly neutral, salts, such as the chlorides and sulfates of sodium, calcium, and magnesium, do not make the soil strongly alkaline; but an

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excessive amount of exchangeable sodium may cause a strongly alkaline reaction.

The exchangeable cations in a soil greatly influence its properties. Calcium clays are mildly alkaline to moderately alkaline and are not easily dispersed. Conversely, sodium clays are strongly alkaline to very strongly alkaline and are more easily dispersed. If a high concentration of salt is maintained in the soil, the colloids are flocculated; but if drainage improves and excess salts are removed, the sodium clays become strongly alkaline or very strongly alkaline and are easily dispersed in water.

As drainage in soils improves, the excessive amounts of salts are leached. The sodium clays, which are easily dispersed, are puddled or run together. Some of the colloids also move downward from the surface layer and accumulate in the layer beneath. After a long period, most of the fine material has accumulated in the B horizon, and mostly silt and sand are left in the A horizon. Weathering of minerals in the B horizon also contributes to its high content of clay.

If leaching continues for a long time, the A horizon of the soil finally becomes acid. The B horizon becomes very slightly acid to strongly alkaline and has well-developed, columnar structure. This horizon underlies a distinct leached A2 horizon. The soil generally has hog-wallowed relief. Apparently, the A horizon is eroded, and the B horizon is exposed in many places. Locally, the shallow depressions are called slickspots.

Classification of Soil Series in Great Soil Groups

Soils are placed in narrow classes for the organization and application of knowledge about their behavior within farms, ranches, or counties. They are placed in broad classes for study and comparison of large areas such as continents. In the comprehensive system of soil classification used in the United States, the soils are placed in six categories (*17*). Beginning with the highest, the six categories are order, suborder, great soil group, family, series, and type.

In the highest category, the soils are grouped into three orders—zonal, intrazonal, and azonal. In the lowest category, thousands of soil types are recognized in the United States. The suborder and family categories have never been fully developed and thus have been little used. Most attention has been given to the classification of the soils into soil types and series within counties and comparable areas and to subsequent grouping of series into great soil groups.

Soil types are divided into phases so as to provide finer distinctions significant to soil use and management. Soil series, type, and phase are defined in the Glossary at the back of this report.

Some soil series are placed only tentatively in the established great soil groups because their characteristics are not known well enough or because they depart from those of the given group. Also, many soil series are intergrades between great soil groups and are not clearly members of a single group. In the following list, the soil series are classified by orders and great soil groups.

Order and great soil group	*Series*
Zonal—	
Brunizem (Prairie)	Danville, Henneke, Lobitos, Los Gatos, Los Osos.
Noncalcic Brown	Parrish, Perkins, Vallecitos.
Noncalcic Brown intergrading toward Brunizem (Prairie).	Azule, Livermore, Pleasanton, Rincon, Zamora.
Intrazonal—	
Solonetz	Pescadero, Solano.
Planosol	Cotati, Positas, San Ysidro.
Grumusol	Altamont, Clear Lake, Diablo.
Calcium Carbonate Solonchak.	Sunnyvale.
Azonal—	
Lithosol	Gaviota, Millsholm.
Regosol	Linne, Shedd.
Alluvial	Sycamore, Yolo.

Zonal order

Soils in the zonal order have characteristics that reflect the dominant influence of the active factors of soil genesis—climate and living organisms. The profiles of zonal soils have well-differentiated horizons. The soils formed in materials that have been in place a long time. They have not been subject to extremes of drainage and topography.

In the Alameda Area, the great soil groups in the zonal order are the Brunizems, Noncalcic Brown soils, and Noncalcic Brown soils that intergrade toward Brunizems.

BRUNIZEM SOILS

The Danville, Henneke, Lobitos, Los Gatos, and Los Osos soils are in the Brunizem great soil group. Brunizems (Prairie soils) are a zonal group of soils having a very dark brown or grayish-brown surface horizon that grades through brown soil to the lighter colored parent material at 2 to 5 feet; they developed under tall grasses, in a temperate, relatively humid climate (*16*).

The Danville soils are representative of this group. Their dark-colored solum indicates an accumulation of organic matter; the greatest accumulation is in the A horizon. Soluble salts and carbonates have been leached from the solum. Clay films on ped faces in the B horizon indicate the translocation of some silicate clay.

The soil-forming processes have influenced the other soils of the groups in a slightly different way. The Henneke soils were formed from serpentine on very steep uplands. These soils are shallow, and their reddish color reflects the kind of material from which they were formed. The Los Gatos soils occur in a complex association with the Los Osos soils on steep and very steep uplands. They formed from sedimentary rocks that contain iron that is released upon weathering, as indicated by the strong chromas and reddish hues of the soils. The Los Osos soils formed from interbedded, noncalcareous, sedimentary rock. They have an accumulation of or-

ganic matter in the A1 horizon, a slight increase in base saturation in the B horizon, and a slight increase in the content of clay with increasing depth.

Profile of Danville silty clay loam at a roadcut on the east side of Cull Canyon Road and 2.5 miles north of Crow Canyon Road. Vegetation consists of annual grasses and forbes. The slope at this site is 10 percent, is convex, and faces west.

A11—0 to 10 inches, grayish-brown (10YR 5/2) silty clay loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist, sticky and plastic when wet; many very fine roots; many very fine, common fine to medium, and few coarse pores; slightly acid; gradual, smooth boundary; 8 to 12 inches thick.

A12—10 to 21 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; hard when dry, friable when moist, sticky and plastic when wet; many very fine roots; many very fine, common fine, and few medium pores; slightly acid; gradual, smooth boundary; 10 to 14 inches thick.

B21t—21 to 39 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic to strong, coarse, blocky structure; very hard when dry, firm when moist, very sticky and plastic when wet; common thick, continuous clay films on ped faces and in tubular pores; common very fine roots; many very fine pores; slightly acid; gradual, smooth boundary; 14 to 22 inches thick.

B22t—39 to 53 inches, grayish-brown (10YR 5/2) heavy silty clay loam, dark grayish brown (10YR 4/2) when moist; strong, coarse, blocky structure; very hard when dry, firm when moist, very sticky and plastic when wet; common thick, continuous clay films on ped faces and in tubular pores; few very fine roots; many very fine pores; slightly acid; gradual, smooth boundary; 10 to 20 inches thick.

B3t—53 to 61 inches, silty clay loam, similar in color to B22t horizon; moderate, coarse, blocky structure; hard when dry, friable when moist, sticky and plastic when wet; common thick, continuous clay films in tubular pores; few, thick, continuous clay films on ped faces; few very fine roots; common very fine pores; neutral; gradual, smooth boundary; 6 to 12 inches thick.

C—61 to 80 inches, grayish-brown (10YR 5/2) silty clay loam, dark brown (10YR 4/3) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; thin, discontinuous clay films in some pores; few very fine roots; few very fine pores; neutral.

Range in characteristics.—The A horizon ranges in color from gray, very dark gray, or grayish brown to dark grayish brown. Texture of the A horizon ranges from heavy loam to silty clay. In places the A horizon has considerable erosion and rodent activity. In some places the B2t horizon has many thick, continuous clay films and colloidal bridges, but in some the clay films are few and thin. The C horizon is slightly calcareous in some places.

NONCALCIC BROWN SOILS

The Parrish, Perkins, and Vallecitos soils are the Noncalcic Brown soils in the Alameda Area. Noncalcic Brown soils are a zonal group of soils with slightly acid, light-pinkish or light reddish-brown A horizons over light reddish-brown or dull-red B horizons; they developed under mixed grass and forest vegetation in a subhumid wet-dry climate (*16*).

The Perkins soils developed on terraces that consisted of mixed materials and have medial (moderate) profile development. The Parrish soils also have medial profile development and developed on steep and very steep uplands from sedimentary and metasedimentary rocks. The Vallecitos soils developed from sedimentary and metasedimentary rocks and have medial profile development (see fig. 17).

The Vallecitos soils are representative of this great soil group. The A horizons are relatively thin, and the greatest accumulation of organic matter is in the A11 horizon. Clay films and colloidal bridges indicate the translocation of silicate clay from the A horizon to the B and R horizons. The reddish-brown color of the B2t horizon indicates some translocation of iron. Soluble salts and carbonates have been leached from the profile. The high percentage of base exchange in the B3t horizon is probably caused by the weathering of interbedded calcite.

The Parrish soils have some characteristics of a Yellowish-Brown Laterite. They have yellowish-red B1 and B2t horizons. The solum becomes more acid with increasing depth. The A11 horizon is slightly acid and the B3t horizon is very strongly acid. This condition may have been caused by the addition of bases to the A11 horizon through the decomposition of oak and grass litter.

Profile of Vallecitos gravelly loam: SW¼SW¼ sec. 9, T. 5 S., R. 4 E. Vegetation is principally annual grasses, scattered oaks and digger pines, and some rabbitbrush and chamise. The slope at this site is 25 to 35 percent, is convex, and faces southeast.

A11—0 to 1½ inches, brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) when moist; weak, fine, granular structure; soft when dry, friable when moist; many very fine roots; many very fine pores; neutral; clear, smooth boundary; 1 to 3 inches thick.

A12—1½ to 6 inches, brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) when moist; massive; hard when dry, friable when moist, plastic and slightly sticky when wet; many very fine roots; many very fine pores; slightly acid; abrupt, wavy boundary; 3 to 7 inches thick.

B2t—6 to 12 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) when moist; massive; very hard when dry, firm when moist, very plastic and slightly sticky when wet; many very fine roots; many very fine pores; thin, continuous clay films in pores and in bridges; neutral; clear, smooth boundary; 4 to 12 inches thick.

B3t—12 to 16 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) when moist; massive; very hard when dry, firm when moist, very plastic and slightly sticky when wet; few very fine roots; common very fine pores; thin and continuous clay films in pores; colloids mainly in bridges; neutral; abrupt, irregular boundary; 3 to 6 inches thick.

R—16 inches +, bluish-gray (5B 5/1) fine-grained, metamorphosed sandstone with calcite seams; clay films along cleavage planes.

Range in characteristics.—Very fine fragments of unweathered parent material occur throughout the profile. Depth to bedrock ranges from 12 to 36 inches. Some areas are free of outcrops of parent material, but typically, outcrops are numerous. Some areas may have 10 to 20 percent, by volume, of quartz gravel throughout the profile. An O1 horizon 2 to 3 inches thick occurs in places that have a fairly dense stand of oaks and pines. In places the color of the A horizon is one unit darker in value than that of the described profile, and the hue may be 7.5YR or 5YR. Texture of the surface horizon may be sandy loam, gravelly loam, or loam.

The B horizon ranges in color from brown or yellowish brown to reddish brown; it ranges in texture from clay loam to clay. On very steep rocky ridges, the B horizons are only a few inches thick.

The principal parent rocks are sandstone and shale, but chert veins are common, and in a few places there are a few calcite veins. In areas that have calcite veins, a yellowish-brown, calcareous C horizon 4 to 8 inches thick may be present. Where the Vallecitos soils are transitional to the Henneke soils, the profile is more reddish.

NONCALCIC BROWN SOILS INTERGRADING TOWARD BRUNIZEMS

The Azule, Livermore, Pleasanton, Rincon, and Zamora soils are Noncalcic Brown soils that integrade toward Brunizems (Prairie soils). The Noncalcic Brown soils and Brunizems have been described for their respective groups in the preceding pages.

All of the soils listed have characteristics of both the Noncalcic Brown soils and the Brunizems but the Zamore and Rincon are more like the Brunizems (Prairie soils) than the rest. All the soils are very hard when dry and all developed under a subhumid, wet-dry climate, which is typical of the Noncalcic Brown soils.

The Pleasanton soils are representative of this group. As shown by laboratory analysis (see table 15) the greatest accumulation of organic matter is in the Ap horizon. Leaching of soluble salts and carbonates has occurred in the A horizon and B21 horizon. Some carbonates have accumulated in the lower part of the B22, in the B3, and in the C horizons; as a result the lower horizons have a high pH value. The reddish color of the B2 horizon indicates the removal of iron from the A horizon and its accumulation in the B horizon. The thick, continuous clay films on ped faces and the colloids that fill the pores in the B horizon indicate a strong movement of silicate clay.

The Pleasanton soils occur on low terraces. Typically, they are gravelly throughout, and their alluvial horizons are weak. The Zamora and Rincon soils occur on low terraces and coalescing fans. They are finer textured than the Pleasanton soils. The Rincon soils have a more prominent B2 horizon than the Zamora soils.

Profile of Pleasanton gravelly loam in a cultivated field: SE¼NE¼NE¼ sec. 24, T. 3 S., R 2 E. The slope at this site is 1 percent, is lightly convex, and faces south. The soil was dry when the profile was examined.

Ap—0 to 9 inches, grayish-brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2 when moist; massive or very weak, granular structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many very fine, fine, and medium, random roots; common very fine and fine, and few medium, random, inped, open, interstitial pores; slightly acid, pH 6.3; abrupt, smooth boundary.

A1—9 to 21 inches, grayish-brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many very fine and fine and few medium, random roots; common very fine and fine, and few medium, random, inped, open, interstitial pores; neutral, pH 6.8; clear, smooth boundary.

B21t—21 to 32 inches, dark-brown (10YR 4/3) gravelly clay loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; many very fine and fine, random roots; many very fine and fine, and few medium, random, inped, open, tubular pores; common moderately thick clay films on ped faces and in pores; neutral, pH 7.1; gradual, wavy boundary.

B22t—32 to 48 inches, dark-brown (10YR 4/3) gravelly clay loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; many very fine and few fine, random roots; many very fine, common fine, and few medium, random, inped (few exped), open, tubular pores; common moderately thick clay films on ped faces and in pores; neutral, pH 7.3; gradual, wavy boundary.

B3t—48 to 64 inches, dark-brown (10YR 4/3) gravelly silty clay loam, dark brown (10YR 3/3) when moist; weak, medium, subangular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; few very fine roots; common very fine and fine, random, open, tubular pores; few thick and thin clay films on ped faces and in pores; neutral, pH 7.3; gradual, wavy boundary.

C—64 to 72 inches, yellowish-brown (10YR 5/4) gravelly silt loam, dark yellowish brown (10YR 4/4) when moist; massive or weak blocky structure; hard when dry, friable when moist, sticky and slightly plastic when wet; common very fine and fine, and few medium, random, inped, open, tubular pores; few thin clay films on ped faces and in pores; mildly alkaline, pH 7.4.

Range in characteristics.—The A horizon ranges from light brownish gray, grayish brown, or pale brown to yellowish brown in color and from gravelly loam or loam to light clay loam in texture. The B horizon ranges from light clay loam to light clay that is gravelly in most places. In areas transitional from this soil to the Rincon soils, the C horizon is slightly calcareous in places.

Intrazonal order

Soils in the intrazonal order have characteristics that reflect the influence of some local factor of relief or parent material over the effect of climate and vegetation. In the Alameda Area, the Solonetz, Planosol, Grumusol, and Calcium Carbonate Solonchak great soil groups are members of the intrazonal order.

SOLONETZ SOILS

In the Alameda Area, the Pescadero and Solano soils are in the Solonetz great soil group. Solonetz soils are an intrazonal group of soils having a variable surface horizon of friable soil underlain by dark hard soil, ordinarily with columnar structure; usually strongly alkaline; and developed under grass or shrub vegetation, mostly in a subhumid or semiarid climate (*17*). If leaching continues active for a long time, the soils become acid in the surface soil and have a deep, gray layer over an acid, blocky B horizon. Such soils are called Soloth, and the process of change from Solonetz to Soloth great soil group is called solodization (*13*). The Pescadero are dark-colored, fine-textured soils that are somewhat transitional to the Humic Gley soils. The Solano soils are representative of the Solonetz soils. They have characteristics of both the Solonetz and Soloth groups, but they are more like the Solonetz. For example, they have a medium acid, fine sandy loam A1 horizon; a thin, medium acid, fine sandy loam A2 horizon; a neutral, loam B2t horizon with massive to weak columnar structure; and a C2 horizon that is strongly alkaline. This indicates the leaching of soluble salts and carbonates from the A and

B horizons. Exchangeable sodium has accumulated in the C2 horizon and made that horizon strongly alkaline. Patchy clay films on ped faces and in root channels indicate the translocation of some silicate clay from the A horizon to the B horizon. Vegetation during the formative years was sparse, and the accumulation of organic matter was slight.

Profile of Solano fine sandy loam: NW¼NW¼SW¼ sec. 36, R. 3 E., T. 1 S., in a roadcut in the Christensen Road. Vegetation consists of annual grasses, scattered saltbush, and iodineplant, but concave areas are nearly barren. The slope at this site is 1 percent and is convex. The soil was dry to a depth of 13 inches when the profile was examined.

A1—0 to 4 inches, very pale brown (10YR 7/4) fine sandy loam, brown (10YR 5/3) when moist; massive; soft when dry, friable when moist, nonsticky and nonplastic when wet; many fine roots; medium acid; clear, smooth boundary; 2 to 8 inches thick.

A2—4 to 6 inches, light-gray (10YR 7/2) fine sandy loam, pale brown (10YR 6/3) when moist; weak platy structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; medium acid; abrupt, wavy boundary; ½ inch to 3 inches thick.

B2t—6 to 13 inches, pale-brown (10YR 6/3) clay loam, dark brown (10YR 4/3) when moist; massive or weak columnar structure; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; thin, discontinuous clay films on vertical faces of peds; common fine and very fine tubular pores; neutral; clear, wavy boundary; 5 to 9 inches thick.

C1—13 to 30 inches, yellowish-brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; mildly alkaline; diffuse boundary; 10 to 20 inches thick.

C2—30 to 60 inches, yellowish-brown (10YR 5/4) light clay loam, dark yellowish brown (10YR 4/4) when moist; massive; hard when dry, friable when moist, sticky and slightly plastic when wet; strongly alkaline.

Range of characteristics.—The thickness of the A1 horizon ranges from 0 on barren alkali spots to 18 inches on the mounds. Texture ranges from sandy loam or fine sandy loam to loam. In places where these soils have strong horizon development, the A horizon is grayish brown, loamy, and massive; and the B2t horizon is dark grayish brown, columnar, and clayey. The soil is slightly affected to strongly affected by salts and alkali.

PLANOSOLS

In the Alameda Area the Cotati, Positas, and San Ysidro soils are classified as Planosols. Planosols are an intrazonal group of soils with an eluviated surface horizon underlain by a B horizon more strongly illuviated, cemented, or compacted than that of associated normal soils; they developed upon a nearly level upland surface under grass or forest vegetation in a humid or subhumid climate (*16*). The San Ysidro and Positas soils lack mottles in the A2 and B2t horizons and are better drained than the Cotati. They also have some properties that resemble those of the strongly developed Noncalcic Brown soils. The Cotati soils are representative of this great soil group and were mapped on strongly sloping topography. Most areas are on concave relief, where rainfall has had the maximum effect on the leaching of the surface horizon and on the movement of clay into the B2t horizon. The gray and dark-gray colors of the A11 and A12 horizons indicate the accumulation of organic matter. Because of the leaching of soluble salts and carbonates, the solum is medium acid. The frequent saturation of these soils, particularly the A horizon, during the winter favors the reduction and translocation of iron. Clay films and colloidal bridges in pores and between sand grains of the B horizon indicate the downward movement of silicate clay from the A horizon.

Profile of Cotati fine sandy loam: 0.25 mile south and 0.15 mile west of the northeast corner of sec. 4 in the SW¼NW¼ sec. 4, T. 3 S, R. 1 W. Present use is annual grass pasture. The slope is 12 percent, is slightly concave, and faces southwest. The soil was moist when the profile was examined.

A11—0 to 10 inches, gray (10YR 5/1) fine sandy loam, very dark gray (10YR 3/1) when moist; few, fine, faint, strong-brown (7.5YR 5/6) mottles; massive; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; many fine roots; many very fine and few fine pores; medium acid; gradual, smooth boundary; 8 to 12 inches thick.

A12—10 to 18 inches, dark grayish-brown (10YR 4/2) loam, very dark gray (10YR 3/1) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; many very fine roots; many very fine and few fine pores; medium acid; clear, smooth boundary; 6 to 10 inches thick.

A21—18 to 24 inches, grayish-brown (10YR 5/2) heavy loam, dark grayish brown (10YR 4/2) when moist; few, fine, faint, gray (10YR 5/1) mottles; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common very fine roots; many very fine and few fine pores; medium acid; clear, smooth boundary; 4 to 8 inches thick.

A22—24 to 27 inches, light brownish-gray (10YR 6/2) heavy loam with yellowish-brown (10YR 5/8) stains, brown (10YR 5/3) when moist; few, fine, faint, strong-brown (7.5YR 5/8) mottles; massive; hard when dry, firm when moist, sticky and plastic when wet; common very fine roots; many very fine and few fine pores; thin, continuous clay films in pores; medium acid; abrupt, smooth boundary; 1 to 3 inches thick.

B2t—27 to 42 inches, light brownish-gray (10YR 6/2) clay with yellowish-brown (10YR 5/6) stains, grayish brown (10YR 5/2) when moist; few, fine, faint, yellowish-brown (10YR 5/8) mottles; weak, very coarse, prismatic structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; few very fine roots; few very fine pores; colloids fill pores; medium acid; gradual, smooth boundary; 12 to 18 inches thick.

B3t—42 to 49 inches, light yellowish-brown (2.5Y 6/4) gritty clay loam, brown (10YR 5/3) when moist; few, fine, faint, yellowish-brown (10YR 5/6) mottles; massive; very hard when dry, firm when moist, sticky and plastic when wet; few very fine roots; few very fine pores; colloids mainly in bridges between sand grains but continuous in some pores; medium acid; clear, smooth boundary; 5 to 9 inches thick.

R—49 inches +, pale-yellow (2.5Y 8/4) shattered sandstone with light yellowish-brown surface stains.

Range in characteristics.—The A22 horizon looks like a degraded B2t horizon. The texture of the surface layer ranges from sandy loam to loam. In places the A11 horizon is grayish brown and the B2t horizon is brown. Where this soil is transitional to the Los Osos soils, the B2t horizon is clay loam, is not mottled, and is only 8 to 12 inches thick.

GRUMUSOLS

Oakes and Thorp have given the Houston Black series (not mapped in the Area) as typical of the Grumusol great soil group (*10*). In addition, they have proposed

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that a soil classified as a Grumusol should have all or most of the following characteristics: (1) Clay texture, (2) no eluvial and illuvial horizons, (3) moderate to strong granular structure in the upper 6 to 20 inches and blocky structure or massive below, (4) calcareous, (5) high coefficient of expansion and contraction on wetting and drying, (6) gilgai microrelief, (7) extremely plastic consistence, (8) exchange complex nearly saturated with calcium or calcium and magnesium, (9) clay minerals dominantly in the montmorillonite group, (10) sola more than 10 inches deep, (11) dark color of low chroma, (12) medium to low content of organic matter, (13) stage of weathering relatively unadvanced or minimal, and (14) tall grass or savannah vegetation.

The Altamont, Clear Lake, and Diablo soils have all but two of these characteristics; they lack a strong granular structure and a gilgai microrelief. The absence of a strong granular structure may be the reason that these soils lack a gilgai microrelief, as described by Oakes and Thorp. These soils do have a very thin, light-gray surface crust over a prismatic or blocky structure. Swelling of the soils after wetting causes them to churn and prevents the formation of illuvial horizons. Many slickensides, a uniform dark color, and pieces of organic carbon in the lower part of the solum indicate a continual churning and mixing of the surface soil with the lower horizons. Also, laboratory data (see table 15) indicate that very little clay has been transported from the surface horizon to subsurface horizons. These soils have a silty clay or clay texture. They do not have an eluvial or illuvial horizon. They have a slightly acid to neutral surface layer that becomes calcareous with depth.

Mottles in the subsoil of the Clear Lake soils indicate the reduction of iron. Numerous seams of gypsum in the C horizon of these Clear Lake soils indicate an accumulation of soluble salts, probably before drainage of these soils was altered by stream cutting, land clearing, or pumping of water from the area.

The dark colors of the soils of this great soil group indicate the accumulation of organic matter, particularly in the Clear Lake soils. The soils of this group have a high coefficient of expansion and contraction on wetting and drying, and they have cracks that extend down to the C or R horizon during dry seasons. Also, they are very plastic when wet.

The soils of this group formed in different kinds of parent material. The Diablo soils formed in slightly calcareous, soft, interbedded shale and fine-grained sandstone. The Altamont soils formed in slightly harder, slightly calcareous, interbedded sedimentary rock. The Clear Lake soils formed in fine-textured sediments in basin areas and in small valleys. The Diablo soils are representative of the Grumusol great soil group in the Area.

Profile of Diablo clay: 1,325 feet east and 275 feet north of the southwest corner of sec. 25, in SW¼SE¼ SW¼ sec. 25, R. 1 E., T. 2 S. The field is now used for pasture but has been cultivated. The slope at this site is 30 percent; it is slightly convex and faces north. The soil was dry when the profile was examined.

A1—0 to 6 inches, dark-gray (5Y 4/1) clay, very dark gray (5Y 3/1) when moist; the very thin surface crust is light gray (5Y 6/1) to gray (5Y 7/1) when dry; strong, coarse, prismatic and strong, coarse and medium, blocky structure; very hard when dry, very firm when moist, very plastic and sticky when wet; many fine roots mainly along structural planes; few extremely fine and very fine, tubular pores; slightly acid; noncalcareous; clear, slightly wavy boundary; 4 to 8 inches thick.

A12—6 to 15 inches, dark-gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) when moist; moderate, coarse, prismatic and moderate, coarse blocky structure; very hard when dry, very firm when moist, very plastic and sticky when wet; few fine roots mainly along structural planes and facings; few extremely fine and very fine, tubular pores; mildly alkaline; noncalcareous; occasional small, hardened, whitish nodules of lime embedded in matrix; few slickensides; clear boundary; 8 to 12 inches thick.

A13ca—15 to 26 inches, finely mottled gray (5Y 5/1) and olive-gray (5Y 5/2) silty clay, dark gray (5Y 4/1) and olive gray (5Y 4/2) when moist; few fine, whitish nodules of lime; moderate, coarse, prismatic and medium, blocky structure; very hard when dry, very firm when moist, very plastic and sticky when wet; few fine roots mainly along structural planes and facings; few extremely fine and very fine, tubular pores; mildly alkaline; slightly calcareous in matrix; strong effervescence of lime nodules; many slickensides; clear, slightly wavy boundary; 8 to 12 inches thick.

A14ca—26 to 32 inches, finely mottled gray (5Y 5/1) and olive-gray (5Y 5/2) silty clay, dark gray (5Y 4/1) and olive gray (5Y 4/2) when moist; few, fine, whitish, hard nodules of lime; weak, coarse, prismatic and weak, medium, blocky structure; very hard when dry, very firm when moist, very plastic and sticky when wet; few fine roots mainly along structural planes and facings and distinctly flattened; few extremely fine and very fine, tubular pores; midly alkaline; slightly calcareous matrix; strong effervescence of the lime nodules; numerous slickensides; diffuse boundary; 4 to 8 inches thick.

C1ca—32 to 42 inches, light olive-gray (5Y 6/2) silty clay, olive gray (5Y 5/2) when moist; many whitish films and soft segregations of lime; weak, medium, subangular blocky structure; very hard when dry, very firm when moist, plastic and slightly sticky when wet; few fine roots; few, extremely fine and very fine, tubular pores; mildly alkaline; moderately calcareous; clear, wavy boundary; 10 to 16 inches thick.

C2ca—42 to 50 inches, fine and medium, mottled, olive-gray (5Y 5/2) and light olive-gray (5Y 6/2) silty clay loam, olive gray (5Y 5/2 or 4/2) when moist; many embedded fragments of shale; many soft, whitish films of lime and soft and hard nodules of lime; weak, fine and medium, subangular blocky structure; very hard when dry, very firm when moist, plastic and slightly sticky when wet; few fine roots; few, extremely fine and very fine, tubular pores; moderately alkaline; moderately calcareous; abrupt, smooth boundary; 8 to 16 inches thick.

R—50 inches +, light olive-gray (5Y 6/2) slightly calcareous, shattered shale and fine-grained sandstone; whitish films on fracture facings; whitish lime segregations; moderately alkaline.

Range in characteristics.—The depth to shale and sandstone ranges from 20 to 60 inches but typically is from 30 to 50 inches. In the shallower areas and on south-facing slopes, the soil may be lighter in color by one unit of value. In areas that are transitional to the Linne soils, lime occurs throughout the profile and slickensides are less common. In some places the profile may be free of lime except for the Cca horizon and along fracture planes of the R horizon. In places where this soil intergrades toward Altamont soils, the chroma of the A horizon is yellowish brown instead of olive gray. Lime occurs in the surface horizon in some places because of erosion, cultivation, or churning of the soil.

CALCIUM CARBONATE SOLONCHAK SOILS

In this Area, Sunnyvale is the only soil series in the Calcium Carbonate Solonchak great soil group. The soils in this great soil group range in drainage from moderately good to poor. They formed under the influence of a high or intermittently high water table in nearly level to depressional areas. Most soils of this group are calcareous throughout their profiles, but in some moderately well drained members the upper part of the A horizon is free of lime. They have a black or very dark gray, friable, granular A horizon. The thickness of this horizon ranges from 6 to 15 inches, and the pH ranges from 7.5 to 8.0. Particularly where the water table is permanently high, the A horizon abruptly overlies a strongly calcareous, grayish-brown to pale-olive or white Cca horizon. The thickness of the Cca horizon ranges from 10 to 25 inches, and the pH ranges from 7.5 to 8.5. The parent material is calcareous and may be gleyed. The pH of this material ranges from 7.8 to 8.2. Moderate amounts of salts and gypsum may occur in the Cca or C horizons. In general, where the water table is close to the surface most of the time, the A horizon is thin and strongly calcareous, and the Cca horizon is most prominent. Burrowing rodents and earthworms are active in better drained profiles (*9*).

The Sunnyvale soils are young, and the influence of the soil-forming processes is slight. The solum becomes more calcareous with increasing depth, which indicates some leaching of carbonates. Some reduction and transfer of iron from the horizons above is indicated by the rust-colored mottles along the root channels. The accumulation of organic matter in these soils has been slight, and there is no visible evidence of the translocation of silicate clay or the accumulation of soluble salts.

Profile of Sunnyvale clay loam described in a field of dry-farmed grain at a point 2,500 feet east of Hopyard Road and 2,750 feet north of Arroyo Las Positas. The slope at the site is less than 1 percent.

Ap—0 to 7 inches, gray (5Y 5/1) heavy clay loam, very dark grayish brown (2.5Y 3/2) when moist; weak, medium to fine, granular structure; hard when dry, friable when moist, plastic and sticky when wet; many medium, fine, and very fine roots; many fine and very fine, open, tubular pores; many worm casts; moderately alkaline; slightly calcareous; abrupt, smooth boundary.

A1—7 to 18 inches, gray (5Y 5/1) silty clay, dark grayish brown (2.5Y 4/2), when moist; weak, medium, granular structure; hard when dry, friable when moist, plastic and sticky when wet; many fine and very fine roots; few medium, and many fine and very fine, open, tubular pores; many worm casts; moderately alkaline; calcareous; abrupt, smooth boundary.

AC—18 to 30 inches, gray (5Y 5/1) silty clay, dark grayish brown (2.5Y 4/2) when moist; common, fine, rust-colored mottles along old root channels; weak, medium, granular structure; hard when dry, friable when moist, plastic and sticky when wet; many fine and very fine roots; few medium, and many very fine, open, tubular pores; moderately alkaline; strongly calcareous; abrupt, smooth boundary.

C1ca—30 to 38 inches, gray (5Y 5/1) silty clay, dark grayish brown (5Y 4/1) when moist; light-gray (5Y 7/2) seams and nodules of lime; weak, medium, granular structure; hard when dry, friable when moist, very plastic and sticky when wet; few fine and many very fine roots; many very fine and fine, open, tubular pores; moderately alkaline; strongly calcareous; abrupt, smooth boundary.

C2—38 to 42 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; moderately coarse, platy structure; slightly hard when dry, friable when moist, plastic and sticky when wet; few fine and very fine roots; many fine and common very fine pores; moderately alkaline; strongly calcareous; clear, smooth boundary.

IIC3—42 to 55 inches, dark-gray (2.5Y 4/0) clay, very dark gray (2.5Y 3/0) when moist; strong, coarse, prismatic structure; very hard when dry, very firm when moist, very plastic and slightly sticky when wet; few medium and many fine roots; few medium, and many fine and very fine, tubular pores; moderately alkaline; few nodules and seams of lime; diffuse, smooth boundary.

IIC4—55 to 66 inches, gray (2.5Y 5/0) clay, dark gray (2.5Y 4/0) when moist; strong, coarse, prismatic to moderate, medium blocky structure; very hard when dry, very firm when moist, very plastic and slightly sticky when wet; few fine and very fine roots; many very fine and fine, tubular pores; moderately alkaline.

Range in characteristics.—The color of Ap and A1 horizons ranges from grayish brown (10YR 5/2) to very dark gray (10YR 3/1). Texture of the surface layer ranges from silt loam to heavy silty clay loam. Small areas have a strongly calcareous surface layer. The C1ca horizon ranges from silt loam to silty clay in texture and contains thin, discontinuous lenses of fine sandy loam. The depth to the IIC3 horizon ranges from 36 to 60 inches.

Azonal order

The Azonal soils lack a genetic profile because they are too young or because conditions of parent material or of relief have prevented the development of normal profile characteristics. Under some conditions, steep topography and rapid runoff have interfered with soil formation. In the Alameda Area are soils of the Lithosol, Regosol, and Alluvial great soil groups in the Azonal order.

LITHOSOLS

In the Alameda Area, the Gaviota and the Millsholm soils have been classified as Lithosols. Lithosols are shallow soils having no clearly expressed soil development and consisting mainly of a freshly and partly weathered mass of hard rock or hard rock fragments.

The Gaviota soils are representative of Lithosols. They formed from hard sandstone or other interbedded sedimentary rock on typically steep topography. In most places runoff is rapid. Runoff water washes away soil material before horizons are formed, and little rainfall enters the soil to aid the soil-forming processes. The addition of a small amount of organic matter is the only soil-forming process evident in Lithosols.

Profile of Gaviota rocky sandy loam: NW¼NE¼ of sec. 30, R. 2 W., T. 3 S. The slope at this site is 12 percent; it is convex and faces south. Approximately 50 percent of the surface area is made up of rock outcrop. The soil was dry when the profile was examined.

A11—0 to 1 inch, brown (10YR 5/3) sandy loam; dark brown (10YR 4/3) when moist; weak, very fine, granular structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; many very fine roots; many very fine pores; slightly acid; clear, wavy boundary; 1 to 3 inches thick.

A12—1 inch to 11 inches, brown (10YR 5/3) sandy loam; dark brown (10YR 4/3) when moist; massive; slightly hard when dry, friable when moist, nonsticky and non-

plastic when wet; medium acid; abrupt, irregular boundary; 8 to 14 inches thick.

R—11 inches +, yellowish-brown (10YR 5/6) hard sandstone.

Range in characteristics.—The depth to bedrock ranges from 6 to 24 inches. The texture of the surface soil ranges from sandy loam to silt loam. Some areas are free of rock outcrops. Where this soil is transitional toward the Los Osos silt loam, the A horizon is finer textured and is more olive colored (2.5Y) throughout. Where this soil intergrades toward the Los Gatos and Los Osos soils, it has a weak, reddish brown B2 horizon. A faintly mottled B2 horizon occurs in places where this soil intergrades toward the Los Osos, seeped variant, soil.

REGOSOLS

The Regosols have developed in soft or weakly consolidated materials and show little evidence of horizon differentiation, except for a darkening of the surface horizons by organic matter. In the Alameda Area, the Shedd and Linne soils are Regosols. They are strongly calcareous throughout their profiles. The high content of calcium carbonate is believed to have inhibited the formation of silicate clay. The accumulation of organic matter has been greater in the Linne soils, which gives them some of the properties of Chestnut soils. Little leaching of carbonates is evident in either the Shedd or Linne soils.

The Shedd soils are representative of Regosols. Profile of Shedd silt loam along a ridge 200 feet east of cattle guard and 20 feet south of road in the SW¼SW¼ NW¼ sec. 8, R. 3 E., T. 4 S. The slope of this site is 45 to 50 percent. The soil was dry when the profile was examined.

A11—0 to 4 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; moderately fine, granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; many fine roots; moderately calcareous; clear, smooth boundary; 3 to 6 inches thick.

A12—4 to 12 inches, color and texture similar to that of A11 horizon; weak, fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; moderately calcareous; clear, smooth boundary; 6 to 12 inches thick.

C1ca—12 to 23 inches, light brownish-gray (2.5Y 6/2) silt loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, fine, granular structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; many roots; clear, smooth boundary; 10 to 14 inches thick.

C2ca—23 to 32 inches, color and texture similar to that of C1ca horizon; moderate, fine, granular structure; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; strongly calcareous; clear, smooth boundary; 8 to 12 inches thick.

C3—32 inches +, pale-olive to olive, weakly consolidated fine sediment of lacustrine origin.

Range in characteristics.—The depth to the C horizon ranges from 12 to 36 inches. Color of the A horizon ranges from dark grayish brown or grayish brown to light grayish brown. Some areas have lime concretions throughout the profile and mycelialike lime in the Cca horizon. A few fine quartz pebbles occur throughout. Where this soil is transitional to Positas soils, the A horizon is brown. Also, the Cca horizon is grayish brown and has a few, thin, discontinuous clay films.

ALLUVIAL SOILS

Alluvial soils are an Azonal group of soils developed from transported and relatively recently deposited material (alluvium) characterized by weak modifications (or none) of the original materials by soil-forming processes (*17*). In the Alameda Area, Yolo and Sycamore soils are in this great soil group. These are young soils, and their characteristics are almost entirely inherited from the parent materials. The addition of organic matter to the surface horizon is indicated by its darker color. The drainage of these soils differed during their formation. The Yolo soils formed under good drainage, and some leaching of carbonates has occurred in places. The Sycamore soils formed under imperfect drainage, as indicated by distinct mottles in the C horizon and the lime throughout the profile. The mottles also indicate some reduction of iron. The alluvium from which these soils formed is predominantly from sedimentary rock. The Yolo soils are representative of the Alluvial great soil group.

Profile of Yolo loam in a field of irrigated tomatoes, 400 feet west of Santa Rita Road and 200 feet north of Delle Valle Creek in the NW¼SW¼SE¼ sec. 17, T. 2 S., R. 1 E. The slope at this site is less than 1 percent. The soil was moist when the profile was examined.

Ap—0 to 8 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; common fine and few medium roots; common fine, few medium, and few coarse pores; mildly alkaline; clear, smooth boundary; 6 to 8 inches thick.

A1—8 to 16 inches, color and texture similar to that of Ap horizon; massive; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; many fine and many medium roots; many fine and few medium pores and worm casts; mildly alkaline; clear, smooth boundary; 6 to 12 inches thick.

C1—16 to 24 inches, brown (10YR 5/3) very fine sandy loam, dark brown (10YR 3/3) when moist; massive; soft when dry, friable when moist, slightly sticky and nonplastic when wet; many fine and few medium roots; moderately alkaline; very slightly calcareous; gradual, smooth boundary; 6 to 12 inches thick.

C2—24 to 46 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; massive; soft when dry, friable when moist, nonsticky and nonplastic when wet; few fine roots; moderately alkaline; very slightly calcareous; gradual, smooth boundary; 12 to 24 inches thick.

C3—46 to 60 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; few very fine roots; few very fine pores; moderately alkaline; moderately calcareous.

Range in characteristics.—Organic stains in Ap and A1 horizon are one-half chip darker in value than the horizons themselves. The A horizon ranges from dark grayish brown or grayish brown to brown in color, and from fine sandy loam to light clay loam in texture. The C horizon ranges from fine sandy loam to light clay loam in texture. Depth to lime ranges from 24 inches to more than 5 feet.

Laboratory Analyses

The results of laboratory analyses of samples taken, by horizons, from seven soil profiles are shown in table 15. The analyses were made at the Soil Survey Labora-

tory, Soil Conservation Service, Riverside, California. Electrical conductivity, soluble cations and anions, and moisture tension were determined by methods described in the U.S. Department of Agriculture Handbook No. 60 (*18*); extractable cations and organic carbon were determined by methods described in the U.S. Department of Agriculture Circular 757 (*11*). The reaction (pH) was determined with the Beckman glass electrode, mechanical analyses were made by the pipette method, and total nitrogen by the AOAC (Association of Official Agriculture Chemists) Kjeldahl method.

Additional Facts About the Alameda Area

In this section some additional facts about the Area are given. The water supply, geology, agriculture, and other subjects of general interest are discussed.

Water Supply

Wells are the chief source of water for irrigation in the Livermore and Amador Valleys. Approximately 3,000 acres in the northeastern part of the county receive irrigation water from the Byron-Bethany Irrigation District. As approximately 6,000 acres of the highly developed agricultural area in the valleys depends on irrigation, an adequate ground-water reserve is of great importance.

The ground water is replenished by rainfall on nearby valleys and mountains. Percolation takes place principally in the streams along the south side of the Livermore Valley. Plans have been made to bring in water through the South Bay Aqueduct, which is now under construction.

Because of the development of agriculture in the valley and greater dependence on irrigation for crop production, the draft on the ground-water reservoir has increased, and fluctuations in the water level have caused some concern. Also, the increase in the population in the Area not only has increased the amount of water used but also has made sewage disposal a greater problem. The valleys are in a closed basin, and the addition of salt from sewage disposal creates another problem. Eventually the salt will make the underground water unfit for use in irrigation.

When the Alameda Area was settled, much of its acreage was poorly drained and was covered with willows and other water-loving plants. Some parts of the Area had artesian wells. As development progressed, the water table was lowered to approximately 100 to 150 feet. Along the eastern side of the Livermore Valley, much of the water is unfit for irrigation because it contains boron and other impurities.

Geology

Geologically the Alameda Area, as well as the San Francisco Bay region or the California Coast Ranges in general, is a complex system of folds and faults. Although sedimentary rocks predominate, many igneous and metamorphic rocks that vary widely in age are represented. Detailed geologic maps and reports on parts of the Alameda Area have been made by Huey (*6*), Hall (*4*), Robinson (*12*), and Taff (*15*).

Decipherable geologic history of the Area begins with the oldest rocks—those in a geosyncline that occupies the site of the present California Coast Ranges—the Franciscan-Knoxville rocks of Jurassic age (*7*). These are an accumulation of different kinds of sedimentary rocks, contemporaneous volcanic rocks, and intrusive rocks. They occupy the highlands of the Diablo Range south of the Livermore Valley, as well as parts of the highlands immediately adjacent to the alluvial plain that extends into the San Francisco Bay depression. The Coyote Hills that protrude from the alluvial plain near the tidelands of the San Francisco Bay depression also consists of these rocks.

The Franciscan-Knoxville rocks consist of marine sandstone, shale, siltstone, and radiolarian chert. The silica making up the chert was originally colloidal. But because the chert was buried at a great depth, and because of the strong folding of the Franciscan formation, the chert is now crystalline and is made up of a fine mosaic of quartz or chalcedony. The chert is bedded, and the individual beds or lenses range from less than 1 inch to 6 inches thickness. Submarine volcanism that poured basic volcanic rocks, chiefly pillow basalt, on the sea floor was widespread. Flow and fragmental volcanic rocks are commonly interbedded with sandstone and shale.

The Franciscan-Knoxville rocks are extensively intruded by basic and ultrabasic igneous rocks (*7*). The ultrabasic rocks now are dominantly serpentine. Large, irregular areas of serpentine are widely distributed in the Area. The Franciscan-Knoxville rocks nearly everywhere are strongly folded and faulted, and most of the stratified rocks stand at high angles.

The Cretaceous rocks consist of marine sandstone, shale, conglomerate, and some lenses of limestone. Lower Cretaceous rocks have been mapped as the Horsetown formation and the Oakland conglomerate. Rocks of the Upper Cretaceous age include the Moreno Grande, Panoche, and Chico formations. These rocks occupy part of the highlands east and west of Livermore Valley. A small area of Cretaceous sediments occurs adjacent to the Arroyo del Valle Creek south of the Livermore Valley.

In the vicinity of Corral Hollow, 2,000 feet of middle Eocene sand, clay, and shale have been mapped by Huey and named the Tesla formation (*6*).

Miocene rocks consist of fossiliferous marine sandstone, shale, and conglomerate. They also include interbedded tuff, coal seams, and, in places, diatomaceous and siliceous shales. The Leona rhyolite, which consists of surface flows and near-surface intrusions, is of upper Miocene age. The Neroly, Cierbo, Briones, and Oursan formations, as well as the Monterey Group, represent the Miocene rocks in the highlands above the intermountain valleys of the region. The Miocene rocks occur in a large area exposed on the west wall of the San Ramon and Amador Valleys, in the highlands above Calaveras Canyon, in the Altamont Hills bordering the east side of the Livermore Valley, and in the southern highlands adjacent to the alluvial plain of the San Francisco Bay depression.

TABLE 15.—*Mechanical and*

[Analyses made at Soil Survey Laboratory, Soil Conservation Service,

Soil type and sample number	Horizon	Depth	Particle size distribution								Moisture held at tension of 15 atmosphere	Moisture at saturation	Organic carbon	Total nitrogen
			Larger than 2 mm.	Very coarse sand (2.0–1.0 mm.)	Coarse sand (1.0–0.5 mm.)	Medium sand (0.5–0.25 mm.)	Fine sand (0.25–0.10 mm.)	Very fine sand (0.10–0.05 mm.)	Silt (0.05–0.002 mm.)	Clay (less than 0.002 mm.)				
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Altamont clay (S58–Cal–1–3).	A11	0–7	<1	0. 1	1. 0	2. 1	5. 1	6. 8	34. 2	50. 7			1. 23	0. 148
	A12	7–19	<1	. 1	. 9	1. 8	4. 7	6. 7	35. 4	50. 4			. 79	. 108
	A13	19–28	<1	. 2	1. 0	1. 9	4. 6	6. 3	36. 6	49. 4			. 63	. 095
	A14ca	28–37	<1	. 2	1. 0	1. 7	4. 1	6. 0	39. 4	47. 6			. 50	. 087
	Cca	37–50	<1	. 4	. 9	1. 5	3. 4	5. 2	41. 8	46. 8			. 34	
	R	50+												
Diablo clay (S58–Cal–1–1).	A11	0–6	<1	0	. 1	. 2	3. 3	8. 5	42. 0	45. 9			1. 37	. 172
	A12	6–15	<1	0	. 1	. 3	3. 3	7. 4	41. 5	47. 4			. 92	. 135
	A13ca	15–26	<1	. 1	. 1	. 2	2. 6	6. 3	43. 7	47. 0			. 71	. 109
	A14ca	26–32	<1	0	. 1	. 2	2. 5	6. 0	43. 1	48. 1			. 64	. 102
	C1ca	32–42	<1	. 2	. 5	. 4	2. 1	4. 6	48. 3	43. 9			. 41	. 091
	C2ca	42–50	<1	. 4	. 6	. 4	1. 1	4. 3	56. 0	37. 2			. 25	
	R	50+												
Livermore very gravelly course sandy loam[4] (S59–Cal–1–3).	Ap1	0–4	[4] 61	13. 9	17. 0	8. 8	13. 9	7. 9	29. 1	9. 4	3. 9	18. 1	. 72	. 066
	Ap2	4–12	[4] 61	14. 4	15. 1	8. 0	14. 4	8. 6	30. 2	9. 3	4. 6	20. 1	. 58	. 061
	A3	12–21	[4] 50	11. 2	14. 7	8. 5	15. 5	9. 4	28. 7	12. 0	4. 9	20. 3	. 50	. 052
	B1t	21–28	[4] 59	12. 1	16. 3	8. 9	15. 2	9. 0	27. 1	11. 4	5. 4	19. 3	. 36	. 043
	B2t	28–34	[4] 74	16. 8	20. 8	10. 2	15. 4	6. 9	16. 4	13. 5	5. 8	20. 9	. 23	
	IIC	34–60+	[4] 70	22. 9	34. 6	15. 3	7. 1	1. 2	5. 8	13. 1	5. 9	23. 4	. 13	
Millsholm silt loam (S59–Cal–1–5).	A1	0–7	0	. 1	. 5	. 6	2. 9	7. 2	65. 9	22. 8	10. 1	44. 0	1. 43	. 131
	B21	7–14	1	0	. 3	. 4	1. 8	7. 5	63. 1	26. 9	11. 4	38. 0	. 64	. 077
	B22	14–22	6	0	. 3	. 4	1. 9	7. 2	63. 3	26. 9	11. 7	38. 2	. 53	. 066
	R	22+												
Pleasanton gravelly loam (S60–Cal–1–1).	Ap	0–9	55	6. 2	12. 7	8. 7	20. 2	10. 1	29. 0	13. 1	3. 6	29. 6	2. 02	. 172
	A1	9–21	27	7. 0	11. 8	8. 1	18. 7	10. 3	29. 9	14. 2	3. 5	23. 8	. 96	. 087
	B21t	21–32	49	7. 2	12. 8	7. 9	18. 0	10. 0	27. 2	16. 9	5. 7	22. 7	. 45	. 052
	B22t	32–48	40	6. 1	13. 5	6. 6	17. 3	10. 3	26. 3	19. 9	7. 6	26. 1	. 23	. 032
	B3t	48–64	42	3. 8	7. 0	6. 4	17. 6	14. 5	31. 6	19. 1	7. 4	27. 8	. 17	
	C	64–72	30	3. 0	5. 4	6. 9	14. 9	22. 0	29. 9	17. 9	4. 4	27. 6	. 12	
Positas gravelly loam (S59–Cal–1–1).	Ap	0–8	21	3. 1	4. 1	3. 6	9. 7	10. 3	53. 2	16. 0	5. 8	29. 2	1. 07	. 080
	A2	8–11	10	3. 6	3. 8	3. 4	9. 4	10. 0	53. 4	16. 4	6. 4	23. 4	. 54	. 049
	B21t	11–20	14	1. 9	2. 3	1. 8	5. 3	5. 8	29. 9	53. 0	23. 1	64. 3	. 56	. 080
	B22t	20–29	4	2. 5	2. 9	2. 9	10. 9	3. 7	34. 4	42. 7	18. 4	63. 8	. 34	. 045
	B31t	29–39	8	2. 9	4. 3	4. 6	15. 4	11. 0	34. 9	26. 9	10. 8	35. 9	. 04	
	B32t	39–54	14	2. 9	3. 5	6. 8	21. 4	12. 3	29. 7	23. 4	9. 7	39. 7	. 03	
	IIC	54–64+	[5] 40	13. 8	10. 8	9. 6	18. 4	8. 2	18. 1	21. 1	8. 9	31. 5	. 03	
Vallecitos rocky loam (S59–Cal–1–8).	A11	0–1½	30	11. 1	13. 4	7. 1	11. 0	7. 2	37. 1	13. 1	6. 4	37. 6	2. 06	. 168
	A12	1½–6	[6] 29	10. 1	12. 5	6. 7	11. 0	7. 6	41. 4	10. 7	5. 8	25. 1	. 95	. 075
	B2t	6–12	8	7. 8	8. 6	3. 9	6. 8	5. 5	30. 3	37. 1	11. 5	38. 5	. 60	. 052
	B3t	12–16	8	6. 4	7. 9	4. 3	7. 9	6. 3	29. 7	37. 5	10. 8	38. 6	. 41	. 044
	R	16+												

[1] Na or K extracted with NH_4OAc, less that in saturation extract.
[2] NH_4 distillation for Altamont and Diablo; Na acetate procedure for other soils.
[3] Calcareous when tested with HCl.
[4] Stones and gravel larger than 1 inch in diameter discarded at time of sampling made up the following amounts: Ap1, 5 percent; Ap2, 5 percent; A3, 15 percent; B1t, 40 percent; B2t, 15 percent; and IIC, 30 percent.

chemical analyses of selected soils

Riverside, Calif. Absence of data indicates values not determined]

C/N ratio	Reaction (pH)		Electrical conductivity (Ecx10³ millimhos per cm. at 25° C.)	Extractable cations (Meq. per 100 gm.)					Base saturation	Saturation extract soluble (meq. per liter)					Cation exchange capacity [2]	Cation exchange capacity per 100 gm. clay
	Paste	1:10		Ca	Mg	[1] Na	[1] K	H		Na	K	Ca	Mg	Cl		
									Percent						*Meq/100 g.*	*Meq/100 g.*
8	6.5	------	----------	25.5	10.0	0.9	3.3	0.2	92	------	------	----	----	----	36.4	71.8
7	6.8	------	1	27.8	9.2	.8	2.2	.3	94	------	------	----	----	----	37.0	73.4
7	7.8	------	2	[3]	------	.6	------	.5	------	------	------	----	----	----	33.7	68.2
6	7.8	------	3	[3]	------	.6	------	.7	------	------	------	----	----	----	31.9	67.0
------	8.0	------	4	[3]	------	.6	------	.9	------	------	------	----	----	----	30.3	64.7
8	6.4	------	----------	22.9	9.0	1.0	3.1	.1	91	------	------	----	----	----	32.6	71.0
7	7.4	------	1	[3]	------	.9	------	.1	------	------	------	----	----	----	32.0	67.5
7	7.6	------	3	[3]	------	.9	------	.2	------	------	------	----	----	----	30.5	64.9
6	7.7	------	4	[3]	------	.8	------	.3	------	------	------	----	----	----	31.6	65.7
5	7.8	------	8	[3]	------	.8	------	.3	------	------	------	----	----	----	26.5	60.4
------	7.9	------	8	[3]	------	.7	------	.4	------	------	------	----	----	----	26.8	72.0
10.9	6.4	6.7	.4	3.5	2.5	.1	.6	1.8	79	1.0	0.5	----	----	----	----------	----------
9.5	6.7	6.9	.2	4.0	2.9	.1	.4	1.7	81	.8	.2	----	----	----	----------	----------
9.6	6.8	6.9	.2	4.1	3.6	.1	.3	3.2	72	.9	.1	----	----	----	----------	----------
8.4	7.0	7.1	.3	3.7	4.7	.2	.3	2.5	78	1.1	.1	----	----	----	----------	----------
------	7.1	7.4	.3	3.1	6.8	.1	.2	2.2	82	.8	<.1	----	----	----	----------	----------
------	7.1	7.2	.3	2.1	7.7	.2	.3	1.8	85	.9	.1	----	----	----	----------	----------
10.9	6.0	6.6	.5	13.4	8.3	.2	.4	6.7	77	1.0	.1	----	----	----	----------	----------
8.3	5.7	6.6	.2	14.4	10.1	.3	.3	6.8	79	.8	<.1	----	----	----	----------	----------
8.0	5.7	6.6	.1	13.5	10.5	.2	.3	6.5	79	.7	<.1	----	----	----	----------	----------
11.7	6.3	6.6	.5	10.1	2.0	.1	.6	4.6	74	.8	.3	3.7	0.8	1.3	----------	----------
11.0	6.8	7.0	.3	9.3	1.5	.1	.4	2.7	81	.7	.1	2.2	.5	.4	----------	----------
8.7	7.1	7.3	.3	9.4	3.6	.1	.3	2.3	85	.9	<.1	1.6	.7	.4	----------	----------
7.2	7.3	7.7	.2	8.4	7.1	.2	.3	2.1	93	1.0	<.1	.9	.9	.2	----------	----------
------	7.3	7.6	.2	8.0	8.9	.4	.3	2.0	90	1.1	<.1	.6	.7	.2	----------	----------
------	7.4	8.1	.3	7.3	8.0	.4	.3	1.6	91	1.6	<.1	1.0	.6	.6	----------	----------
13.4	5.9	6.6	.3	5.5	4.8	.3	.2	4.0	73	1.8	.1	----	----	----	----------	----------
11.0	5.8	6.8	.3	5.8	6.0	.5	.2	4.7	73	1.9	<.1	----	----	----	----------	----------
9.3	6.0	7.4	.3	20.7	8.7	2.1	.5	7.5	81	2.3	.1	----	----	----	----------	----------
7.6	7.4	8.5	.6	20.7	9.9	2.2	.4	3.8	90	4.7	<.1	----	----	----	----------	----------
------	7.9	9.0	1.3	10.0	13.7	1.9	.4	.8	97	9.3	.1	----	----	----	----------	----------
------	8.0	8.9	1.8	7.4	13.0	2.3	.4	1.2	95	13.3	.1	----	----	----	----------	----------
------	7.7	8.6	2.2	6.5	11.9	2.7	.3	1.6	93	16.0	.1	----	----	----	----------	----------
12.3	6.6	6.7	.9	7.1	5.2	<.1	.5	4.2	75	1.0	.4	----	----	----	----------	----------
12.7	6.5	6.8	.3	7.1	6.2	.1	.2	3.7	79	.8	.1	----	----	----	----------	----------
11.5	6.6	7.3	.3	12.0	13.6	.2	.3	4.0	87	.6	<.1	----	----	----	----------	----------
9.3	7.0	7.5	.3	10.2	11.7	.2	.2	1.2	95	.8	<.1	----	----	----	----------	----------

[5] Stones and gravel greater than 1 inch in diameter discarded at time of sampling made up 25 percent.
[6] Stones and gravel greater than 1 inch in diameter discarded at time of sampling made up 5 percent.

The surface and near-surface intrusions of the Leona rhyolite occur in the Franciscan-Knoxville rocks in the northern highlands adjacent to the alluvial plain of the San Francisco Bay depression.

The lower Pliocene sediments consist mostly of silt and clay but contain some sand, gravel, and in a few places, concretionary and tuffaceous beds. These sediments are known as the Green Valley, or Orinda formation. They occur in the highlands bordering the San Francisco Bay depression as well as in the highlands north of Livermore Valley and east of San Ramon Valley.

Plio-Pleistocene sediments in the Livermore and Sunol Valley areas are known as the Livermore-Tassajara or Livermore formation. The Santa Clara formation, of similar age, occurs along the east side of the San Francisco Bay depression. These sediments consist of sand, gravel, and clay as much as 4,000 feet thick. Limy and concretionary beds are fairly common, and some tuffaceous beds are present near their base. The sediments were deposited in lakes, swamps, and streams, but apparently not as alluvial fans. Quaternary sediments of upper Pleistocene and Recent age consist of sand, silt, and clay that occur throughout the intermountain valleys of the Diablo Range, as well as in the tideland and alluvial areas of the San Francisco Bay depression.

The lakes and swamps in the vicinity of Pleasanton have been caused by the depression of the block lying between major faults (*4*). As a result, the alluvium is deeper here than elsewhere in the Livermore Valley.

In the southern part of the Livermore Valley, the alluvium contains a relatively large amount of gravel because of deposition by the two largest streams in the valley and because of the coarser textured soils on the watershed. The smaller streams that enter the Livermore Valley from the north have deposited much of the finer sediment.

The rocks of the Alameda Area are folded into a series of anticlines and synclines and are cut by a number of prominent faults. The trend of the faults and the axes of the folds are northwesterly, except just north of Livermore Valley, where the trend is more westerly.

The larger intermountain valleys are all structurally controlled, with the possible exception of Castro Valley. Livermore Valley has developed in an east-west trenching syncline, which is expressed very strongly in the Livermore-Tassajara formation. The axis of this structure plunges gently westward and is cut off on the west by the Pleasanton Ridge, an uplifted fault block. The syncline is asymmetrical; the south limb dips northward about 5 to 25 degrees, whereas the north limb dips about 60 to 80 degrees to the south. The syncline becomes more nearly symmetrical in the eastern part of Livermore Valley. Variations in the general pattern occur locally because of minor faulting and folding.

Sunol Valley lies mainly between the Calaveras-Sunol and Sinbad faults. This valley resulted from the dropping of the block between the faults, or from the erosion of relatively weak, nonresistant rocks between them. San Ramon Valley developed east of the Calaveras-Sunol fault, along which the ridge west of the valley has been uplifted. Castro Valley lies just east of these faults, at the edge of the San Francisco Bay depression, but the effect that the faults had in the formation of the valley is not known.

The principal faults in Livermore Valley are the Calaveras-Sunol, the Pleasanton, and the Livermore faults. The Calaveras-Sunol fault extends along the base of the Pleasanton Ridge block on the west side of Livermore Valley. The steep, eastward face of Pleasanton Ridge is thus an eroded fault scarp. The fault is at least 90 miles long and is therefore one of the longest faults in the California Coast Ranges.

The Pleasanton fault trends about N. 25° W. and passes just east of the city of Pleasanton. The Livermore fault trends about N. 40° W. and passes about 1½ miles west of Livermore. This fault appears as a low scarp extending for a distance of about ½ mile between the Pleasanton-Livermore Road and Vallecitos Road. The scarp is west facing and varies in height; it may be as much as 15 feet in places.

The San Francisco Bay area is a depression between the Diablo and the Santa Cruz Ranges. Depressions in this area occur principally along faults near the edge of the basin. The principal structure feature of the San Francisco Bay depression in the Alameda Area is the Hayward fault. Movement along this fault has occurred during historic times. The strongest earthquake caused by movement on the Hayward fault occurred in 1869 and resulted in much damage, including the destruction of Mission San Jose. The fault extends along the foothills of the Diablo Range, generally at their base, adjacent to the San Francisco Bay depression. On the surface, evidences of the fault are numerous and well developed (*7*, *5*).

The Coyote Hills lie between the alluvial and the tideland areas west of Newark. A fairly gentle slope of the bedrock surface beneath the alluvium occurs on the northeastern side of the hills, as determined by log of wells, but such data are lacking for the southwestern side. It is possible that these hills were formed by faults on their southwestern side. The bedrock of the Coyote Hills probably extends along the trend of the hills in a northwest-southeast direction beneath the alluvium.

A distinct relationship exists between the geologic formations, landforms, and soil series (fig. 20). This relationship is shown along a north-south line extending across the Area in the vicinity of Pleasanton.

Agriculture

As industrial and residential developments have spread over Alameda County, the acreage of cultivated crops has been reduced sharply. Along with the reduction of cropland, there has been an increase in pasture in the outlying foothills. Farming, however, is still important in the county and is well diversified and highly efficient. Moreover, the total annual value of agricultural products, both crops and livestock, is currently not far below that of the past.

The greatest emphasis at present is on the production of cut flowers and fresh vegetables for the nearby cities. Among the more important crops are cauliflower, lettuce, tomatoes, cucumbers, and apricots.

In 1959 there were 1,107 farms in Alameda County. The number of farms has decreased steadily since 1940, and the average size of farms has increased. There were 67 farms of 1,000 acres or more in 1959. The census of

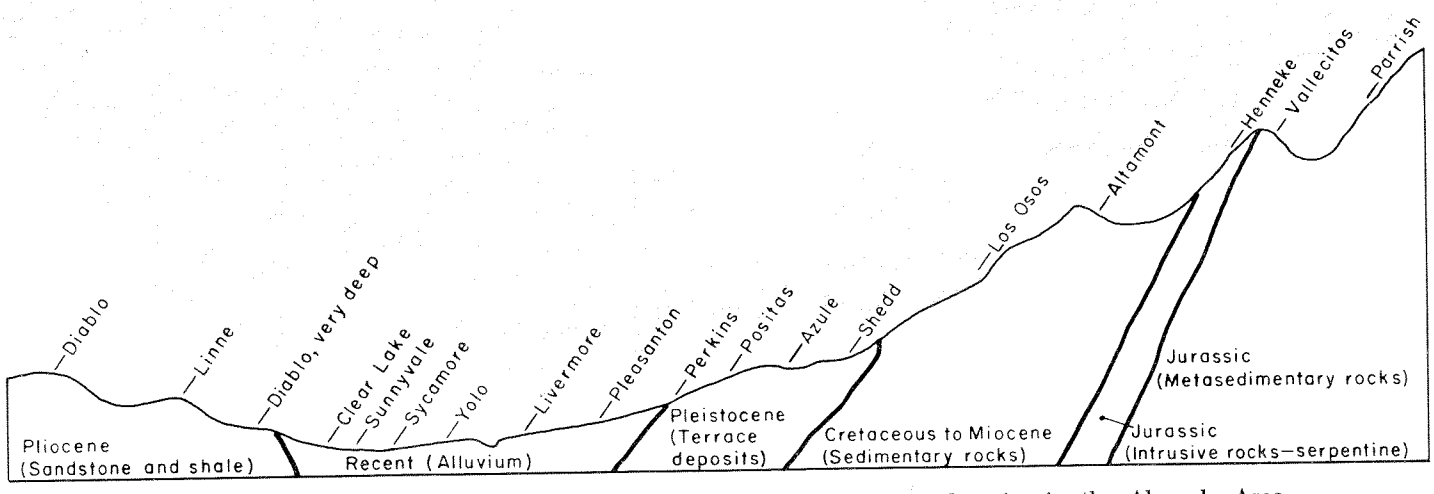

Figure 20.—**The relationship of geologic formations, landforms, and soil series in the Alameda Area.**

agriculture for 1959 lists 550 miscellaneous and unclassified farms. The rest are classified as follows:

Type of farm	*Number of farms*
Cash grain	14
Other field crops	15
Vegetable farms	138
Fruit and nut	95
Poultry farms	85
Dairy farms	24
Livestock farms other than poultry and dairy	168
General farms	18

The acreage of principal crops in Alameda County in 1940, 1950, and 1959 is given in table 16. The acreage of oats, wheat, and hay crops has decreased since 1940. Vegetables and wine grapes were not reported in the census of agriculture in 1940 but showed a large acreage in 1950 and 1959.

TABLE 16.—*Acreage of principal crops in stated years*

Crop	1940 [1]	1950 [2]	1959
	Acres	*Acres*	*Acres*
Oats threshed	143, 166	1, 121	458
Barley threshed	14, 869	16, 504	16, 088
Wheat threshed	3, 712	1, 932	955
Alfalfa hay	3, 842	3, 204	1, 463
Small grain hay	21, 775	29, 312	9, 968
Sugar beets for sugar	4, 348	3, 579	2, 247
Vegetables for sale	([3])	11, 561	14, 137
Wine or juice grapes	([3])	3, 036	2, 062

[1] Partly 1939, partly 1940.
[2] Partly 1949, partly 1950.
[3] Not given in U.S. Census.

The number of livestock on farms in 1940, 1950, and 1959 is given in table 17. The number of hogs and sheep showed an increase in 1959, but the number of milk cows and chickens showed a decrease.

TABLE 17.—*Number of livestock on farms in stated years*

Livestock	1940	1950	1959
Milk cows	8, 644	7, 946	5, 737
Hogs and pigs	4, 209	13, 217	21, 244
Sheep and lambs 6 months old and over	20, 891	10, 176	26, 463
Chickens 4 months and over	445, 395	511, 611	399, 615

History

Alameda County was created in 1853 from parts of Contra Costa and Santa Clara Counties. Its name comes from the Spanish word meaning "grove of poplar trees." As early as 1795, the Spaniards called the southern part of the county Alameda, and the stream running through it Rio de la Alameda. Alameda Creek was mentioned in the California Statutes in 1850, and the name was chosen for the county by popular vote in 1853.

In 1769 members of a land expedition led by Gaspar de Portola discovered San Francisco Bay. At this time a reconnoitering party under Sergeant Ortega was sent to search the "contra costa", or opposite shore, for a land route to Point Reyes, but the rugged topography and hostile natives forced the party to turn back. This area was explored in 1770 by Pedro Fages, and by de Anza in 1776. In 1795 the southern part of the county was visited by Sergeant Pedro Amador, and the same year Father Antonio Danti made preliminary explorations for a mission site and erected a cross on the location of the Mission San Jose de Guadalupe. In June 1797 construction was begun on the San Jose Mission, and by 1831 it had become one of the most prosperous and populous of the California missions.

In 1820 the vast Rancho San Antonio was granted to Don Luis Peralta. This domain extended 5 leagues along the eastern shore of San Francisco Bay on land where the cities of Oakland, Alameda, Berkeley, Albany, Emeryville, Piedmont, and San Leandro are now located. Other large grants, such as the Rancho San Leandro and the Rancho San Lorenzo, were made to Spanish ranchers.

The American occupation in 1847 and the gold rush in 1849 helped advance the settlement of the county. In 1852 Horace Carpenter, Andrew Moon, and Edson Adams, three adventurers who had sailed for California around Cape Horn, staked out tracts where the city of

Oakland is now located. Seventeen years later the first transcontinental train arrived in Oakland. The population of this city increased from 1,543 in 1860 to 10,500 in 1870.

Oakland was the site of the Contra Costa Academy, established in 1853 by the Reverend Henry Durant and incorporated as the College of California in 1855. This property and a 160-acre tract in Berkeley were deeded to the State, which had established the University of California by an act of legislature in 1868. Berkeley was founded by Dr. Samuel Wiley, who named it in honor of the philosopher, Bishop Berkeley.

By 1890 Alameda County had a population of 93,864. In 1960, according to the U.S. Census, the population of Alameda County was 908,209.

Transportation

The bayshore cities of the county are natural terminals for long-distance transportation lines. Three transcontinental railways—the Southern Pacific Lines, the Santa Fe Lines, and the Western Pacific Railroad Company—have terminals directly connected with port facilities, belt-line tracks, and local electric lines. In addition to the truck lines, there are interconnecting tracks to all Pacific Coast cities and to interior valleys.

The port of Oakland has more than 19 miles of deep water frontage, representing an investment of nearly $400 million. Even before World War II, this port served more than 100 steamship lines engaged in coastwise, intercoastal, and foreign trade.

Adjoining the bay and 6 miles south of the center of Oakland is the Metropolitan Oakland International Airport. It occupies more than 1,000 acres. Another 1,000 acres adjacent to the airport is reserved for harbor and airport industrial development. The airport is suitable for major jet aircraft. It is a western terminus of transcontinental airlines and is the central division of West Coast air service. There are seven other airports in the county. Two of these are municipally controlled, two are operated by the military, and three are privately owned.

The San Francisco-Oakland Bay Bridge provides passage for buses, trucks, and private automobiles. The southern part of Alameda County is connected with the cities in San Mateo County and with the coastal highways by way of the San Mateo Bridge and the Dumbarton Bridge, both of which cross the San Francisco Bay. Preliminary engineering studies are under way for a second bay bridge.

Major paved highways branching out in all directions make Alameda County a natural center for bus and truck traffic. These include the transcontinental U.S. Highways Nos. 40 and 50 leading to the San Francisco-Oakland Bay Bridge. Alameda County has 219 miles of State highways and 562 miles of county roads, including 227 miles of primary roads.

Industries

Manufacturing is the principal industry of Alameda County. The plants of nearly 300 nationally known manufacturers are in this area. The volume of business in 1959 amounted to nearly $1 billion.

The food processing industry ranks first in the economy of the county. It employs more than 20,000 workers and disburses $24 million in wages. The major activity of this industry is the canning of fruits, vegetables, and fish. Most of the foods canned are produced outside of Alameda County. The most important items processed include peaches, pears, mixed fruit, apricots, spinach, tomatoes, and potatoes. The wine industry produces a number of table and dessert wines, as well as vermouth and champagne.

The manufacture of machinery provides the second largest payroll. The fabricated metals industry and the transportation equipment industry also account for a large part in the county's economy. More than 100 chemical firms employ 5,000 workers and primary metals production firms employ about the same number. Other important industries are printing and publishing, sand and gravel, glass, paper and allied products, and electrical machinery.

Electric energy for industry is provided by the Pacific Gas and Electric Company through its system of hydroelectric plants and transmission and distribution lines. The supply is supplemented by steam electric-generating plants at key cities.

Natural gas is piped into Alameda County from the Rio Vista gasfield and the Kettleman Hills oilfield, as well as from Texas, New Mexico, and Canada. Fuel oil and gasoline are available from neighboring refineries of four major oil companies.

A twin aqueduct, 93 miles long, brings soft, mountain water from the Sierra Nevada to the East Bay cities.

Descriptions of Soil Profiles

In the following pages are detailed descriptions of a representative profile of the soil series in the Alameda Area that are not described in the section "Formation and Classification of Soils." The location in the Area where each profile was described is given.

Technical terms used in describing the profiles are defined in the Soil Survey Manual (*13*). Letters and numbers at the left designate the horizons in each soil profile. Combinations of letters and numbers in parentheses, such as (10YR 5/4), give the Munsell notation of color in terms of hue, value, and chroma. This notation is more precise than the color name, which is also given. Unless otherwise stated, the description is that of a dry soil. The terminology used to describe soil pores is that proposed by Johnson and others (*8*).

ALTAMONT CLAY: The site described is 750 feet east and 2,250 feet south of the northeast corner of sec. 19, in SE¼SW¼NE¼ sec. 19, T. 2 S., R. 3. E. The soil is used for pasture consisting of annual grasses, but it may have been cultivated in the past.

A11—0 to 7 inches, dark-brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; grayish brown (10YR 5/2) or lighter in the very thin surface crust; strong, coarse, prismatic and strong, coarse and medium, blocky structure; very hard to extremely hard when dry, very firm to extremely firm when moist, very plastic and sticky when wet; many fine roots, which tend to concentrate along structural planes and faces, and which appear flattened or compressed; few extremely fine and very fine, tubular pores; structural faces have very dark brown

to black carbonaceous films and mats in places; slightly acid, pH 6.5; clear, smooth boundary; 4 to 8 inches thick.

A12—7 to 19 inches, brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; moderate, coarse, prismatic and moderate, coarse, blocky structure; very hard when dry, very firm when moist, very plastic and sticky when wet; few fine roots, mostly along structural planes; few extremely fine and very fine, tubular pores; few whitish films of lime on surface of peds in lower part; many slickensides; neutral, pH 6.8; clear, smooth boundary; 8 to 14 inches thick.

A13—19 to 28 inches, brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; moderate, coarse, prismatic and moderate, coarse and medium, blocky structure; very hard when dry, very firm when moist, very plastic and sticky when wet; few fine roots concentrated mainly along structural faces; few extremely fine and very fine, tubular pores; few fine, whitish, soft to slightly hard segregations and films of lime; slightly calcareous, the lime mostly disseminated; many slickensides; mildly alkaline, pH 7.8; clear, smooth boundary; 8 to 14 inches thick.

A14ca—28 to 37 inches, finely mottled dark-brown and dark yellowish-brown (10YR 4/3 and 4/4) clay, dark brown and dark yellowish brown (10YR 3/3 and 4/3) when moist; weak, coarse, prismatic and moderate, medium, blocky structure; very hard when dry, very firm when moist, very plastic and sticky when wet; few fine roots, mostly along structural faces; few extremely fine and very fine, tubular pores; few, soft, fine, yellowish-brown (10YR 5/6 and 5/8) segregations of iron oxide; few, small, embedded fragments of shale; many slickensides; slightly to moderately calcareous; few, fine, whitish, soft to slightly hard segregations and films of lime; mildly alkaline, pH 7.8; clear, smooth boundary; 6 to 12 inches thick.

Cca—37 to 50 inches, yellowish-brown (10YR 5/4) silty clay, dark yellowish-brown (10YR 4/4) when moist; weak, medium, blocky structure; very hard when dry, very firm when moist, plastic and sticky when wet; few fine roots, mostly along structural faces; few extremely fine and very fine, tubular pores; few, small, embedded fragments of shale; few slickensides; moderately calcareous, much disseminated lime and many whitish, soft to slightly hard, embedded segregations and nodules of lime; moderately alkaline, pH 8.0; clear, smooth boundary; 6 to 18 inches thick.

R—50 inches +, olive (5Y 5/3) highly fractured, fine-grained sandstone and shale, darker olive (5Y 4/3) when moist, and light olive-brown (2.5Y 5/4) silty clay loam, olive brown, 2.5Y 4/4) when moist; undecomposed shale increases with depth; shale fragments very slightly calcareous, and have many soft to somewhat hardened, whitish, segregations, nodules, and films of lime in upper part; lime less disseminated and segregated with depth; moderately alkaline, pH 8.0.

Range in characteristics.—The color of the A horizon ranges from brown, dark brown, or light grayish brown to very dark grayish brown. Depth to bedrock ranges from 18 to 60 inches, but in most places it is 36 to 50 inches. Depth to lime ranges from a few inches below the surface to the Cca horizon. In some severely eroded areas, lime is on the surface.

AZULE CLAY LOAM: The site described is in the Valle de San Jose land grant, SE¼SE¼NW¼ sec. 24, T. 4 S., R. 1 E. (projected). The soil is gently rolling to hilly. The slope at this site is 12 percent, is convex, and faces east. The soil is used for pasture.

A1—0 to 6 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; massive or weak, coarse, blocky structure; very hard when dry, firm when moist, plastic and sticky when wet; many fine and very fine roots; many very fine, common fine, and few medium, open, tubular pores; slightly acid, pH 6.5; clear, smooth boundary.

B21t—6 to 12 inches, grayish-brown (10YR 5/2) clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, coarse, prismatic and strong, medium, blocky structure; very hard when dry, very firm when moist, very plastic and slightly sticky when wet; many fine and very fine roots; many very fine and fine, open, tubular pores; common thin clay films on ped faces and in pores; slightly acid, pH 6.5; diffuse, smooth boundary.

B22t—12 to 21 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, coarse, prismatic and moderate, medium, blocky structure; very hard when dry, very firm when moist, very plastic and sticky when wet; many fine and very fine roots; many very fine and fine pores; common, moderately thick clay films on ped faces and in pores; slightly acid, pH 6.5; gradual, irregular boundary.

B3t—21 to 25 inches, mottled grayish-brown (2.5Y 5/2) and light yellowish-brown (2.5Y 6/4) clay, very dark grayish brown (2.5Y 3/2) and light olive brown (2.5Y 5/4) when moist; moderate, coarse, subangular blocky structure; very hard when dry, firm when moist, very plastic and sticky when wet; few very fine roots; many very fine and fine, open tubular pores; common thin clay films on ped faces and in pores; slightly acid, pH 6.5; clear, smooth boundary.

C—25 inches +, light yellowish-brown (2.5Y 6/4) gravelly clay loam, light olive brown (2.5Y 5/4) when moist; massive; very hard when dry, firm when moist, plastic and sticky when wet; few very fine roots; common fine and very fine pores; few thin clay films in pores.

Range in characteristics.—The A horizon ranges from 6 to 18 inches in thickness and from grayish brown, gray, or dark gray to very dark gray in color. The texture of this horizon ranges from silt loam to light clay. The B22t horizon ranges from dark grayish brown to grayish brown in color. Clay films in this horizon are thick and continuous in places. There are a few slickensides in the B horizon. The C horizon ranges from light yellowish brown or yellowish brown to light olive brown in color and from gravelly clay loam to silty clay in texture. Some very dark brown stains occur along old root channels. This horizon is slightly calcareous in some places. In a few small areas that have concave relief, the C horizon has many olive and olive brown mottles. Very fine, smooth, well-rounded, quartz pebbles occur throughout the solum.

CLEAR LAKE CLAY, DRAINED: The site described is 200 feet north of the junction of North Livermore Avenue and Hartford Avenue and west of North Livermore Avenue in a field used for dry-farmed grain.

Ap—0 to 8 inches, dark-gray (N 4/0) clay, black (10YR 2/1) when moist; strong, coarse, prismatic structure that breaks to moderate, medium, blocky structure; very hard when dry, very firm when moist, very plastic and sticky when wet; many fine and very fine roots; common, medium, tubular pores and many fine, tubular pores; slightly acid, pH 6.5; clear, wavy boundary.

A11—8 to 23 inches, faintly mottled dark-gray (N 4/0) and (10YR 4/1) clay, black (10YR 2/1) and very dark gray (10YR 3/1) when moist; strong, coarse, prismatic structure that breaks to moderate, medium, blocky; very hard when dry, very firm when moist, very plastic and sticky when wet; many fine and very fine roots; many very fine, tubular pores in peds and along ped faces; many slickensides; neutral, pH 7.0; clear, wavy boundary.

A12ca—23 to 36 inches, clay, very dark gray (10YR 3/1) when dry or moist; strong, coarse, prismatic structure that breaks to moderate, medium, blocky; extremely hard when dry, very firm when moist, very plastic and sticky when wet; many fine and few very fine roots; few fine

and very fine, tubular roots in peds and along ped faces; many slickensides; strongly calcareous; light-gray, irregular, medium concretions of lime; moderately alkaline, pH 8.0; clear, wavy boundary.

ACca—36 to 48 inches, dark-gray (10YR 4/1) clay, very dark brown (10YR 2/2) when moist; weak, coarse, prismatic structure that breaks to moderate, medium, blocky; very hard when dry, firm when moist, very plastic and sticky when wet; few fine and very fine roots; few coarse, common fine and few very fine, tubular pores; few slickensides; slightly calcareous matrix with medium, irregular, light-gray nodules of lime; many seams of gypsum; moderately alkaline, pH 8.0; clear, wavy boundary.

C1ca—48 to 50 inches, dark grayish-brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, blocky structure; very hard when dry, firm when moist, plastic and sticky when wet; few very fine roots; common fine, and few very fine, continuous, open tubular pores; strongly calcareous; irregular medium nodules of lime; moderately alkaline, pH 8.0; clear, wavy boundary.

C2ca—50 to 65 inches, light olive-brown (2.5Y 5/4) silty clay, olive brown (2.5Y 4/4) when moist; moderate, medium, subangular blocky structure; very hard when dry, friable when moist, plastic and sticky when wet; few very fine roots; common fine and few very fine, continuous open, tubular pores; strongly calcareous; moderately alkaline, pH 8.0.

Range in characteristics.—The Ap horizon ranges in color from dark gray to very dark gray. The surface soil is strongly calcareous in some places. The C horizon ranges from light yellowish brown to light olive brown and olive brown. In some small valleys, this soil has an overwash of 12 to 18 inches of very dark grayish-brown noncalcareous silty clay or light-gray calcareous clay loam.

Diablo Clay, Very Deep: The site described is 4,800 feet east of California State Highway No. 17, 3,200 feet north of the Alameda County line, and 1.7 miles southeast of Warm Springs. The slope at this site is 16 percent, is convex, and faces west. This soil is used for range.

A11—0 to 5 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; strong, coarse, prismatic and strong, coarse and medium, blocky structure; extremely hard when dry, very firm when moist, plastic and sticky when wet; many very fine and fine roots; common very fine, and few fine, tubular pores; few slickensides; mildly alkaline, pH 7.5; gradual, wavy boundary.

A12ca—5 to 13 inches, finely mottled very dark gray (10YR 3/1) and light brownish-gray (2.5Y 6/2) silty clay, black (10YR 2/1) and dark grayish brown (2.5Y 4/2) when moist; strong, coarse, prismatic and strong, coarse and medium, blocky structure; extremely hard when dry, very firm when moist, sticky and plastic when wet; many very fine and fine roots; common, very fine, and few fine, tubular pores; common slickensides; calcareous; soft light-gray nodules of lime; moderately alkaline, pH 8.0; clear, irregular boundary.

ACca—13 to 27 inches, finely mottled very dark gray (10YR 3/1) and light olive-brown (2.5Y 5/4) clay, black (10YR 2/1) and olive brown (2.5Y 4/4) when moist; medium, coarse, prismatic and moderate, coarse and medium, blocky structure; very hard when dry, very firm when moist, very plastic and sticky when wet; many very fine and few fine roots; few very fine and fine, tubular pores; common slickensides; calcareous; light-gray, soft nodules of lime; moderately alkaline, pH 8.0; diffuse wavy boundary.

Cca—27 to 60 inches +, light yellowish-brown (2.5Y 6/4) silty clay, light olive brown (2.5Y 5/4) when moist; weak, medium and fine, blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; few very fine roots; common, fine and very fine, tubular pores; white seams of lime; moderately alkaline, pH 8.0.

Range in characteristics.—In some places the color of the A horizon is gray to very dark gray. In other places it is very dark grayish brown (10YR 3/2). In areas transitional from this soil to the Linne soils, the surface is slightly calcareous. In some areas transitional from this soil to the Azule soils, a weak B2t horizon is present. Depth to the Cca horizon ranges from 18 to 50 inches.

Henneke Rocky Loam, Eroded: The site described is 2,200 feet east and 1,600 feet north of the southeast corner of sec. 8, T. 5 S., R. 4 E., in cut on the road to Pointers Lodge. The cover is chamise, ceanothus, manzanita, and scattered bunches of needlegrass. The slope is 55 percent, faces south, and is convex. Typically, the soil is moderately eroded, but in many places it is severely eroded.

A1—0 to 7 inches, dark reddish-brown (5YR 3/2) loam, very dusky red (2.5YR 2/2) when moist; massive; slightly hard when dry, friable when moist, slightly sticky when wet; few coarse, medium and fine roots; few medium and common fine and very fine pores; moderately alkaline, pH 8.0; clear, wavy boundary.

B2t—7 to 15 inches, dark reddish-brown (5YR 3/2) light clay loam; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly plastic and slightly sticky when wet; few coarse and medium roots and many very fine roots; few coarse and many fine and very fine pores; common moderately thick clay films on ped faces and in pores; moderately alkaline, pH 8.0; many fine angular fragments of serpentine; clear, wavy boundary.

R—15 inches +, weathered serpentine.

Range in characteristics.—The color of the A horizon ranges from dark reddish brown or reddish brown to dark brown. The color of the B horizon has a similar range. The texture of the B horizon ranges from light clay loam to light clay. The pH ranges from neutral to moderately alkaline. Depth to serpentine ranges from a few inches to 48 inches.

Linne Clay Loam: The site described is in the NW¼SW¼NE¼ sec. 1, R. 1 E., T. 3 S., in a cut along the Patterson Pass Road. The slope at this site is 16 percent, is convex, and faces south. The soil was moist when the profile was examined.

A11ca—0 to 12 inches, dark-gray (10YR 4/1) clay loam, very dark grayish brown (10YR 3/2) when moist; strong, very fine, granular structure; slightly hard when dry, very friable when moist, sticky and slightly plastic when wet; many very fine roots; many fine, interstitial pores and common fine, tubular pores; strongly calcareous; disseminated lime and fine, irregular concretions of lime; moderately alkaline, pH 8.0; gradual, wavy boundary; 8 to 14 inches thick.

A12ca—12 to 19 inches, this horizon is similar to horizon above but it has more lime concretions.

A13ca—19 to 36 inches, dark-gray (10YR 4/1) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, blocky structure; slightly hard when dry, very friable when moist, sticky and slightly plastic when wet; many fine roots; many fine interstitial pores, common fine pores, and few medium pores; strongly calcareous; disseminated lime and irregular nodules and filaments of lime; moderately alkaline, pH 8.0; abrupt, smooth boundary; 12 to 30 inches thick.

R—36 inches +, light-gray (5Y 7/2) sandstone; accumulation of white lime along cleavage planes.

Range in characteristics.—The texture of the surface layer ranges from loam to silty clay. The coarser tex-

tured areas are typically grayish brown and have scattered outcrops of sandstone. The silty clay areas are generally dark gray and have some slickensides in the lower part of the profile. Where it developed on shale, this soil has an olive-brown Cca horizon 12 to 24 inches thick. The lime is leached from the surface in some places. The amount of lime varies, but lime nodules occur throughout the profile. Depth to bedrock ranges from 10 to 50 inches.

LIVERMORE VERY GRAVELLY COARSE SANDY LOAM: The site described is in the NW¼NE¼SW¼ sec. 23, T. 3 S., R. 2 E., in a vineyard on the Raboil Ranch. The slope at this site is 1 percent, is convex, and faces northwest.

Ap1—0 to 4 inches, brown (10YR 5/3) very gravelly coarse sandy loam, dark brown (10YR 3/3) when moist; weak, very fine, granular structure; soft when dry, and friable when moist; slightly acid, pH 6.4; diffuse, smooth boundary; 4 to 6 inches thick.

Ap2—4 to 12 inches, dark grayish-brown (10YR 4/2) very gravelly coarse sandy loam, very dark grayish brown (10YR 3/2) when moist; massive; slightly hard when dry, friable when moist, slightly sticky when wet; many fine and very fine roots; many fine and very fine pores; neutral, pH 6.7; diffuse, smooth boundary; 4 to 8 inches thick.

A3—12 to 21 inches, dark grayish-brown (10YR 4/2) very gravelly coarse sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist, slightly sticky when wet; many fine and very fine roots; many fine and very fine pores; neutral, pH 6.8; diffuse, smooth boundary; 8 to 12 inches thick.

B21t—21 to 28 inches, brown (10YR 5/3) very gravelly coarse sandy loam, dark brown (10YR 3/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; many fine and very fine pores, mainly interstitial; few, thin, discontinuous clay films in pores; neutral, pH 7.0; diffuse, smooth boundary; 5 to 10 inches thick.

B22t—28 to 34 inches, brown (10YR 5/3) very gravelly coarse sandy loam, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine roots; many, fine and very fine, interstitial pores; very thin, nearly continuous clay films in pores; most of the colloids in bridges; neutral, pH 7.1; diffuse, smooth boundary; 4 to 6 inches thick.

IIC—34 to 60 inches, brown (10YR 5/3) very gravelly loamy coarse sand, dark brown (10YR 4/3) when moist; massive; slightly hard when dry, friable when moist, nonsticky when wet; few fine roots; many fine and very fine pores; small amount of colloids occurs in bridges between sand grains and stains the sand and gravel; neutral, pH 7.1; 10 to 20 inches thick.

Range in characteristics.—The texture of the A horizon ranges from very gravelly sandy loam or very gravelly loam to gravelly loam. The percentage of gravel, by volume, ranges from 40 to 75; some cobbles and stones occur throughout the profile. In places where this soil intergrades toward the Pleasanton soils, the B2t horizon is more distinct; clay films are continuous, and the textural gradation from the A horizon to the B2t horizon is greater. In places transitional from this soil to the Yolo soils, the B2t horizon is less distinct or almost nonexistent; clay films are very thin and patchy, and there is little textural difference between the A horizon and the B2 horizon. The color throughout the profile is ½ to 1 unit darker in value and 1 unit less in chroma. In some places the IIC horizon consists of loose, open gravel and loamy sand.

LOBITOS SHALY LOAM: The site described is on Vargas Ranch, NW¼SW¼NW¼NW¼ sec. 24, T. 4 S., R. 1 W., 400 feet northwest of Morrison Canyon Road. The cover is annual grasses and some oaks. The slope is 35 percent.

A1—0 to 14 inches, grayish-brown (10YR 5/2) shaly loam, very dark grayish brown (10YR 3/2) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; many fine and very fine roots; common medium and few fine pores; strongly acid, pH 5.5; gradual, smooth boundary.

B1—14 to 24 inches, pinkish-gray (7.5YR 6/2) shaly loam, dark brown (7.5YR 4/2) when moist; massive or weak, granular structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine and very fine roots; common medium and few fine pores; very few clay films in pores; strongly acid, pH 5.5; gradual, smooth boundary.

B2t—24 to 38 inches, pinkish-gray (7.5YR 6/2) shaly light clay loam, dark brown (7.5YR 4/2) when moist; massive or weak, granular structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few fine and few very fine roots; very few or few clay films in pores; strongly acid, pH 5.5; gradual, wavy boundary.

R—38 inches +, pinkish-gray (7.5YR 6/2) highly shattered diatomaceous shale.

Range in characteristics.—In some shallow areas the B horizons are absent. In the deeper areas, the B2t horizon is clay loam or light clay. Depth to the R horizon varies widely in short distances. Outcrops of shale are flush with the surface in places and occur mostly on the edge of slope breaks.

LOS GATOS LOAM: The site described is in the SE¼ SE¼SW¼SW¼ sec. 3, T. 4 S., R. 2 E. (projected) [5] in a road cut. Erosion is slight, and the soil is in pasture that is in good condition. The slope at this site is 35 percent; it is convex and faces east. The soil was moist when the profile was examined.

A11—0 to 5 inches, dark-brown (10YR 4/3) light loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many very fine roots; few, fine and very fine, interstitial pores; neutral, pH 6.7; clear, smooth boundary.

A12—5 to 11 inches, dark-brown (10YR 4/3) loam, dark brown (7.5YR 3/2) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many very fine roots; few, medium and fine, tubular pores and many, very fine, tubular pores; many, very fine, interstitial pores; neutral, pH 6.7; gradual, smooth boundary.

B1—11 to 19 inches, dark-brown (10YR 4/3) loam, dark brown (7.5YR 3/2) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many very fine, few fine, and few medium roots; few, medium and fine, tubular pores and many, very fine, tubular pores; many, very fine, interstitial pores; many discontinuous clay films in pores; neutral, pH 6.7; gradual, smooth boundary.

B2t—19 to 32 inches, reddish-brown (5YR 5/4) heavy loam, dark reddish brown (5Y 3/4) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many very fine, few fine, and few medium roots; few medium and fine, and many very fine, tubular pores; many very fine, interstitial pores; continuous clay films in pores; neutral, pH 6.7; gradual, smooth boundary.

[5] Section lines from map by U.S. Geological Survey were projected to the site, which is in an old Spanish land grant.

B3t—32 to 42 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 4/5) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; few very fine, fine, and medium roots; many, very fine, tubular and interstitial pores; slightly acid, pH 6.5; hard sandstone fragments, 25 percent, by volume; gradual, irregular boundary.

R—42 inches +, very pale brown (10YR 7/4) shattered sandstone.

Range in characteristics.—The A horizon ranges in color from brown or dark brown to dark reddish brown. The B2t horizon ranges in color from reddish brown to dark reddish brown. Some areas have a yellowish-brown C horizon that ranges from a few inches to 20 inches in thickness.

About 1 mile south of Lake Chabot there is a small area mapped with this soil that developed from intrusive gabbro rock. The soil in this area typically has a dusky-red, friable, clay loam A horizon. The B horizon is dark reddish brown, clayey, and slightly acid to neutral.

Los Osos Silty Clay Loam: The site described is 40 feet east and 120 feet south of the northwest corner of sec. 19, T. 2 S., R. 1 W. (projected). The slope is 30 percent; it is convex and faces south.

A1—0 to 8 inches, grayish-brown (10YR 5/2) light silty clay loam, very dark grayish brown (2.5Y 3/2) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; few medium, and many fine and very fine roots; few medium and common very fine pores; few worm casts; medium acid, pH 6.0; clear, wavy boundary.

B21t—8 to 24 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, blocky structure; hard when dry, friable when moist, sticky and plastic when wet; few fine, and many very fine roots; few medium and common very fine pores; many moderately thick clay films on ped faces; slightly acid, pH 6.5; gradual, wavy boundary.

B22t—24 to 30 inches, dark grayish-brown (10YR 4/2) silty clay loam, dark brown (10YR 3/3) when moist; moderate medium, blocky structure; hard when dry, friable when moist, sticky and plastic when wet; few fine and many very fine roots; few medium, few fine, and common very fine pores; common thin clay films in pores and on ped faces; slightly acid, pH 6.5; clear, irregular boundary.

R—30 inches +, pale-olive shale.

Range in characteristics.—The A horizon ranges from 8 to 18 inches in thickness and from silty clay loam to clay loam in texture. The color ranges mainly from grayish brown to dark grayish brown, but in a few places it is light brownish gray. The B2t horizon ranges from 14 to 24 inches in thickness and from silty clay loam to clay in texture. The color ranges from dark grayish brown to dark yellowish brown. Development in this horizon ranges from weak to moderate. In areas where development is weak, the clay films are thin and patchy.

Los Osos Loam, Seeped Variant: The site described is 1 mile south of Fairview Road in NE¼SE¼NE¼ sec. 30, T. 3 S., R. 1 W. in a pasture that formerly had been cultivated. The slope is 7 percent; it is slightly convex and faces west. The soil was dry below a depth of 20 inches when the profile was examined.

Ap—0 to 7 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, very fine, granular structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many very fine roots; many very fine pores; medium acid, pH 6.0; clear, smooth boundary; 5 to 8 inches thick.

A11—7 to 14 inches, loam that is similar in color to that of horizon above; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many very fine roots; many very fine, common fine, and very few medium pores; medium acid, pH 6.0; gradual, smooth boundary; 5 to 10 inches thick.

A12—14 to 20 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; few, fine, faint, dark yellowish-brown (10YR 4/4) mottles; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; common fine roots; many very fine pores; medium acid, pH 6.0; gradual, smooth boundary; 4 to 8 inches thick.

B21t—20 to 30 inches, pale-brown (10YR 6/3) light sandy clay loam, brown (10YR 5/3) when moist; many, coarse, distinct, light yellowish-brown (10YR 6/4) mottles, yellowish brown (10YR 5/5) when moist; massive; very hard when dry, friable when moist, sticky and plastic when wet; common fine roots; many very fine pores; thin, continuous clay films in tubular pores; medium acid, pH 6.0; gradual, smooth boundary; 8 to 14 inches thick.

B22t—30 to 41 inches, light brownish-gray (10YR 6/2) sandy clay loam; brown (10YR 5/3) when moist; many, coarse, distinct, yellowish-brown (10YR 5/4) mottles; massive; very hard when dry, friable when moist, sticky and plastic when wet; few very fine roots; many very fine pores; common, moderately thick, continuous clay films in pores; colloids mainly in bridges; strongly acid, pH 5.5; clear, smooth boundary; 8 to 14 inches thick.

R—41 inches +, yellowish-brown (10YR 5/4) sandstone.

Range in characteristics.—The texture of the surface layer ranges from fine sandy loam to silt loam. The color of the A1 horizon ranges from dark gray, gray, or grayish brown to brown. In areas transitional from this soil to the well-drained Gaviota and Los Osos soils, the A horizon is not mottled, and mottles in the B2t horizon are few and faint. In some areas the C horizon has prominent mottles. Depth to bedrock generally ranges from 36 to 72 inches, but in a few places bedrock crops out.

Millsholm Silt Loam: The site described is near the junction of Palomares and Stonybrook Roads in the SE¼SE¼NE¼ sec. 28, T. 3 S., R. 1 W. The slope is 25 percent; it is convex and faces southwest. This soil is used for pasture.

A1—0 to 7 inches, olive (5Y 5/3) silt loam, olive brown (2.5Y 4/3) when moist; massive; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many very fine roots; many very fine pores; few worm casts; medium acid, pH 6.0; clear, smooth boundary; 4 to 8 inches thick.

B21—7 to 14 inches, light olive-brown (2.5Y 5/3) heavy silt loam, olive brown (2.5Y 3/3) when moist; massive; very hard when dry, friable when moist, slightly plastic and slightly sticky when wet; many very fine roots; many very fine pores; few, thin, discontinuous clay films in pores; medium acid, pH 5.7; clear, smooth boundary; 6 to 10 inches thick.

B22—14 to 22 inches, light olive-brown (2.5Y 5/3) heavy silt loam, olive brown (2.5Y 4/3) when moist; massive; very hard when dry, firm when moist, plastic and sticky when wet; many fine roots; many very fine pores; many, thin, continuous clay films in pores; medium acid, pH 5.7; clear, smooth boundary; 6 to 12 inches thick.

R—22 inches +, grayish-brown (2.5Y 5/2) shale, dark grayish brown (2.5Y 4/2) when moist; some tongues of the B22 horizon in cracks.

Range in characteristics.—The texture of the A horizon ranges from loam or silt loam to light clay loam. The color ranges from olive brown or light brownish gray to dark grayish brown. The texture of the B2 horizon ranges from silt loam to clay loam; the color ranges from light olive brown or brown to yellowish brown. In small areas on toe slopes, this horizon is more strongly developed than typical and is strong-brown or reddish-brown clay.

PARRISH GRAVELLY LOAM: The site described is in the SW¼SE¼SE¼ sec. 17, T. 5 S., R. 4 E. (1,000 feet east and 400 feet north of the southeast corner of sec. 17). The slope at this site is 20 percent; it is convex and faces west by northwest. This soil is steep and has a few outcrops of rock. The present cover is annual grasses and oaks.

O1—¼ inch to 0, litter of partly decomposed oak leaves and grasses.

A11—0 to 2 inches, dark-brown (10YR 4/3) gravelly loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; many fine roots; many fine and common very fine pores; slightly acid, pH 6.5; gradual, wavy boundary.

A12—2 to 13 inches, dark-brown (7.5YR 4/4) gravelly light clay loam, dark brown (7.5YR 3/2) when moist; weak, medium, granular structure; hard when dry, friable when moist, slightly sticky and plastic when wet; many fine roots; common fine and few very fine pores; medium acid, pH 6.0; clear, wavy boundary.

B1—13 to 16 inches, yellowish-red (5YR 5/6) gravelly clay loam, yellowish red (5YR 4/6) when moist; weak, fine, subangular blocky structure; hard when dry, firm when moist, slightly sticky and plastic when wet; few fine and very fine roots; few fine and very fine pores; medium acid; diffuse, wavy boundary.

B2t—16 to 33 inches, yellowish-red (5YR 5/6) gritty clay, yellowish red (5YR 4/6) when moist; weak, fine, subangular blocky structure; very hard when dry, firm when moist, slightly sticky and plastic when wet; few fine roots; common fine pores; common moderately thick clay films on ped faces; strongly acid, pH 5.5; clear, irregular boundary.

B3t—33 to 36 inches, brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) when moist; weak, fine, subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; few fine roots; common fine and few very fine pores; common moderately thick clay films; very strongly acid, pH 4.5; clear, irregular boundary.

R—36 inches +, shattered shale that has clay films along cleavage planes.

Range in characteristics.—In some areas the A horizon is reddish brown (5YR 4/3). Also, in some areas the B2t horizon is medium acid. The depth to bedrock ranges from 12 to 48 inches but typically is between 18 and 36 inches.

PERKINS LOAM: The site described is 1,550 feet south and 550 feet west of the northeast corner of section 19, T. 3 S, R. 2 E. The slope is 1 percent; it faces west and is slightly convex. The present cover consists of annual grasses.

A1—0 to 10 inches, pale-brown (10YR 6/3) loam, dark brown (10YR 4/3) when moist; massive; hard when dry, friable when moist, slightly plastic and slightly sticky when wet; few very fine roots and many fine roots; few, medium, tubular pores and many, fine and very fine, tubular pores; medium acid, pH 6.0; gradual, smooth boundary.

B21t—10 to 15 inches, light yellowish-brown (10YR 6/4) silt loam, dark brown (7.5YR 4/4) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist, slightly plastic and sticky when wet; few very fine and many fine roots; many, fine and very fine, tubular pores; common thin clay films in pores and on ped faces; slightly acid, pH 6.5; clear, smooth boundary.

B2t—15 to 33 inches, yellowish-brown (10YR 5/4) gravelly clay loam with brown (7.5YR 5/4) coatings, dark brown (7.5YR 4/4) when moist; moderate, medium, blocky structure; very hard when dry, firm when moist, plastic and sticky when wet; few very fine roots; few, fine, and many, very fine, tubular pores; many moderately thick clay films in pores and on ped faces; slightly acid, pH 6.5; gradual, wavy boundary.

B3t—33 to 55 inches, brown (7.5YR 5/4) very gravelly clay loam, dark brown (7.5YR 4/4) when moist; moderate, medium, blocky structure; hard when dry, firm when moist, plastic and slightly sticky when wet; very fine roots; few fine and common very fine pores; continuous moderately thick clay films in pores and on ped faces; mildly alkaline, pH 7.5; gradual, wavy boundary.

B32t—55 to 65 inches, brown (7.5YR 5/4) very gravelly clay loam, reddish brown (5YR 4/4) when moist; weak, medium, blocky structure; hard when dry, firm when moist, plastic and slightly sticky when wet; few very fine pores; continuous moderately thick clay films and few thick clay films on ped faces; mildly alkaline, pH 7.5.

Range in characteristics.—The B2t horizon is reddish brown in areas transitional from this soil to Positas soils. The B31t and B32t horizons range from very gravelly to gravelly. The C horizon ranges from reddish brown to yellowish brown in color and from very gravelly clay loam to gravelly loam in texture.

PESCADERO CLAY: The site described is 150 feet south of Hartford Avenue and 0.7 mile east of the junction of North Livermore and Hartford Avenues. The soil is used for pasture consisting of grasses but may have been cultivated in the past. The slope at this site is 1 percent. The soil was dry to a depth of 20 inches when the profile was examined.

A2—0 to 2 inches, gray (10YR 5/1) clay loam, dark-gray (10YR 4/1) when moist; platy structure; hard when dry, friable when moist, sticky and plastic when wet; slightly acid, pH 6.5; clear boundary; 1 to 3 inches thick.

B21t—2 to 12 inches, dark-gray (N 4/0) clay, very dark gray (N 3/0) when moist; moderate, medium, prismatic structure; very hard when dry, firm when moist, slightly sticky and plastic when wet; moderately alkaline, pH 8.0; gradual boundary; 8 to 12 inches thick.

B22t—12 to 20 inches, dark-gray (10YR 4/1) clay, black (10YR 2/1) when moist; moderate, medium, prismatic structure; very hard when dry, firm when moist, slightly sticky and plastic when wet; slightly calcareous; moderately alkaline, pH 8.0; gradual boundary; 6 to 12 inches thick.

C1ca—20 to 30 inches, light-gray (5Y 7/1) clay, gray (5Y 5/1) when moist; massive; very hard when dry, firm when moist, slightly sticky and plastic when wet; strongly calcareous; moderately alkaline, pH 8.0; gradual boundary; 8 to 16 inches thick.

C2ca—30 to 40 inches, gray (5Y 6/1) clay loam, gray (5Y 5/1) when moist; massive; very hard when dry, slightly sticky and plastic when wet; lime in matrix and in concretions; moderately alkaline, pH 8.0; 8 to 12 inches thick.

C3ca—40 to 58 inches, light olive-gray (5Y 6/2) clay loam, olive-gray (5Y 5/2) when moist; massive; very hard when dry, firm when moist, slightly sticky and plastic when wet; lime in matrix and in concretions; moderately alkaline, pH 8.0; 12 to 24 inches thick.

C4ca—58 to 72 inches, light-gray (5Y 7/2) clay loam, light olive-gray (5Y 5/2) when moist; massive; hard when dry, firm when moist, slightly sticky and plastic when wet; many concretions of lime; moderately alkaline, pH 8.0.

Range in characteristics.—On hummocks the A horizon is dark-gray clay loam from 4 to 8 inches thick.

POSITAS GRAVELLY LOAM: The site described is in a field 216 feet west of Greenville Road and 168 feet south of the northeast corner of sec. 25, T. 3 S., R. 2 E. The soil is used for pasture consisting of annual grasses, but it was formerly cultivated. The slope is 4 percent; it is slightly convex and faces southwest.

Ap—0 to 8 inches, brown (10YR 5/3) gravelly loam, dark brown (7.5YR 3/2) when moist; mostly massive but upper part has weak horizontal cleavage; hard when dry, friable when moist; many fine roots; many fine pores; medium acid, pH 5.9; abrupt, smooth boundary; 6 to 8 inches thick.

A2—8 to 11 inches, this horizon is similar to the Ap horizon in all respects except colors, which are nearly 1/2 chip lighter in value; medium acid, pH 5.8; abrupt, smooth boundary; 2 to 4 inches thick.

B21t—11 to 20 inches, dark reddish-gray (5YR 4/2) clay, dark reddish brown (5YR 3/3) when moist; strong, coarse, prismatic structure; extremely hard when dry, extremely firm when moist, very plastic and sticky when wet; few fine roots along structural faces; few, fine, tubular pores; thick, continuous clay films on ped faces; colloids nearly fill pores; common slickensides; medium acid, pH 6.0; gradual, smooth boundary; 6 to 12 inches thick.

B22t—20 to 29 inches, reddish-brown clay, (5YR 4/4) when dry or moist; strong, coarse, prismatic structure; similar to B21t horizon but has less clay; mildly alkaline, pH 7.4; abrupt, smooth boundary; 6 to 12 inches thick.

B31t—29 to 39 inches, brown (7.5YR 5/5) heavy loam, dark brown (7.5YR 4/4) and yellowish red (5YR 4/6) when moist; many yellowish-red (5YR 5/5) coatings and common, fine, black stains 1 to 2 millimeters across; strong, medium, blocky structure; very hard when dry, firm when moist, plastic and sticky when wet; few fine roots; few, fine, tubular pores; moderately thick continuous clay films on ped faces and in pores; moderately alkaline, pH 7.9; very weakly calcareous; gradual, smooth boundary; 8 to 14 inches thick.

B32t—39 to 54 inches, light yellowish-brown (10YR 6/5) heavy loam, yellowish brown (10YR 5/4) and yellowish red (5YR 4/6) when moist; few yellowish-red (5YR 4/6) coatings and common, fine, black stains; strong, medium, blocky structure; very hard when dry, firm when moist, sticky and slightly plastic when wet; few fine roots; few, fine, tubular pores; moderately thick continuous clay films on ped faces and in pores; moderately alkaline, pH 8.0; very weakly calcareous; gradual, smooth boundary; 12 to 18 inches thick.

IIC—54 inches +, light yellowish-brown (10YR 6/5) gravelly light sandy clay loam with a few yellowish-red (5YR 4/6) coatings when dry, yellowish brown (10YR 5/4) with yellowish-red (5YR 4/6) coatings when moist; massive; slightly hard when dry, friable when moist; contains about 1 percent, by volume, of stones more than 3 inches across and about 15 percent of stones 1 to 3 inches across; mildly alkaline, pH 7.7.

Range in characteristics.—The A2 horizon looks like a degraded B2t horizon in places, and has some clay films on small, angular blocks. Thickness of the A horizon ranges from 8 to 20 inches. The color ranges from brown or grayish brown to dark grayish brown. Texture of the surface layer ranges from gravelly sandy loam or gravelly loam to loam. Some areas have coarse gravel or cobbles throughout the profile. Although the A horizon is predominantly brown (5YR), in some areas it is reddish brown. In places where this soil intergrades toward the Perkins soils, the B2t horizon is coarser textured (light clay), clay films are thinner, colloidal filling of pores is less common, and the color may be browner (7.5YR). The C horizon ranges from yellowish colored silt to yellowish-brown gravelly loam sediment.

RINCON CLAY LOAM: The site described is 150 feet west of Mountain House Road between Mountain House School and an east-west dirt road in the SE¼SE¼SE¼ NW¼ sec. 6, T. 2 S., R. 4 E. The slope at this site is less than 1 percent, and the cover consists of annual grasses.

Ap—0 to 8 inches, grayish-brown (10YR 5/2) clay loam, dark brown (10YR 3/3) when moist; massive; very hard when dry, friable when moist, plastic and sticky when wet; few medium, many fine, and few very fine roots; few medium, common fine, and few very fine, tubular pores; neutral, pH 7.0; clear, smooth boundary.

A1—8 to 16 inches, dark grayish-brown (10YR 4/2) clay loam, dark brown (10YR 3/3) when moist; massive; very hard when dry, friable when moist, plastic and sticky when wet; many fine and very fine roots; common, fine and very fine, tubular pores; neutral, pH 7.0; abrupt, smooth boundary.

B1t—16 to 28 inches, dark grayish-brown (10YR 4/2) heavy clay loam, dark brown (10YR 3/3) when moist; weak, coarse, blocky structure; very hard when dry, friable when moist, plastic and sticky when wet; many fine and very fine roots; many, fine and very fine, tubular pores; few thin clay films on ped faces and in pores; neutral, pH 7.0; gradual, wavy boundary.

B21t—28 to 38 inches, brown (10YR 5/3) and grayish-brown (10YR 5/2) light clay, dark brown (10YR 4/3) and dark grayish brown (10YR 4/2) when moist; moderate, coarse, blocky structure; extremely hard when dry, firm when moist, very plastic and sticky when wet; few fine and many very fine roots; common fine and very fine, tubular pores; common thin clay films in pores and on ped faces; neutral, pH 7.0; gradual, wavy boundary.

B22t—38 to 52 inches, brown (10YR 5/3) clay, dark brown (10YR 4/3) when moist; moderate, medium, blocky structure; extremely hard when dry, very firm when moist, and sticky when wet; few fine and very fine roots; common fine and very fine, tubular pores; common thin and few moderately thick clay films on ped faces and in pores; mildly alkaline, pH 7.5; gradual, wavy boundary.

B3tca—52 to 60 inches, yellowish-brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) when moist; moderate, medium, blocky structure; extremely hard when dry, very firm when moist, very plastic and slightly sticky when wet; few very fine roots; common fine and very fine pores; many moderately thick clay films in pores and on ped faces; moderately alkaline, pH 8.0; seams of lime; tongues of material from the horizon above.

Range in characteristics.—Because of land leveling, the Ap horizon consists of fill material. The color of the A horizon ranges from dark gray, grayish brown, or dark brown to brown. The texture of this horizon is light clay loam or heavy clay loam. The B horizons range from dark grayish brown to brown in color, and the C horizon ranges from pale brown to yellowish brown. The B3tca horizon ranges from mildly calcareous to strongly calcareous. Lime occurs in seams, as disseminated lime, and as nodules. In areas transitional from this soil to the San Ysidro soils, the B2t horizon is more strongly developed. Very fine manganese concretions occur throughout the profile but increase in number with depth.

SAN YSIDRO LOAM: The site described is 950 feet east and 1,200 feet south of the northeast corner of sec. 36, T. 2 S., R. 2 E. The slope is less than 1 percent and slightly convex. The vegetation consists of annual grasses and tarweeds.

Ap—0 to 6 inches, pale-brown (10YR 6/3) loam, dark brown (10YR 3/3) when moist; massive; hard when dry and slightly plastic and slightly sticky when wet; many very fine and few fine roots; few medium and many very fine and fine, tubular pores; medium acid, pH 6.0; clear, wavy boundary.

A11—6 to 9 inches, faintly mottled pale-brown (10YR 6/3) and brown (10YR 5/3) silt loam, dark brown (10YR 3/3) when moist; massive; hard when dry, friable when moist, slightly plastic and sticky when wet; many very fine and few fine roots; few medium and many fine and very fine, tubular pores; medium acid, pH 6.0; gradual, wavy boundary.

A12–A2—9 to 16 inches, silt loam, similar to horizon above in color, but has pale siliceous coatings on peds and in pores; massive; hard when dry, friable when moist, very slightly plastic and sticky when wet; many very fine and few fine roots; few medium and many fine and very fine pores; medium acid, pH 6.0; clear, smooth boundary.

B21t—16 to 24 inches, brown (10YR 5/3) clay, dark brown (10YR 3/3) when moist; strong, coarse, columns that have light-gray (10YR 7/2) vesicular, porous loam caps ½ inch thick; extremely hard when dry, very firm when moist, very plastic and slightly sticky when wet; few fine roots; many fine and very fine pores; many moderately thick clay films on ped faces and in pores; neutral, pH 7.0; gradual, wavy boundary.

B22t—24 to 34 inches, dark-brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; strong, coarse, prismatic to strong, medium blocky structure; extremely hard when dry, very firm when moist, very plastic and slightly sticky when wet; few fine and very fine roots; few fine and many very fine pores; continuous moderately thick clay films on ped faces and in pores; moderately alkaline, pH 8.0; gradual, wavy boundary.

B31t—34 to 52 inches, yellowish-brown (10YR 5/4) silty clay, dark yellowish brown (10YR 4/4) when moist; moderate, medium, blocky structure; very hard when dry, firm when moist, very plastic and slightly sticky when wet; few fine and very fine roots; few fine and many very fine pores; many moderately thick clay films on ped faces and in pores; moderately alkaline, pH 8.0; gradual, wavy boundary.

B32t—52 to 60 inches, yellowish-brown (10YR 5/4) silty clay, dark yellowish brown (10YR 4/4) when moist; moderate, medium, blocky to moderate, fine, blocky structure; very hard when dry, firm when moist, plastic and sticky when wet; many, very fine, tubular pores; common moderately thick clay films on ped faces and in pores; moderately alkaline, pH 8.0.

Range in characteristics.—The texture of the A horizon ranges from silt loam to fine sandy loam; the color ranges from pale brown or brown to grayish brown. In places the B21t horizon is dark brown (7.5YR 4/4) and reddish brown (5YR 5/4). The B32t horizon ranges from clay or silty clay to silty clay loam. In places the clay loam is gravelly. In areas transitional from this soil to the Pescadero soils, the A horizon is dark gray and the A2 horizon is gray. The B21t horizon is gray in the upper part but grades to yellowish brown with depth.

SYCAMORE SILT LOAM: The site described is 1,250 feet east of Hopyard Road, 50 feet north of Black Avenue, and ¼ mile north of Pleasanton in a nearly level field that is used for irrigated row crops.

Ap—0 to 7 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; weak, medium, granular structure; slightly hard when dry, friable to very friable when moist, sticky and slightly plastic when wet; many fine, inped and exped roots; few, fine, tubular pores and common, medium, interstitial pores; moderately alkaline, pH 8.0; moderately calcareous; gradual, smooth boundary.

A1—7 to 18 inches, silt loam similar to the above horizon but has not been disturbed by cultivation.

ACg—18 to 30 inches, grayish-brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; few, fine, distinct, rust-colored mottles; massive or weak, medium, granular structure; slightly hard when dry, friable to very friable when moist, sticky and slightly plastic when wet; few fine roots; few, fine, tubular pores and few, medium, interstitial pores; moderately calcareous; moderately alkaline, pH 8.0; gradual, smooth boundary.

C1g—30 to 44 inches, light olive-gray (5Y 6/2) silt loam, olive gray (5Y 5/2) when moist; common, fine, distinct, rust-colored mottles; massive; slightly hard when dry, friable to very friable when moist, slightly sticky, slightly plastic when wet; few fine roots; few and very few, fine, tubular pores; strongly calcareous; disseminated lime and small, soft, whitish concretions and seams of lime; moderately alkaline, pH 8.2; abrupt, smooth boundary.

C2g—44 to 60 inches, light olive-gray (5Y 6/2) heavy silt loam, olive gray (5Y 4/2) when moist; common, fine, yellowish-brown mottles and medium, distinct, yellowish-brown mottles; massive; slightly hard when dry, friable to very friable when moist, sticky and plastic when wet; few fine roots; very few, fine, tubular pores; strongly calcareous; disseminated lime and soft, small, whitish nodules and seams of lime; moderately alkaline, pH 8.2.

Range in characteristics.—The texture of the surface layer ranges from gravelly loam or loam to silt loam. The color of the A horizon ranges from light brownish gray or grayish brown to light gray. Where these soils were formed in moderately well drained areas, the mottles are few, fine, and faint, and the color of the A horizon is brownish gray. In small areas, the soil is gravelly throughout.

ZAMORA SILTY CLAY LOAM: The site described is 1,900 feet north of East Avenue and 20 feet west of Vasco Road in a field used for irrigated crops and dry-farmed grain.

Ap—0 to 7 inches, grayish-brown (10YR 5/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, subangular blocky structure; hard when dry, friable when moist, sticky and slightly plastic when wet; many fine and very fine roots; common fine and very fine pores; mildly alkaline, pH 7.5; clear, smooth boundary.

A1—7 to 18 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, blocky structure; hard when dry, friable when moist, sticky and slightly plastic when wet; many fine and very fine roots; common fine and very fine pores; mildly alkaline, pH 7.5; gradual, smooth boundary.

B1t—18 to 30 inches, dark grayish-brown (10YR 4/2) light silty clay loam, dark brown (10YR 3/3) when moist; massive or weak, medium, blocky structure; hard when dry, friable when moist, sticky and slightly plastic when wet; many fine and very fine roots; common fine and very fine pores; few thin clay films on pores; moderately alkaline, pH 8.0; gradual, smooth boundary.

B2t—30 to 50 inches, dark grayish-brown (10YR 4/2) heavy clay loam, dark brown (10YR 3/3) when moist; massive or weak, medium, blocky structure; hard when dry, friable when moist, sticky and plastic when wet; few very fine roots; common very fine and few fine pores;

common thin clay films on pores; moderately alkaline, pH 8.0; gradual, smooth boundary.

C—50 to 60 inches, brown (10YR 5/3) clay loam, dark yellowish brown (10YR 3/4) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; few very fine roots; common very fine and few fine pores; few thin clay films in pores; moderately alkaline, pH 8.0; slightly calcareous.

Range in characteristics.—The A horizon ranges from grayish brown or dark grayish brown to dark brown in color and from heavy silt loam or silty clay loam to clay loam in texture. In areas transitional from this soil to the Rincon soils, the B horizon is more strongly developed, and the clay films on the ped faces are few to common. The C horizon ranges from brown to yellowish brown in color and is calcareous in places. A few very fine quartzite pebbles occur throughout the profile.

Summary of Soil Qualities

Important qualities of each soil mapped are summarized in table 18 (pp. 88–95). The table gives the name of each soil, the symbol by which it is shown on the soil map, and the capability unit in which it is grouped. References by page number to the description and interpretation of the capability unit are given in the "Guide to Mapping Units, Capability Units, and Range Sites" in the back of the report.

Terms used to describe the soil qualities in table 18 are defined in the paragraphs that follow.

Effective depth is the depth of soil readily penetrated by roots. It is the depth to a claypan, bedrock, or any other layer in the soil that would stop or greatly hinder the penetration of roots. The classes and their limits are—

	Inches
Very deep	More than 60
Deep	36 to 60
Moderately deep	20 to 36
Shallow	10 to 20
Very shallow	Less than 10

Natural drainage refers to ability of the soil to retain and transmit water. Water is removed from the soil by runoff and by flow through the soil to underground spaces. Seven drainage classes are briefly described here and are more fully described in the "Soil Survey Manual" (*13*). The drainage classes are:

1. Very poor: Water is removed from the soil so slowly that the water table remains at or on the surface the greater part of the time. Soils of this drainage class usually occupy level or depressed sites and are frequently ponded.
2. Poor: Water is removed so slowly that the soil remains wet for a large part of the time. The water table is commonly at or near the surface during a considerable part of the year. Poorly drained conditions are the result of a high water table, of a slowly permeable layer within the profile, of seepage, or of some combination of these conditions.
3. Imperfect or somewhat poor: Water is removed from the soil slowly enough to keep it wet for significant periods but not all the time.
4. Moderately good: Water is removed from the soil somewhat slowly, so that the profile is wet for a small but significant part of the time.
5. Good: Water is removed from the soil readily but not rapidly. A soil with good drainage is well drained.
6. Somewhat excessive: Water is removed from the soil rapidly.
7. Excessive: Water is removed from the soil very rapidly.

Permeability is the ability of a porous material, such as soil, to transmit fluids. Permeability of soil is expressed by the rate of percolation. As measurements have not been made on these soils, the ratings given in the table are estimates. The basis for the estimates is the rate of percolation, by gravity, through a saturated core of soil about 3 inches in diameter and 3 inches in thickness, that was taken with the least possible disturbance of natural soil structure. The rating is a general indication of the ease of root penetration. The classes of permeability and the percolation rate for each are—

	Inches per hour
Very slow	Less than 0.05
Slow	0.05 to 0.20
Moderately slow	0.20 to 0.80
Moderate	0.80 to 2.50
Moderately rapid	2.50 to 5.00
Rapid	5.00 to 10.00
Very rapid	More than 10.00

Runoff refers to the relative rate that water is removed by flow over the surface of the soil. Six classes are defined in the "Soil Survey Manual" (*13*). They are ponded, very slow, slow, medium, rapid, and very rapid.

Erosion hazard is an estimate of the risk of erosion if the soil is cultivated or heavily grazed. Ratings refer to the risk of erosion by water. The classes are none, slight, moderate, severe, and very severe.

The *occurrence of a high water table*, one within 5 feet of the surface, has been estimated. The classes are none, general, and intermittent.

The *available water holding capacity* is the capacity of the soil, to its effective depth as defined, to hold water available to plants, at normal field capacity. This is approximately the moisture content of a well-drained soil 2 to 3 days after it has been saturated by rain or by irrigation. The classes and the amounts of available water held in the soil profile to its effective depth are—

	Inches
Very low	Less than 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

The ratings for *natural fertility* are estimates of the natural ability of the soil to provide plant nutrients in the proper amounts and in the right balance for the growth of adapted crops when other factors, such as light, temperature, and conditions of the soil, are favorable. Estimates for each soil were made in relation to the other soils of the Area. Terms used are very low, low, moderate, and high.

Estimates of the *workability* of soils refer to the amount of work required to till the soil and to the relative difficulty in operating farm machinery. Terms are easy, somewhat difficult, difficult, and very difficult.

Principal use of the soils at the time of the soil survey is also shown in table 18.

Because their qualities vary and they are not suitable for the commercial production of plants, Gravel pit, Riverwash, and Rock land are omitted from table 18.

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Glossary

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has such a high degree of alkalinity (pH 8.5 or higher) or such a high percentage of sodium (15 percent or more of exchangeable bases), or both, that the growth of most crop plants is reduced.

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

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

Available moisture capacity. The capacity of a soil to hold water in a form available to plants. Amount of moisture held in soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

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.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above or below it. A claypan is commonly hard when dry and plastic or stiff when wet.

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

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

Loose. Noncoherent; soil will not hold together in a mass.

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

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

Plastic. When wet, soil is 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, soil adheres to other material; tends to stretch and pull apart, rather than pull free from other material.

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

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

Cemented. Soil is hard and brittle; little affected by moistening.

Field moisture capacity. The moisture content of a soil expressed as a percentage of the oven-dry weight after the gravitational, or free water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called normal field capacity, normal moisture capacity, or capillary capacity.

Friability. Term for the ease with which soil crumbles. A friable soil is one that crumbles easily.

Horizon, soil. A layer of soil, approximately parallel to the soil surface, with characteristics produced by soil-forming processes.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Leaching. The removal of soluble materials from the soils by percolating water.

Metamorphic rocks. Rocks of any origin that have been completely changed physically by heat, pressure, and movement. Such rocks are nearly always crystalline.

Microrelief. Minor surface configurations of the land.

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

Neutral soil. In practice, a soil having a pH value between 6.6 and 7.3. Strictly speaking, a soil that has a pH value of 7.0.

Phase, soil. A subdivision of a soil type, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil type, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects management.

Piping. The ability of water to move soil grains through the soil mass.

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

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

Saline soil. A soil that contains soluble salts in amounts that impair the growth of crop plants but that does not contain excess exchangeable sodium.

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

Sedimentary rock. A rock composed of particles deposited from suspension in water. The chief sedimentary rocks are conglomerate, from gravel; sandstone, from sand; shale, from clay; and limestone, from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sands have been consolidated into sandstone.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

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

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

Soil variant. A kind of soil having properties sufficiently different from those of other known soils to justify establishing a new soil series, but of such limited known area that creation of a new series is not believed to be justified.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary particles. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms rounded on the top), *blocky* (angular or subangular), and *granular*. Structureless soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

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

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. (See also Clay, Sand, and Silt.) The basic textural classes, in order of their increasing proportions of fine particles are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

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

Type, soil. A subdivision of the soil series that is made on the basis of differences in the texture of the surface layer.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks at or near the earth's surface by atmospheric agents. Three changes result in more or less complete disintegration and decomposition of the rock.

TABLE 18.--SUMMARY OF IMPORTANT

Symbol	Soil	Capability unit	Effective depth for roots	Natural drainage	Permeability of subsoil
AaC	Altamont clay, 3 to 15 percent slopes--	IIIe-5	Deep----------	Good---------	Slow---------
AaD	Altamont clay, 15 to 30 percent slopes-	IVe-5	Deep----------	Good---------	Slow---------
AmE2	Altamont clay, moderately deep, 30 to 45 percent slopes, eroded.	VIe-5	Moderately deep.	Good---------	Slow---------
AmF2	Altamont clay, moderately deep, 45 to 75 percent slopes, eroded.	VIIe-5	Moderately deep.	Good---------	Slow---------
ArD	Altamont rocky clay, moderately deep, 7 to 30 percent slopes.	VIe-5	Moderately deep.	Good---------	Slow---------
AzD	Azule clay loam, 3 to 30 percent slopes.	IVe-5	Moderately deep.	Good---------	Slow---------
AzE2	Azule clay loam, 30 to 45 percent slopes, eroded.	VIe-5	Moderately deep.	Good---------	Slow---------
AzF2	Azule clay loam, 45 to 60 percent slopes, eroded.	VIIe-5	Moderately deep.	Good---------	Slow---------
Cc	Clear Lake clay, 0 to 3 percent slopes.	IIIw-5	Deep----------	Imperfect----	Slow---------
CdA	Clear Lake clay, drained, 0 to 3 percent slopes.	IIIs-5	Very deep------	Moderately good.	Slow---------
CdB	Clear Lake clay, drained, 3 to 7 percent slopes.	IIIe-5	Very deep------	Moderately good.	Slow---------
CoC2	Cotati fine sandy loam, eroded--------	IVe-3	Moderately deep.	Imperfect----	Very slow----
DaA	Danville silty clay loam, 0 to 3 percent slopes.	IIs-3	Very deep------	Good---------	Slow---------
DaB	Danville silty clay loam, 3 to 10 percent slopes.	IIe-3	Very deep------	Good---------	Slow---------
DbC	Diablo clay, 7 to 15 percent slopes---	IIIe-5	Deep----------	Good---------	Slow---------
DbD	Diablo clay, 15 to 30 percent slopes--	IVe-5	Deep----------	Good---------	Slow---------
DbE2	Diablo clay, 30 to 45 percent slopes, eroded.	VIe-5	Deep----------	Good---------	Slow---------
DmF2	Diablo clay, moderately deep, 45 to 60 percent slopes, eroded.	VIIe-5	Moderately deep.	Good---------	Slow---------
DvC	Diablo clay, very deep, 3 to 15 percent slopes.	IIIe-5	Deep----------	Good---------	Slow---------
DvD2	Diablo clay, very deep, 15 to 30 percent slopes, eroded.	IVe-5	Deep----------	Good--------	Slow---------
DvE2	Diablo clay, very deep, 30 to 45 percent slopes, eroded.	VIe-5	Deep----------	Good--------	Slow---------

QUALITIES OF THE SOILS

Runoff	Erosion hazard	Occurrence of high water table	Available water holding capacity	Natural fertility	Workability	Principal use
Slow to medium.	Slight------	None-------	Moderate to high.	High---------	Somewhat difficult.	Grain and grain hay.
Medium-----	Moderate----	None-------	Moderate to high.	High---------	Difficult--------	Grain, grain hay, pasture and range.
Medium to rapid.	Severe------	None-------	Moderate------	Moderate-----	Very difficult---	Pasture, range, grain, and grain hay.
Very rapid-	Very severe.	None-------	Moderate------	Moderate-----	Very difficult---	Pasture and range.
Slow to medium.	Moderate----	None-------	Moderate------	Moderate-----	Very difficult---	Pasture and range.
Slow to medium.	Slight to moderate.	None-------	Moderate------	Moderate-----	Somewhat difficult to difficult.	Pasture, range and grain.
Medium to rapid.	Severe------	None-------	Moderate------	Moderate-----	Very difficult---	Pasture and range.
Rapid to very rapid.	Very severe.	None-------	Moderate------	Moderate-----	Very difficult---	Pasture and range.
Very slow--	None--------	General----	High----------	High---------	Somewhat difficult.	Irrigated pasture, grain, and grain hay.
Very slow--	None--------	None-------	High----------	High---------	Somewhat difficult.	Irrigated pasture, grain, and grain hay.
Slow-------	Slight------	None-------	High----------	High---------	Somewhat difficult.	Grain and grain hay.
Slow to medium.	Slight to moderate.	None-------	Low-----------	Low----------	Easy to somewhat difficult.	Pasture.
Slow-------	Slight------	None-------	High----------	High---------	Easy------------	Vegetables, apricots, irrigated pasture, grain, and grain hay.
Slow to medium.	Slight to moderate.	None-------	High----------	High---------	Easy------------	Grain, grain hay, pasture and range.
Slow to medium.	Slight to moderate.	None-------	Moderate------	High---------	Somewhat difficult.	Grain, grain hay, pasture and range.
Medium-----	Moderate----	None-------	Moderate------	High---------	Difficult--------	Grain, grain hay, pasture and range.
Medium to rapid.	Severe------	None-------	Moderate------	High---------	Very difficult---	Pasture and range.
Rapid to very rapid.	Very severe.	None-------	Low-----------	Moderate-----	Very difficult---	Pasture and range.
Slow to medium.	Slight to moderate.	None-------	High----------	High---------	Somewhat difficult.	Grain, grain hay, pasture and range.
Medium-----	Moderate----	None-------	High----------	High---------	Difficult--------	Grain, grain hay, pasture and range.
Medium to rapid.	Severe------	None-------	High----------	High---------	Very difficult---	Pasture and range.

TABLE 18.--SUMMARY OF IMPORTANT

Symbol	Soil	Capability unit	Effective depth of roots	Natural drainage	Permeability of subsoil
DvF2	Diablo clay, very deep, 45 to 60 percent slopes, eroded.	VIIe-5	Deep----------	Good---------	Slow---------
GaE2	Gaviota rocky sandy loam, 5 to 40 percent slopes, eroded.	VIe-8	Shallow---------	Somewhat excessive.	Moderately rapid.
GaF2	Gaviota rocky sandy loam, 40 to 75 percent slopes, eroded.	VIIe-8	Shallow---------	Excessive----	Moderately rapid.
HnF2	Henneke rocky loam, eroded----------	VIIIs-9	Shallow to very shallow.	Somewhat excessive.	Moderate-----
LaC	Linne clay loam, 3 to 15 percent slopes.	IIIe-5	Moderately deep.	Good---------	Moderately slow.
LaD	Linne clay loam, 15 to 30 percent slopes.	IVe-5	Moderately deep.	Good---------	Moderately slow.
LaE2	Linne clay loam, 30 to 45 percent slopes, eroded.	VIe-5	Moderately deep.	Good---------	Moderately slow.
LcF2	Linne clay loam, shallow, 45 to 75 percent slopes, eroded.	VIIe-5	Shallow---------	Good---------	Moderately slow.
Lg	Livermore gravelly loam----------	IIs-4	Very deep-------	Somewhat excessive.	Moderately rapid.
Lm	Livermore very gravelly coarse sandy loam.	IVs-4	Very deep-------	Somewhat excessive.	Rapid--------
LoE2	Lobitos shaly loam, eroded----------	VIe-8	Very shallow to moderately deep.	Good---------	Moderate-----
LpE2	Los Gatos-Los Osos complex, 30 to 45 percent slopes, eroded:				
	Los Gatos loam, 30 to 45 percent slopes, eroded.	VIe-8	Shallow to moderately deep.	Good---------	Moderate-----
	Los Osos silty clay loam, 30 to 45 percent slopes, eroded.	VIe-5	Shallow to moderately deep.	Good---------	Moderately slow.
LpF2	Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded:				
	Los Gatos loam, 45 to 75 percent slopes, eroded.	VIIe-1	Shallow to moderately deep.	Somewhat excessive.	Moderate-----
	Los Osos silty clay loam, 45 to 75 percent slopes, eroded.	VIIe-5	Shallow to moderately deep.	Somewhat excessive.	Moderately slow.
LsC	Los Osos loam, seeped variant, 3 to 15 percent slopes.	IIIe-1	Deep----------	Imperfect to moderately good.	Moderately slow.
LtD	Los Osos silty clay loam, 7 to 30 percent slopes.	IVe-5	Moderately deep.	Good---------	Moderately slow.
LtE2	Los Osos silty clay loam, 30 to 45 percent slopes, eroded.	VIe-5	Moderately deep.	Good---------	Moderately slow.
LtF2	Los Osos silty clay loam, 45 to 75 percent slopes, eroded.	VIIe-5	Moderately deep.	Somewhat excessive.	Moderately slow.

QUALITIES OF THE SOILS--Continued

Runoff	Erosion hazard	Occurrence of high water table	Available water holding capacity	Natural fertility	Workability	Principal use
Rapid to very rapid.	Very severe.	None-------	High----------	High---------	Very difficult---	Pasture and range.
Slow to rapid.	Slight to severe.	None-------	Very low------	Low----------	Very difficult---	Pasture and range.
Very rapid.	Very severe.	None-------	Very low------	Low----------	Very difficult---	Pasture and range.
Very rapid.	Severe------	None-------	Very low------	Very low-----	Very difficult---	Watershed, recreation, and wildlife.
Slow to medium.	Slight to moderate.	None-------	Moderate------	High---------	Easy------------	Grain and grain hay.
Medium-----	Moderate----	None-------	Moderate------	High---------	Somewhat difficult.	Grain, grain hay, pasture and range.
Medium to rapid.	Severe------	None-------	Moderate------	High---------	Difficult--------	Pasture and range.
Very rapid.	Very severe.	None-------	Low-----------	Moderate-----	Very difficult---	Pasture and range.
Very slow to slow.	Slight------	None-------	Low-----------	Moderate-----	Easy------------	Vineyards, grain, and grain hay.
Very slow to slow.	Slight------	None-------	Very low------	Low----------	Somewhat difficult.	Vineyards.
Medium to rapid.	Moderate to severe.	None-------	Low-----------	Low----------	Difficult--------	Pasture and range.
Medium to rapid.	Severe------	None-------	Low to moderate.	Low to moderate.	Difficult--------	Pasture and range.
Medium to rapid.	Severe------	None-------	Low to moderate.	Moderate-----	Difficult--------	Pasture and range.
Very rapid.	Very severe.	None-------	Low to moderate.	Low to moderate.	Very difficult---	Pasture and range.
Rapid to very rapid.	Very severe.	None-------	Low to moderate.	Moderate-----	Very difficult---	Pasture and range.
Slow to medium.	Slight to moderate.	Intermittent.	Moderate-----	Moderate-----	Somewhat difficult.	Grain and grain hay.
Medium-----	Moderate----	None-------	Low to moderate.	Moderate-----	Somewhat difficult.	Pasture, range, grain, and grain hay.
Rapid------	Severe------	None-------	Low to moderate.	Moderate-----	Difficult--------	Pasture, range, and grain.
Rapid to very rapid.	Very severe.	None-------	Low to moderate.	Moderate-----	Very difficult---	Pasture and range.

TABLE 18.--SUMMARY OF IMPORTANT

Symbol	Soil	Capability unit	Effective depth for roots	Natural drainage	Permeability of subsoil
LuD	Los Osos and Millsholm soils, 7 to 30 percent slopes:				
	Los Osos silt loam, 7 to 30 percent slopes.	IVe-3	Moderately deep.	Good	Moderately slow.
	Millsholm silt loam, 7 to 30 percent slopes.	IVe-3	Moderately deep.	Good	Moderate
LuE2	Los Osos and Millsholm soils, 30 to 45 percent slopes, eroded:				
	Los Osos silt loam, 30 to 45 percent slopes, eroded.	VIe-8	Moderately deep.	Good	Moderately slow.
	Millsholm silt loam, 30 to 45 percent slopes, eroded.	VIe-8	Moderately deep.	Good	Moderate
MhE2	Millsholm silt loam, 30 to 45 percent slopes, eroded.	VIe-8	Shallow	Good	Moderate
MhF2	Millsholm silt loam, 45 to 75 percent slopes, eroded.	VIIe-8	Shallow	Somewhat excessive.	Moderate
PaE2	Parrish gravelly loam, 30 to 45 percent slopes, eroded.	VIe-8	Shallow to moderately deep.	Good	Slow
PaF2	Parrish gravelly loam, 45 to 75 percent slopes, eroded.	VIIe-1	Shallow to moderately deep.	Good	Slow
PcD	Perkins loam, 3 to 30 percent slopes		Deep	Good	Moderately slow.
PcF2	Perkins loam, 45 to 75 percent slopes, eroded.	VIIe-3	Deep	Somewhat excessive.	Moderately slow.
Pd	Pescadero clay	VIw-2	Moderately deep.	Imperfect	Very slow
PgA	Pleasanton gravelly loam, 0 to 3 percent slopes.	IIs-3	Very deep	Good	Moderately slow.
PgB	Pleasanton gravelly loam, 3 to 12 percent slopes.	IIIe-3	Very deep	Good	Moderately slow.
PoC2	Positas gravelly loam, 2 to 20 percent slopes, eroded.	IVe-3	Shallow	Good	Very slow
PoE2	Positas gravelly loam, 20 to 40 percent slopes, eroded.	VIe-3	Shallow	Good to somewhat excessive.	Very slow
PoF2	Positas gravelly loam, 40 to 60 percent slopes, eroded.	VIIe-3	Shallow	Excessive	Very slow
PtB2	Positas gravelly loam, thick surface, 2 to 10 percent slopes, eroded.	IIIe-3	Moderately deep.	Good	Very slow
Rc	Rincon loam, 0 to 3 percent slopes	IIs-3	Very deep	Good	Slow
RdA	Rincon clay loam, 0 to 3 percent slopes.	IIs-3	Very deep	Good	Slow
RdB	Rincon clay loam, 3 to 7 percent slopes.	IIIe-3	Very deep	Good	Slow
Sa	San Ysidro loam, 3 to 7 percent slopes.	IVe-3	Shallow	Moderately good.	Very slow
SdD2	Shedd silt loam, 15 to 30 percent slopes, eroded.	IVe-3	Moderately deep.	Good	Moderate
SdE2	Shedd silt loam, 30 to 45 percent slopes, eroded.	VIe-8	Moderately deep.	Good	Moderate

QUALITIES OF THE SOILS--Continued

Runoff	Erosion hazard	Occurrence of high water table	Available water holding capacity	Natural fertility	Workability	Principal use
Slow to medium.	Moderate---	None-------	Low to moderate.	Moderate-----	Somewhat difficult.	Pasture, range, grain, and grain hay.
Slow to medium.	Moderate---	None-------	Low----------	Low----------	Somewhat difficult.	Pasture, range, grain, and grain hay.
Medium to rapid.	Severe-----	None-------	Low to moderate.	Moderate-----	Difficult--------	Pasture and range.
Medium to rapid.	Severe-----	None-------	Low----------	Low----------	Difficult--------	Pasture and range.
Rapid------	Severe-----	None-------	Low----------	Low----------	Difficult--------	Pasture and range.
Very rapid.	Very severe.	None-------	Low----------	Low----------	Very difficult---	Pasture and range.
Medium to rapid.	Severe-----	None-------	Low to moderate.	Low----------	Difficult--------	Pasture and range.
Very rapid.	Very severe.	None-------	Low to moderate.	Low----------	Very difficult---	Pasture and range.
Slow to medium.	Slight to moderate.	None-------	Moderate------	Low----------	Somewhat difficult.	Grain, grain hay, pasture and range.
Very rapid.	Very severe.	None-------	Moderate------	Low----------	Very difficult---	Range.
Slow-------	Slight-----	None-------	Low----------	Low----------	Difficult--------	Saltgrass pasture.
Slow-------	Slight-----	None-------	Moderate------	Moderate-----	Somewhat difficult.	Vineyards, grain, and grain hay.
Slow to medium.	Slight to moderate.	None-------	Moderate------	Moderate-----	Somewhat difficult.	Grain and grain hay.
Slow to medium.	Slight to moderate.	None-------	Low----------	Low----------	Somewhat difficult.	Pasture, range, grain, and grain hay.
Rapid------	Severe-----	None-------	Low----------	Low----------	Difficult--------	Pasture and range.
Rapid to very rapid.	Very severe.	None-------	Low----------	Low----------	Very difficult---	Pasture and range.
Slow to medium.	Slight to moderate.	None-------	Low----------	Low----------	Somewhat difficult.	Grain, grain hay, pasture and range.
Slow-------	Slight-----	None-------	High---------	Moderate-----	Easy----------	Grain and grain hay.
Slow-------	Slight-----	None-------	High---------	Moderate-----	Somewhat difficult.	Irrigated pasture, and alfalfa.
Slow to medium.	Slight to moderate.	None-------	High---------	Moderate-----	Somewhat difficult.	Grain and grain hay.
Slow-------	Slight-----	None-------	Low----------	Low----------	Easy----------	Pasture, range, grain, and grain hay.
Medium-----	Moderate---	None-------	Moderate------	Moderate-----	Somewhat difficult.	Grain, grain hay, pasture and range.
Rapid------	Severe-----	None-------	Moderate------	Moderate-----	Difficult--------	Pasture and range.

TABLE 18.--SUMMARY OF IMPORTANT

Symbol	Soil	Capability unit	Effective depth for roots	Natural drainage	Permeability of subsoil
SdF3	Shedd silt loam, 45 to 75 percent slopes, severely eroded.	VIIe-8	Moderately deep to shallow.	Somewhat excessive.	Moderate----
Sf	Solano fine sandy loam----------	VIw-2	Shallow---------	Imperfect----	Moderately slow to slow.
Sl	Sunnyvale clay loam----------	IIw-2	Deep----------	Poor---------	Moderately slow.
Sm	Sunnyvale clay loam over clay----------	IIw-3	Deep----------	Poor---------	Slow--------
Sn	Sunnyvale clay loam, drained----------	I-1	Very deep-------	Poor---------	Moderately slow.
So	Sycamore silt loam----------	I-1	Very deep-------	Moderately good.	Moderate----
Sy	Sycamore silt loam over clay----------	IIs-3	Deep----------	Moderately good.	Slow--------
VaE2	Vallecitos rocky loam, 30 to 45 percent slopes, eroded.	VIe-8	Shallow---------	Good---------	Moderately slow.
VaF2	Vallecitos rocky loam, 45 to 75 percent slopes, eroded.	VIIe-1	Shallow---------	Somewhat excessive.	Moderately slow.
YmA	Yolo loam, 0 to 3 percent slopes------	I-1	Very deep-------	Good---------	Moderate----
YmB	Yolo loam, 3 to 10 percent slopes-----	IIe-1	Very deep-------	Good---------	Moderate----
Yo	Yolo loam over gravel, 0 to 3 percent slopes.	IIIs-0	Moderately deep-	Good---------	Moderate to very rapid.
Yr	Yolo gravelly loam, 0 to 3 percent slopes.	IIs-4	Very deep-------	Good---------	Moderate----
Ys	Yolo sandy loam, 0 to 3 percent slopes.	I-1	Very deep-------	Good---------	Moderately rapid.
Za	Zamora silt loam, 0 to 4 percent slopes.	I-1	Very deep-------	Good---------	Moderately slow.
Zc	Zamora silty clay loam, 0 to 3 percent slopes.	I-1	Very deep-------	Good---------	Moderately slow.

QUALITIES OF THE SOILS--Continued

Runoff	Erosion hazard	Occurrence of high water table	Available water holding capacity	Natural fertility	Workability	Principal use
Very rapid.	Very severe.	None	Moderate to low.	Moderate to low.	Very difficult	Pasture and range.
Slow	Slight	None	Low	Low	Somewhat difficult.	Saltgrass pasture.
Slow	Slight	General	Very high	High	Easy	Irrigated pasture and row crops.
Slow	Slight	General	Very high	High	Easy	Irrigated row crops, grain, and grain hay.
Slow	Slight	None	High	High	Easy	Irrigated pasture, and row crops.
Slow	Slight	None	High	High	Easy	Irrigated pasture, row crops, and alfalfa.
Slow	None to slight.	Intermittent.	Moderate	Moderate	Easy	Irrigated pasture.
Rapid	Severe	None	Low	Low	Difficult	Pasture and range.
Very rapid.	Very severe.	None	Low	Low	Very difficult	Pasture and range.
Very slow to slow.	Slight	None	High	Moderate	Easy	Irrigated pasture, row crops, and alfalfa.
Slow to medium.	Slight to moderate.	None	High	Moderate	Easy	Irrigated pasture and alfalfa.
Very slow to slow.	Slight	None	Moderate to low.	Moderate to low.	Easy	Irrigated pasture, row crops, and alfalfa.
Very slow to slow.	Slight	None	Moderate	Moderate	Easy	Grain, grain hay, irrigated alfalfa, and pasture.
Very slow to slow.	Slight	None	Moderate	Moderate	Easy	Irrigated row crops and alfalfa.
Slow	Slight	None	High	Moderate	Easy	Irrigated row crops, alfalfa, grain, and grain hay.
Slow	Slight	None	High	Moderate	Easy	Irrigated row crops, alfalfa, roses, grain, and grain hay.

GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND RANGE AND PASTURE SITES

[See table 7, p. 14, for approximate acreage and proportionate extent of the soils, and table 9, p. 42, for estimated yields of each unit. See pp. 49 to 62 for information on engineering interpretations of the soils. Dashed lines indicate soil was not assigned to a range and pasture site]

Map symbol	Mapping unit	Page	Capability unit		Range and pasture site	
			Symbol	Page	Name	Page
AaC	Altamont clay, 3 to 15 percent slopes	13	IIIe-5	36	----------	--
AaD	Altamont clay, 15 to 30 percent slopes	13	IVe-5	37	----------	--
AmE2	Altamont clay, moderately deep, 30 to 45 percent slopes, eroded	13	VIe-5	38	Clayey Hills	45
AmF2	Altamont clay, moderately deep, 45 to 75 percent slopes, eroded	13	VIIe-5	38	Steep Clayey Slopes	47
ArD	Altamont rocky clay, moderately deep, 7 to 30 percent slopes	13	VIe-5	38	Clayey Hills	45
AzD	Azule clay loam, 3 to 30 percent slopes	15	IVe-5	37	----------	--
AzE2	Azule clay loam, 30 to 45 percent slopes, eroded	15	VIe-5	38	Clayey Hills	45
AzF2	Azule clay loam, 45 to 60 percent slopes, eroded	15	VIIe-5	38	Steep Clayey Slopes	47
Cc	Clear Lake clay, 0 to 3 percent slopes	16	IIIw-5	37	----------	--
CdA	Clear Lake clay, drained, 0 to 3 percent slopes	15	IIIs-5	36	----------	--
CdB	Clear Lake clay, drained, 3 to 7 percent slopes	15	IIIe-5	36	----------	--
CoC2	Cotati fine sandy loam, eroded	16	IVe-3	37	----------	--
DaA	Danville silty clay loam, 0 to 3 percent slopes	17	IIs-3	35	----------	--
DaB	Danville silty clay loam, 3 to 10 percent slopes	16	IIe-3	35	----------	--
DbC	Diablo clay, 7 to 15 percent slopes	17	IIIe-5	36	----------	--
DbD	Diablo clay, 15 to 30 percent slopes	17	IVe-5	37	----------	--
DbE2	Diablo clay, 30 to 45 percent slopes, eroded	17	VIe-5	38	Clayey Hills	45
DmF2	Diablo clay, moderately deep, 45 to 60 percent slopes, eroded	17	VIIe-5	38	Steep Clayey Slopes	47
DvC	Diablo clay, very deep, 3 to 15 percent slopes	18	IIIe-5	36	----------	--
DvD2	Diablo clay, very deep, 15 to 30 percent slopes, eroded	17	IVe-5	37	----------	--
DvE2	Diablo clay, very deep, 30 to 45 percent slopes, eroded	18	VIe-5	38	Clayey Hills	45
DvF2	Diablo clay, very deep, 45 to 60 percent slopes, eroded	18	VIIe-5	38	Steep Clayey Slopes	47
GaE2	Gaviota rocky sandy loam, 5 to 40 percent slopes, eroded	18	VIe-8	38	Shallow Loamy Uplands	46
GaF2	Gaviota rocky sandy loam, 40 to 75 percent slopes, eroded	18	VIIe-8	39	Steep Shallow Loamy Uplands.	46
Gp	Gravel pit	18	VIIIw-4	39	----------	--
HnF2	Henneke rocky loam, eroded	18	VIIIs-9	39	----------	--
LaC	Linne clay loam, 3 to 15 percent slopes	19	IIIe-5	36	----------	--
LaD	Linne clay loam, 15 to 30 percent slopes	19	IVe-5	37	----------	--
LaE2	Linne clay loam, 30 to 45 percent slopes, eroded	19	VIe-5	38	Clayey Hills	45
LcF2	Linne clay loam, shallow, 45 to 75 percent slopes, eroded	19	VIIe-5	38	Steep Clayey Slopes	47
Lg	Livermore gravelly loam	20	IIs-4	35	----------	--
Lm	Livermore very gravelly coarse sandy loam	20	IVs-4	37	----------	--
LoE2	Lobitos shaly loam, eroded	20	VIe-8	38	Loamy Uplands	48
LpE2	Los Gatos-Los Osos complex, 30 to 45 percent slopes, eroded	21				
	Los Gatos loam part	--	VIe-8	38	Shallow Loamy Uplands	46
	Los Osos silty clay loam part	--	VIe-5	38	Loamy Uplands	48
LpF2	Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded	21				
	Los Gatos loam part	--	VIIe-1	38	Steep Shallow Loamy Uplands.	46
	Los Osos silty clay loam part	--	VIIe-5	38	Steep Loamy Slopes.	48
LsC	Los Osos loam, seeped variant, 3 to 15 percent slopes	22	IIIe-1	36	----------	--
LtD	Los Osos silty clay loam, 7 to 30 percent slopes	22	IVe-5	37	----------	--
LtE2	Los Osos silty clay loam, 30 to 45 percent slopes, eroded	22	VIe-5	38	Loamy Uplands	48
LtF2	Los Osos silty clay loam, 45 to 75 percent slopes, eroded	22	VIIe-5	38	Steep Loamy Slopes	48
LuD	Los Osos and Millsholm soils, 7 to 30 percent slopes	22		37		
	Los Osos silt loam part	--	IVe-3	37	----------	--
	Millsholm silt loam part	--	IVe-3	37	----------	--
LuE2	Los Osos and Millsholm soils, 30 to 45 percent slopes, eroded	22				
	Los Osos silt loam part	--	VIe-8	38	Loamy Uplands	48
	Millsholm silt loam part	--	VIe-8	38	Loamy Uplands	48
MhE2	Millsholm silt loam, 30 to 45 percent slopes, eroded	22	VIe-8	38	Loamy Uplands	48
MhF2	Millsholm silt loam, 45 to 75 percent slopes, eroded	23	VIIe-8	39	Steep Loamy Slopes	48
PaE2	Parrish gravelly loam, 30 to 45 percent slopes, eroded	23	VIe-8	38	Shallow Loamy Uplands	46
PaF2	Parrish gravelly loam, 45 to 75 percent slopes, eroded	23	VIIe-1	38	Steep Shallow Loamy Uplands.	46
PcD	Perkins loam, 3 to 30 percent slopes	23	IVe-3	37	----------	--
PcF2	Perkins loam, 45 to 75 percent slopes, eroded	23	VIIe-3	38	Steep Upland Terraces	47
Pd	Pescadero clay	24	VIw-2	38	----------	--
PgA	Pleasanton gravelly loam, 0 to 3 percent slopes	24	IIs-3	35	----------	--
PgB	Pleasanton gravelly loam, 3 to 12 percent slopes	24	IIIe-3	36	----------	--
PoC2	Positas gravelly loam, 2 to 20 percent slopes, eroded	25	IVe-3	37	----------	--
PoE2	Positas gravelly loam, 20 to 40 percent slopes, eroded	25	VIe-3	37	Upland Terraces	45
PoF2	Positas gravelly loam, 40 to 60 percent slopes, eroded	25	VIIe-3	38	Steep Upland Terraces	47
PtB2	Positas gravelly loam, thick surface, 2 to 10 percent slopes, eroded	25	IIIe-3	36	----------	--
Rc	Rincon loam, 0 to 3 percent slopes	26	IIs-3	35	----------	--
RdA	Rincon clay loam, 0 to 3 percent slopes	26	IIs-3	35	----------	--
RdB	Rincon clay loam, 3 to 7 percent slopes	26	IIIe-3	36	----------	--
Rh	Riverwash	26	VIIIw-4	39	----------	--
RoF	Rock land	26	VIIIs-9	39	----------	--
Sa	San Ysidro loam	27	IVe-3	37	----------	--
SdD2	Shedd silt loam, 15 to 30 percent slopes, eroded	27	IVe-3	37	----------	--
SdE2	Shedd silt loam, 30 to 45 percent slopes, eroded	27	VIe-8	38	Loamy Uplands	48
SdF3	Shedd silt loam, 45 to 75 percent slopes, severely eroded	27	VIIe-8	39	Steep Loamy Slopes	48
Sf	Solano fine sandy loam	27	VIw-2	38	----------	--
Sl	Sunnyvale clay loam	28	IIw-2	35	----------	--
Sm	Sunnyvale clay loam over clay	28	IIw-3	35	----------	--
Sn	Sunnyvale clay loam, drained	28	I-1	34	----------	--
So	Sycamore silt loam	29	I-1	34	----------	--
Sy	Sycamore silt loam over clay	29	IIs-3	35	----------	--
VaE2	Vallecitos rocky loam, 30 to 45 percent slopes, eroded	29	VIe-8	38	Shallow Loamy Uplands	46
VaF2	Vallecitos rocky loam, 45 to 75 percent slopes, eroded	30	VIIe-1	38	Steep Shallow Loamy Uplands.	46
YmA	Yolo loam, 0 to 3 percent slopes	30	I-1	34	----------	--
YmB	Yolo loam, 3 to 10 percent slopes	30	IIe-1	34	----------	--
Yo	Yolo loam over gravel, 0 to 3 percent slopes	30	IIIs-0	36	----------	--
Yr	Yolo gravelly loam, 0 to 3 percent slopes	30	IIs-4	35	----------	--
Ys	Yolo sandy loam, 0 to 3 percent slopes	30	I-1	34	----------	--
Za	Zamora silt loam, 0 to 4 percent slopes	31	I-1	34	----------	--
Zc	Zamora silty clay loam, 0 to 3 percent slopes	30	I-1	34	----------	--

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