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Soil Survey of The San Luis Obispo Area California

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Bureau of Chemistry and Soils

In cooperation with the
University of California Agricultural Experiment Station

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SOIL SURVEY OF THE SAN LUIS OBISPO AREA, CALIFORNIA

By E. J. CARPENTER, United States Department of Agriculture, in Charge, and R. EARL STORIE, University of California

AREA SURVEYED

The San Luis Obispo area is in the western part of California about midway between the cities of Los Angeles and San Francisco. (Fig. 1.) With the exception of several square miles in the southern part, which are in Santa Barbara County, the area lies entirely in San Luis Obispo County. It includes 734 square miles, or 469,760 acres.

The boundaries of the area are rather irregular, conforming in part to the coast line, in part to the crest of the Santa Lucia Range, and on the south to the north boundary of the previously surveyed Santa Maria area (*8*).[1] The position of the area, its shape, and its relation to State boundaries are shown in Figure 1.

FIGURE 1.—Sketch map showing location of the San Luis Obispo area, Calif.

The San Luis Obispo area lies in that part of the State where the trend of the Coast Range features changes from the dominant north-northwest south-southeast direction in the northern part of the southern half of the State to the dominant east-southeast, west-northwest direction in the Santa Barbara region. The greater part of the area lies north of the point at which the change in direction begins and therefore in that part of the State where the trend is north-northwestward. This includes all that part occupying the west slope of the Santa Lucia Range, including the coastal belt north of Morro Bay. The lowland belt, known locally under the three names of Chorro, Los Osos, and San Luis Valleys, lying south of the foot of the Santa Lucia Range and extending southeastward from the coast of Estero Bay, has a general southeastward course. This lowland belt has a somewhat more definite eastward extension than the Santa Lucia Range, and the San Luis Range changes to a still more definitely eastward direction than the lowland belt. Thus it may be seen the San Luis Obispo area lies in the northern part of the belt within which the change of direction takes place.

Physiographically the area includes parts of, or the entire width of, three belts extending north and south, as follows: (1) The Santa Lucia Range; (2) the San Luis Valley lowland, including the locally

[1] Italic numbers in parentheses refer to Literature Cited, p. 60.

designated San Luis, Los Osos, and Chorro Valleys; and (3) the San Luis Range.

The Santa Lucia Range includes the most westerly of the ridges of the Coast Range from Monterey Bay south to Estero Bay. It extends in an almost direct course, approximately north 40° west. The elevation of the crest ranges, within this area, between somewhat more than 2,500 feet and about 1,500 feet. The range is crossed by a number of low gaps. It constitutes a watershed ridge, its eastern slope draining into Salinas River, and the western slope, north of Estero Bay, directly into the Pacific, and south of the bay through a number of small streams. The west slope of the range, that part lying within the San Luis Obispo area, is thoroughly dissected by a great number of short deep ramifying valleys, the lower part of the slopes directly along the coast being less steep than the higher part.

Almost due east of San Luis Obispo the course of the Santa Lucia Range changes from north northwest-south southeast to east-southeast, and its definiteness as a range, clearly differentiated physiographically from the lowlands on both sides, decreases, although the change bringing this about is one that affects the lowland on the south to a greater extent than it does the mountain range. Here the range runs nearly east and west across the southeastern part of the area covered by the soil map.

The lowland belt south of the Santa Lucia Range, designated here as the San Luis Obispo lowland, but locally as three valleys, the Chorro, Los Osos, and San Luis, is a well-defined lowland belt extending from the coast of Estero Bay southeastward, becoming progressively narrow to a point about 8 miles southeast of San Luis Obispo. East of this point it is merely a hilly belt, lower than the Santa Lucia Range and in general lower than the southeastern extension of the San Luis Range, but a number of hills within it are practically as high as the latter mountains south of the lowland. That this hilly area is an ill-defined lowland underlain by less resistant rocks than those in the Santa Lucia Range is shown by the comparatively wide valleys of Huasna River and its small tributaries and of Arroyo Grande, south of the points where these streams emerge from the canyons on the south slope of the Santa Lucia Range.

The San Luis Obispo Valley west of San Luis Obispo includes two subordinate valleys and a range of low hills separating them, all running parallel to the general physiographic features of the region. Southeast of San Luis Obispo the valley, locally designated here as the San Luis Valley, is a smooth-floored lowland interrupted by a few low hills, the last one being Islay Hill, southeastward extensions of the chain of hills in the valley west of San Luis Obispo.

The San Luis Range, lying south of the San Luis Valley and between the valley and the coast, its crest constituting also the southern boundary of the area covered by the survey, is a range of rugged hills with a maximum height of a little less than 2,000 feet. The central part lying north of Arroyo Grande is low, with a maximum elevation of about 700 feet, and it is crossed by the narrow valleys of San Luis Obispo Creek, Pismo Creek, and Arroyo Grande. In the extreme southeastern part of the area this range is crossed by the valley

of Cayuma River, east of which the range continues as the San Rafael Mountains.

While sailing up the coast on a voyage of exploration, Cabrillo, in the summer of 1542, entered San Luis Obispo Bay. He was the first white person known to visit this region. More than two centuries elapsed, however, after the visit of Cabrillo, before any attempt at settlement took place. With the founding of the mission at San Luis Obispo in 1772, settlement was begun (*1*). A few Spanish land grants were made prior to the secularization of the missions in 1833, but following this act the country was rapidly granted in tracts, ranging from 3,000 to 50,000 acres, to various Spanish subjects who utilized their grants for the raising of cattle.

Following severe droughts in 1862, 1863, and 1864, the large grants were broken up, and from that time on for several years settlement progressed rapidly. The settlers were drawn mostly from the Northeastern and Central States, but many came from the gold fields in the northern part of California.

On February 18, 1850, San Luis Obispo County was created by legislative act, together with 26 other counties embracing the area of the State. The boundaries of the county established at that time remain practically the same to-day. San Luis Obispo has been the county seat since the formation of the county.

The early settlers were dependent entirely on ocean transportation for communication with the outside world, and the first settlements were along the coast. At the present time the coast section, together with the stream bottoms adjacent to San Luis Obispo, are the most thickly populated parts of the area.

No census data covering only the area surveyed are available, but figures given for the county as a whole are used, as they are representative of conditions in the area. According to the census for 1930 [2] San Luis Obispo County has a population of 29,613, of which 63.4 per cent is classed as rural. The rural population, which includes persons living in towns of less than 2,500 inhabitants, has a density of 5.6 persons a square mile. A large proportion of the population of the county is native white. The greater proportion of the foreign-born whites, who came largely from southern Switzerland and have the customs and language of Italians, live in the area surveyed and are engaged largely in the dairy industry. A small percentage of Indians, Chinese, Japanese, and negroes live in the county. Very few Indians remain, but many Japanese are engaged in vegetable gardening on the alluvial lands south of San Luis Obispo. Most of the Chinese and negroes live in the towns.

San Luis Obispo is the county seat of San Luis Obispo County and the principal town of the area, with a population of 8,276, according to the United States census for 1930. This town is a division point on the Southern Pacific Railroad, and serves as a shipping point for cattle, grain, dairy products, and other products of the region. Edna, a terminus of an oil pipe line; Port San Luis; Avila; Morro; Cayucos; Cambria; and San Simeon are small towns of local importance.

[2] Soil survey reports are dated as of the year in which the field work was completed. Later census figures are given when available.

The coast line of the Southern Pacific Railroad was built into San Luis Obispo from the north in May, 1894, and was completed through to Los Angeles in March, 1901. At the present time it provides transportation facilities to Pacific coast cities, as well as those in the Central and Eastern States. The Pacific Coast Railroad (narrow-gage) has its northern terminus at San Luis Obispo and operates a line through the Santa Maria Valley and south to Los Olivos in Santa Barbara County. A branch runs from San Luis Obispo to Port San Luis. This road hauls a rather large quantity of freight to and from the port, as well as agricultural products, including grain, hay, and dairy products, from the surrounding farming districts.

The Coast Highway, United States Highway No. 101, which is paved, passes through San Luis Obispo, affording comfortable travel by automobile to all points in the northern and southern parts of the State. A paved road from San Luis Obispo to Morro continues up the coast as far as Cambria, where it connects with a good graveled road which borders the coast to a point several miles above San Simeon. A road is now under construction along the coast which will ultimately connect this road with one being built down the coast from Monterey Bay. A paved road links Avila with the Coast Highway near Miles. A graveled, well-improved road extends eastward from San Luis Obispo into the upper Arroyo Grande Valley. Most of the other roads in the area are graded and are passable throughout the year.

Telephones are available in most of the rural districts, and rural schools and meeting places are conveniently located.

Dairy products, grain, beans, and vegetables are the principal agricultural products grown in excess of local consumption. Good markets are available for these products in Los Angeles and San Francisco.

CLIMATE

The climate in that part of the San Luis Obispo area lying along the coast is similar to that of the many coastal valleys occurring in this section of California, but the climate of the southeastern part of the area is decidedly different, more nearly resembling that of the intermountain coastal valleys of the State.

Along the coast and for several miles inland, in most places as far as the summit of the bordering mountain range, a distinguishing feature of the summer climate is the prevalence of fogs which are of almost daily occurrence, creeping into the valleys and up the mountain slopes in mid afternoon and remaining throughout the night, being dissipated only for an interval by the heat of the noonday sun. The prevalence of fog has an important bearing on the soil formation and the crop production of this region, inasmuch as the high humidity favors vegetal growth and materially reduces the loss of soil moisture by evaporation or by transpiration from plants.

Owing to the moderating influence of the ocean and to the prevalence of fog, the summers are cool, with little variation in temperature from day to day or from season to season. In many of the coastal valleys and lower points adjacent to the coast frost is of rare occurrence, and many grasses and vegetables, including

alfalfa, peas, and artichokes, are produced during the winter. Another frost-free belt includes a series of favorable spots on the mountain slopes, where air drainage is good and fogs are rare.

The summers in the southeastern part of the area are characterized by low humidity and hot days when temperatures of 115° F. or more may occur. The hot spells are commonly of short duration but contribute materially to loss of moisture from the soils and crops. During the winter frosts are frequent, and when they occur in late September, they sometimes damage crops.

The rainy season, as is characteristic of the Pacific coast climate, extends from late October or November to the early part of April. During late spring, summer, and early fall the rainfall is seldom sufficient to more than dampen the surface of the ground. The rains accompany southwest or west winds and are generally gentle. However, heavy rains occur at intervals and when they continue for several days are accompanied by much run-off with resultant erosion on the slopes and heavy floods over the river bottoms.

No rainfall records are available for the southeastern part of the area, though, judging from the natural vegetation and the reports of local residents, the rainfall is appreciably higher here than along the coast. This part of the area lies on the western slope of the Santa Lucia Range and receives an increase in rainfall resulting from elevation and the presence of a mountain barrier. The rainfall here is probably equal to that received at Santa Margarita just outside the area surveyed, to the north, where the mean annual rainfall is 28.41 inches. At San Luis Obispo the average annual rainfall is 20.61 inches, which is slightly more than is received on the coastal plain adjacent to the ocean. Increase in elevation from the coast eastward to the summit of the Santa Lucia Range is accompanied by increase in precipitation.

The rainfall varies greatly from year to year, and such variations are of decided influence on the agriculture of the area. The total amount of rainfall at San Luis Obispo for the driest year on record was 6.93 inches, and for the wettest year it is 49.99 inches. During the wet years fall-sown grain drowns out in most places, the soils remain wet until late in the spring, preventing cultural operations, and the hills are matted with sufficient native grasses to pasture a great number of cattle. A wet season may be followed by several years of low rainfall, when crops wither and die before reaching maturity and the hills in the eastern part of the area are brown and barren during most of the year. Bordering the coast the rainfall is generally sufficient, together with the moderating influence of the fogs, to insure against a failure of grass for pasture unless the range is overstocked.

The mean average temperature as recorded by the United States Weather Bureau station at San Luis Obispo is 58.5° F. There is a difference of only 11° between the mean summer and winter temperatures.

Table 1 gives the normal monthly, seasonal, and annual temperature and precipitation at San Luis Obispo.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at San Luis Obispo, San Luis Obispo County, Calif.*

[Elevation, 201 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1898)	Total amount for the wettest year (1884)
	°F.	°F.	°F.	Inches	Inches	Inches
December	53.0	87	24	2.34	0.64	8.85
January	51.6	84	20	4.72	1.37	10.57
February	53.1	87	25	3.58	2.20	10.21
Winter	52.6	87	20	10.64	4.21	29.63
March	54.7	93	28	3.98	.91	12.41
April	55.8	97	32	1.48	.06	3.39
May	58.2	98	34	.88	1.04	.00
Spring	56.2	98	28	6.34	2.01	15.80
June	62.2	110	37	.10	.04	2.26
July	64.7	103	42	.01	.00	.00
August	65.1	106	40	.04	.00	.00
Summer	64.0	110	37	.15	.04	2.26
September	64.5	109	41	.45	.20	.00
October	61.8	103	35	1.33	.39	2.17
November	57.3	94	24	1.70	.08	.13
Fall	61.2	109	24	3.48	.67	2.30
Year	58.5	110	20	20.61	6.93	49.99

Winds of high velocity are of rare occurrence, though a gentle breeze blowing in from the ocean is experienced nearly every day during the summer. The nights are calm and cool during all seasons of the year, affording opportunity for pleasant rest.

The average date of the last killing frost at San Luis Obispo is March 6, and the average date of the first is December 17, giving an average frost-free season of 286 days. Killing frosts have been recorded as late as April 21 and as early as October 22. Such frosts sometimes result in much damage to early-blossoming fruits or late-maturing fruit, vegetable, or hay crops. Bordering the coast, garden peas are grown successfully during the winter, and in the interior, wheat, oats, and barley may be fall sown without danger of winter killing.

AGRICULTURE

The extent to which the history of the early agriculture of the San Luis Obispo area is interwoven with the history of the missions is well expressed in the following quotation from an early history of this region (*1*):

> The missionaries who in 1769 brought to California the semicivilization of patriarchal, or medieval, times came dependent on the soil for their subsistence, and through three-quarters of a century of Spanish occupancy undisturbed by foreign intrusion prospered with their flocks and herds; rudely tilled the soil in favored localities; planted the grape, the orange, and the olive; and thus, to a limited extent, proved the capacity of the country to support mankind.

The mission founded at San Luis Obispo in 1772 prospered and was reported to be at one time one of the richest of the missions. With the secularization of the missions in 1833 the lands were granted by the Spanish Crown to various subjects. Agriculture as fostered by the padres fell into decline, and the raising of cattle became the dominant industry. Only sufficient wheat, corn, and beans were grown to supply the needs of the settlers.

With plenty of natural pasture and water available, the raising of great herds of cattle flourished so that with the coming of a period of drought in 1862–1864 the ranges were stocked to capacity. During the drought most of the cattle died and the landowners, unable to buy more cattle to restock the ranges, were forced to sell their holdings. With the subdivision of the large ranches, settlers began coming in rapidly and it was not long before all the better lands of the area were under private ownership.

Dairying was first introduced into the area about 1866, when about 600 head of dairy cattle were brought in. Owing to lack of transportation facilities, cheese was at first practically the only dairy product marketed. With ocean steamers anchoring regularly at Port San Luis, San Simeon, and Cayucos, transportation with the outside world was established, and by 1873, 300,000 pounds of butter and 500,000 pounds of cheese were produced in the area. The dairy industry continued to grow in importance, and 1,331,160 pounds of butter and 872,362 pounds of cheese were produced in the area in 1881. By 1915 the production of butter had increased to 2,759,751 pounds, but cheese production had decreased to 134,662 pounds.

The dairy industry at the present time is one of the most important industries in the area surveyed. The United States census for 1920 shows the value of all dairy products in San Luis Obispo County, excluding those used at home, to be $1,084,282 in 1919; and as practically all the dairy products produced in the county are produced in the surveyed area, the data have direct application. The 1920 census reports 26,366 dairy cattle in the county on January 1. In 1925, 4,078,000 pounds of butter were produced in the area (7). This was an average year, and data for this year are given as they are believed to more nearly represent conditions at this time than the reports for 1926, the last year for which data are available. During 1925, 32,000 pounds of cheese, 59,600 gallons of ice cream, and 460,000 gallons of market milk were produced in the county.

A cost study of the dairy industry bordering the coast is of interest, as this is the major agricultural industry in that part of the area. The study was conducted in 1928 by the dairy department of the San Luis Obispo County Farm Bureau cooperating with the University of California Agricultural Extension Service. The data is furnished through the courtesy of the San Luis Obispo County farm advisor. The study involves six high-net-profit herds and six low-net-profit herds. Table 2 gives a résumé of the findings.

TABLE 2.—*Cost data of selected dairy herds in the San Luis Obispo area in 1928*

	High-net-profit herds [1]	Low-net-profit herds [1]	Average, all herds
	Number	*Number*	*Number*
Average cows per herd	34.30	37.20	35.75
Average animal units per herd	46.38	46.80	46.59
	Pounds	*Pounds*	*Pounds*
Butterfat per cow	247.40	199.08	222.24
	Dollars	*Dollars*	*Dollars*
Total receipts per farm	5,707.41	4,789.09	5,248.25
Total expenses per farm	3,441.80	4,449.52	3,945.66
Net profit per farm	2,365.75	126.14	1,245.94
Farm income per farm	3,612.87	1,328.58	2,470.73
Labor income per farm	3,071.79	818.48	1,945.14
Total receipts per cow	176.24	128.55	152.40
Total expenses per cow	107.23	125.17	116.20
Net profit per cow	69.01	3.38	36.20
Farm income per cow	105.34	35.67	70.51
Labor income per cow	80.70	21.97	54.34

[1] 6 herds.

The study showed that the high-net-profit herds were fed 2,726 pounds of silage per cow and the low-net-profit herds, 1,790 pounds. About the same quantities of hay and concentrates were fed to the high-producing herds as to the low-producing herds, though the cost of pasturage per animal unit for the high-producing herds was $18.31 and for the low-producing herds was $29.29. The use of purebred sires and the practice of culling the poor producers through cow-testing records resulted in a difference of about 50 pounds of butterfat per cow between the high-producing and low-producing herds.

As in all other agricultural districts, the production of wheat, oats, and barley occupied the attention of the settlers at an early date. Wheat was grown for making bread, and other cereals were necessary for feeding horses and cattle. As settlements became established and markets were made available these crops continued to occupy the attention of the settlers, as they were staple commodities that stood shipment and for which a market was always available.

The United States census for San Luis Obispo County for 1880 shows wheat occupying 10,618 acres in 1879; barley, 9,658 acres; rye, 1,023 acres; and oats, corn, and buckwheat each less than 1,000 acres. Hay was grown on 7,950 acres.

The Southern Pacific Railroad was extended to Templeton in 1886 and to Santa Margarita in 1889; by 1894 it had reached San Luis Obispo and was completed through to Los Angeles in 1901. With transportation available the agricultural products of the county became more diversified. Potatoes, apples, and dry beans became important crops.

Barley increased in acreage until 1899, when the crop occupied 43,287 acres. After this the production of barley decreased and the acreage in 1929 was 12,324. There has been a decided increase in the acreage of beans. The acreage in alfalfa has materially increased, 4,543 acres being reported for 1929. Other hay and forage crops occupied about the same acreage as in the two previous decades.

In addition to dairying, an important agricultural pursuit in the hills and mountains is the production of beef cattle. Under the stim-

ulus of the high prices prevailing for beef cattle at the present time (1928) the industry will probably be expanded to some extent, greater use being made of waste areas, though it is not anticipated that the acreage devoted to this industry will ever be greatly increased, owing to the competition of crops, nor is it likely to be materially reduced in the near future, owing to the character of the country supporting the industry. Most of the land in this region is poorly adapted to other purposes.

The production of dry edible beans is an important industry. The crop is grown largely in rotation with barley, occupying the land every second year. Following harvesting of the barley crop the fields are pastured until the first fall rains. They are then plowed and left idle until spring, when the soils are thoroughly worked to a firm mellow seed bed. The crop is not planted until after the spring rains cease, as the moisture from the rains starts a growth of weeds that may spring up and choke out the beans. It is not uncommon for fields to be plowed and resown when late spring rains start a heavy weed growth following planting. The beans are sown in rows about 18 inches apart and given one or two cultivations as the season requires. They ripen in late September or in early October, when a V-shaped blade is run a few inches under the surface and the roots are cut, thus allowing men with forks to lift the plants and place them in bunches to dry. When thoroughly dry, the bunches are loaded on wagons and carried to a machine, where the beans are threshed and sacked, and are then ready for hauling to market. Barley is sown on the bean land in the fall without further preparation, as soon as there is sufficient moisture to germinate the seed.

The small white, pink, and baby Lima (Henderson Bush) beans are the principal varieties grown in the area. The baby Lima is grown only in the southeastern part where the absence of summer fogs gives favorable climatic conditions. The small white and pink beans are grown largely bordering the coast and in the coastal valleys. The pink bean is a somewhat heavier yielder than the small white, and, when prices warrant, the acreage of this bean sometimes exceeds that of the small white bean, but, as a rule, the price of the small white bean offsets the difference in favor of the higher-yielding pink bean.

The principal pest attacking the beans at present is an aphid which works on the leaves and stalks, sucking the juice from the plants and sometimes so reducing the crop that it does not pay to harvest it. Aphids can be controlled by spraying, but this is expensive and not practiced by many farmers. A root borer that did considerable damage has been reported in certain fields the past season. This pest can probably be controlled by keeping the bean crop off the land for a few years.

In a cost survey of this industry conducted by the University of California Agricultural Extension Service in Santa Barbara County, where conditions are similar to those prevailing in this area, it was found that for the season of 1927 the cost of labor and materials in the production of a bean crop on 18 different ranches ranged from $1.56 to $5.58 per hundredweight. The highest cost was from

a farm with a yield of 429 pounds an acre, and the lowest cost was from a field with a yield of 1,297 pounds an acre (*9*).

Wheat is not grown extensively in the area, owing to the tendency of the plants to rust under the moist atmosphere of the coast climate, but barley and oats are grown very successfully. Oats are grown only in a small way to supply individual requirements. Barley is grown in rotation with beans where beans can be grown, and in other sections it is grown on the same land year after year. Prior to growing barley in rotation with beans the yield had fallen off very materially, but in recent years when grown on bean land the increase in yields has ranged from 8 to 10 or more bushels an acre.

Alfalfa is produced under irrigation on the bottom lands where water for irrigation can be pumped at reasonable cost or diverted from the streams. Along the coast the crop is cut an average of four times a season and yields an average of 1 ton a cutting. This hay is in great demand among dairymen for supplemental feed during the dry season. The crop is irrigated almost exclusively by a system of metal pipes which may be moved about and joined together to lead water over the surface to different parts of the fields.

Sugar beets were at one time extensively grown on the bottom lands of the San Luis and Los Osos Valleys. At the present time less than 100 acres are grown in the area. Instead, vegetables, including peas, lettuce, and tomatoes, are grown to an increasing extent by Japanese farmers. During the season of 1927, 150 carloads of lettuce, 15 carloads of peas, and 10 carloads of tomatoes were shipped from the area, which did not include an appreciable quantity shipped by truck, express, and parcel post. A number of other vegetables are produced in the area for local consumption or are shipped in less than car lots. Apples, pears, peaches, and plums are grown in many of the intermountain valleys, but the growers are not organized and have no marketing association, consequently the prices received for their products depend largely on local demand.

Fertilizer (including lime) was purchased on 101 farms in the county in 1929 at a total cost of $75,298. Practically the only method of maintaining soil fertility on some farms is the application of chicken manure purchased from poultrymen in the northern part of the county. This manure is applied to vegetable or melon land.

Farm buildings in the area are fairly modern and in a fair state of repair. The work animals are of medium weight, and most of them are of good quality. Dairy cattle are largely of mixed breeds, the Shorthorn breed predominating along the coast. Cows of this breed are not heavy producers but are adapted to local conditions. Beef cattle are largely of the Hereford type. Some purebred herds are kept to produce breeding stock.

Many dairymen along the coast employ Swiss laborers as milkers throughout the year, others employ less help during the dry summer season. The help is generally well paid and efficient.

The size of dairy farms averages about 800 acres a farm; farms devoted to general farm crops range in size from 320 to 600 acres; and ranches devoted to the production of beef cattle range from 10,000 to 20,000 acres or more.

According to the 1930 census, 62 per cent of the farms in the county are operated by the owners, 33.4 per cent by tenants, and 4.6 per cent

by managers. Vegetable land is rented for cash or on a labor contract basis. Cash rents average about $40 an acre. On the share basis the owner generally receives one-fourth of the crop, and the tenant, who furnishes everything except the land, receives the rest.

The soils of the Clear Lake and Botella series are in general the best-developed and most valuable soils of the area, and ranking close to these in value are soils of the Yolo, Metz, Elder, Agueda, and Dublin series. Not all of these soils are used to the same extent, owing largely to a lack of water for irrigation. Were water available they would be of high value for crop production, the medium-textured types probably heading the list. The soils of the Lockwood series in this area are of high value partly because of their favorable location and partly because water is available for irrigation over most of them. Many of the residual soils developed on consolidated rocks bordering the coast, though not used for crops, have high value as grazing land in connection with the dairy industry. Many ranches located on these soils return the greatest revenue on the capital invested of any soils of the area. The Montezuma soils are the most productive soils in the more maturely weathered old valley-filling group, with the exception of the Lockwood soils already referred to.

More attention should be paid to the keeping of individual production records in connection with the dairy industry. The use of purebred bulls of the Jersey, Guernsey, or Ayrshire breeds crossed with grade Shorthorn cows should do much toward producing a better grade of dairy cattle. The keeping of more poultry, hogs, and dairy cattle on the ranches devoted to general farming is suggested. Strict adherence to a rotation, which should include a cultivated crop, such as beans, every second or third year, will do much toward maintaining the fertility of the soils.

SOIL SERIES AND TYPES

The dominant features of the soils within the San Luis Obispo area, except those lying on steep slopes and those lying above an elevation of about 1,200 feet, are such as have developed under the influence of low rainfall. By low rainfall in this connection is meant an amount too low either to maintain a dominant downward percolation of water through the soil or a percolation sufficient to remove all alkali and alkaline-earth carbonates present in the parent materials from which the soils have developed, but sufficient to prevent the accumulation of carbonates in the solum through the operation of soil-developing processes. The fully developed soils, with very few exceptions, contain carbonates in some part of the profile. With minor exceptions, all the well-developed soils, except those lying at high elevations, are dark colored. The exceptions consist of soils that are somewhat sandy, lying on flat surfaces where run-off has been at a minimum and percolation at a maximum for the region and the soil texture concerned, or of soils with a more or less perfectly developed solonetzlike horizon.

The soils of the area have been subdivided into soil series on the basis of differences in details of profile, including the parent materials, and each series has been further subdivided into texture units

on the basis of the texture of the surface layer of the soil to a depth ranging from 6 to 10 inches.

The parent materials have been accumulated from the rocks of the mountain ranges, mainly more or less metamorphosed fine-grained sedimentary rocks, through residual decay. This material has been left in place or has been shifted by different agencies and redeposited, the redeposited material occupying the lowlands, as a rule.

A brief description of the several soil series identified within the area, arranged, merely for convenience, according to the source and character of the parent materials, is given in the following pages of this report. The first group includes the soils developed or developing from materials accumulated by the disintegration and decomposition of the underlying rock. This group includes the Los Osos, Arnold, Cayucos, and Zaca series. Those soils developed from redeposited materials of relatively recent geologic age are included in the Elkhorn, Baywood, Botella, and Clear Lake series. Those soils developed from redeposited materials, relatively old geologically, are included in the Hames, Garey, Lockwood, McClusky, and Montezuma series. The recently deposited alluvium has been differentiated into the Yolo, Elder, Dublin, Metz, and Agueda series. The steep slopes have been designated as rough mountainous land or rough broken and stony land. Coastal beach and dune sand, also river wash, have been differentiated.

Where typically developed, soils of the Los Osos series are characterized by brown, dark dull-brown, or, in places, rich-brown surface soils. The upper subsoil layers are brown or dark-brown slightly compact material which grades into more compact dull-brown heavier-textured material in the lower subsoil layers. At a depth ranging from 30 to 40 inches the subsoils contain many fragments of partly weathered rock overlying bedrock. The Los Osos soils are developing from residual material weathered from sandstones and shales. The surface soils and subsoils are typically noncalcareous.

As mapped in this area some of the materials included with soils of this series are somewhat grayer and less maturely developed than typical, and they approach in character soils of the Hugo series of previous surveys (*5*).

As typically developed the surface soils of soils of the Arnold series are brownish gray or dark brownish gray, and they are generally low in organic matter. The subsoils are lighter in color than the surface soils and have a well-developed solonetzlike horizon at a depth ranging from 10 to 24 inches from the surface. The material is in many places sufficiently degraded to have developed a thin gray horizon abruptly underlain by the heavy horizon which breaks into well-defined columns, the rounded tops of which are coated with gray silty material from the overlying layer. The lower part of the subsoil grades very gradually into bedrock of fine-textured sandstone at a depth ranging from 30 to 40 inches. Drainage is well developed except in local areas having poor subdrainage.

As mapped in this area, the soils of the Arnold series include wide variations in color and in the character of the subsoils. Some of the areas have dark-colored surface soils with tough waxy compact subsoils which are more representative of the Tierra soils as mapped in previous surveys. Some of the included material is of rather

brown color and joins with somewhat gray inclusions of the Altamont soils of the adjoining Santa Maria area of earlier date.

Soils of the Cayucos series are characterized by dark-gray or black surface soils which are generally of heavy texture and well supplied with organic matter. The subsoils consist of material similar in color to the surface soils or only slightly browner. At a depth ranging from 30 to 40 inches the subsoils contain an appreciable quantity of rock fragments and are loose and friable. Partly weathered fragments of rock give this zone a grayish-drab mottled appearance. The soil materials are typically leached of lime, but the subsoils are slightly calcareous in places. The parent bedrock consists of sandstone or shale. Drainage is well developed.

Cayucos gravelly loam, however, is not typical of this series, as the subsoil is lighter yellow and the character of the underlying parent rocks is different. This soil probably represents a distinct series of soils but was included with the Cayucos soils owing to its small extent and relatively minor agricultural importance.

A few areas of the Cayucos soils in this area join with areas of the Diablo soils in the earlier Santa Maria area. At the time the Santa Maria area was surveyed the Cayucos soils had not been given recognition as a series so that the soils now included in the Cayucos series were included in the Diablo. The Cayucos soils differ from the Diablo soils in the presence of a very low content of calcium carbonate in the subsoils.

The surface soils of the Zaca series are dark gray, dark brownish gray, or nearly black and are highly calcareous. The subsoils to an average depth of 40 inches are dark-gray calcareous material which contains appreciable rock fragments increasing in number until bedrock is reached. The subsoils directly overlying bedrock are grayer than the material above. These soils are derived from weathered calcareous sandstone and shale materials. The bedrock is softly consolidated and is fragmental to a considerable depth.

A small area of Zaca gravelly clay loam adobe joins with Diablo clay loam adobe of the Santa Maria area. Like the Cayucos soils, the Zaca soils have only recently been given recognition as a separate series. They include dark-colored soils developed on calcareous rocks, and both surface soils and subsoils effervesce freely in dilute acid. They were formerly included in the Diablo series, in which only the subsoils are calcareous. Bodies of the Zaca soils of this area, occurring in localities of rough surface relief, also join with areas of rough broken and stony land of the Santa Maria area, which were not differentiated into soil series and types.

The Yolo soils are characterized by brown or rich-brown surface soils and subsoils in which some stratification is apparent in most places in the subsoils. These soils are well drained and consist of unweathered deposits derived largely from sedimentary rocks.

The surface soils of soils of the Elder series are characterized by dull grayish-brown or dark brownish-gray materials which are loose and friable where supplied with organic matter, but which run together and bake where the organic content is low. The subsoils consist of stratified materials of similar or, more generally, of lighter-colored deposits. The soils of this series consist of an unweathered alluvial deposit derived largely from sedimentary rocks,

though recognized as containing some material from igneous rocks. The Elder soils are differentiated from the Agueda soils on the absence of lime in the Elder.

A few very small areas of Elder fine sandy loam join with areas of Altamont fine sand, Altamont clay loam, Arnold sandy loam, and Diablo gravelly loam of the Santa Maria area. These areas of alluvial soils all occur in very narrow stream valley bottoms within hilly regions of residual soils. In the Santa Maria area they were not everywhere differentiated. A small area about one-eighth mile wide joins with Laguna fine sand, and another only about one-sixteenth mile wide joins with Yolo silt loam of the Santa Maria area. In the Santa Maria area both the Laguna and the Yolo soils included local areas of darker-colored materials given recognition at a later date as members of the Elder series.

The surface soils of soils of the Dublin series are dark gray or black and are characterized by a high organic-matter content. The subsoils are of similar color to, or only slightly lighter than, the surface soils. In many places, owing to poor drainage, they are mottled somewhat with rust brown and yellow. The soils of this series consist of unweathered or very slightly weathered materials having their origin typically in sedimentary rocks; but as occurring in this area, they are derived from a wider variety of rocks. The Dublin soils generally occupy first bottoms where drainage conditions are rather poorly developed. They are similar to the related Agueda soils but are differentiated from those soils on their darker color and the absence of lime throughout the profile.

The surface soils of types in the Metz series consist of light-brown or grayish-brown mildly or moderately calcareous material, in places having a shade of yellow. The subsoils are of similar color and of about the same lime content as the surface soils but are somewhat stratified. Typically, these soils are well drained except during periods of overflow, though as mapped in this area they include some poorly drained areas. They are of mixed origin.

The Metz soils, which were later recognized as soils of a distinct series, were included with the Yolo soils of the earlier California surveys, and a small area of Metz fine sandy loam joins with an area of Yolo fine sandy loam of the Santa Maria area.

The soils of the Agueda series are characterized by very dark brownish-gray or dark dull grayish-brown calcareous surface soils of moderate organic-matter content. The subsoils, to a depth of 6 feet or more, are somewhat lighter in color than the surface soils and of a stratified character. Lime is evenly distributed throughout the soil profile. These soils consist of unweathered deposits of mixed mineralogical character. Drainage is somewhat restricted.

The surface soils of soils of the Elkhorn series are brown or dull brown, and they overlie upper subsoil layers which are slightly richer brown and somewhat compact. The lower subsoil layers, to an average depth of 40 inches, are light-brown moderately compact material having a shade of red. Below this and extending to a depth of 6 feet or more is pale reddish-brown compact material containing numerous irregular seams of iron cementation, occurring without conformity to the existing surface relief. The soils of this series are immaturely weathered and represent marine deposits that

have been modified in part by weathering and in part by redistribution of the materials by wind action.

The dark-brown or dull dark-brown surface soils of the Baywood soils contain moderate or comparatively high quantities of organic matter. The subsoils, to a depth of 6 feet or more, are of similar or of slightly lighter brown color, and they have little or no evidence of compaction where freshly disturbed. Gullies in these soils, however, have vertical banks, and the faces of cuts show a zone of compaction or partial cementation. The soils are wind-accumulated or wind-modified marine sediments and are noncalcareous. Drainage ranges from good to excessive.

The Botella soils are characterized by dull dark-brown, dark grayish-brown, or brownish-gray surface soils moderately well supplied with organic matter. The upper subsoil layers are slightly compact material of similar color, which may be readily broken down under cultural operations to a granular structure. The next lower subsoil layer, to a depth ranging from 60 to 70 inches, is dark grayish-brown or lighter grayish-brown moderately compact material of slightly heavier texture than the overlying soil material. Beneath this layer is lighter-colored material which is lighter textured and, in most places, stratified, showing little evidence of weathering. The Botella soils have developed on low terrace and alluvial-fan materials of mixed origin, in which weathering is but slightly advanced. They are as a rule well drained, except in local areas which have poor subdrainage.

The Clear Lake series includes soils having dark-gray or black surface soils which contain comparatively high amounts of organic matter. The upper subsoil layers, to a depth ranging from 24 to 36 inches, are composed of moderately compact material of the same color and character as the surface soils. The lower subsoil layers consist of dull dark-gray or light grayish-brown heavy tough clay with moderately well defined solonetz characteristics. This material is highly calcareous. (Pl. 1, A.) There is a slight tendency toward an accumulation of lime in the upper part of this layer, though the subsoils are calcareous to a depth of more than 6 feet. The Clear Lake soils are developing on a young valley-filling deposit of mixed origin, which occupies low terraces and alluvial fans. The surface is prevailingly smooth and gently sloping, affording good surface drainage, but subdrainage in most places is poor. Soils of this series are developing on the bottoms and adjacent alluvial-fan slopes throughout the area. They are used in the production of beans, vegetables, grain, and hay.

A very narrow area of Clear Lake fine sandy loam joins with Yolo silt loam of the Santa Maria area, in which local areas of dark-colored material, since recognized as representing a distinct soil series, were included. A small area also joins with rough broken and stony land of the Santa Maria area, in which local narrow areas of alluvial stream-bottom soils were not differentiated.

The Hames soils are brown or dull brown, in many places having a red shade. The upper subsoil layers consist of light-brown, pale reddish-brown, or in places dull-brown slightly compact material of about the same texture as the surface soils. The underlying material, to a depth ranging from 60 to 70 inches, is brown or dull

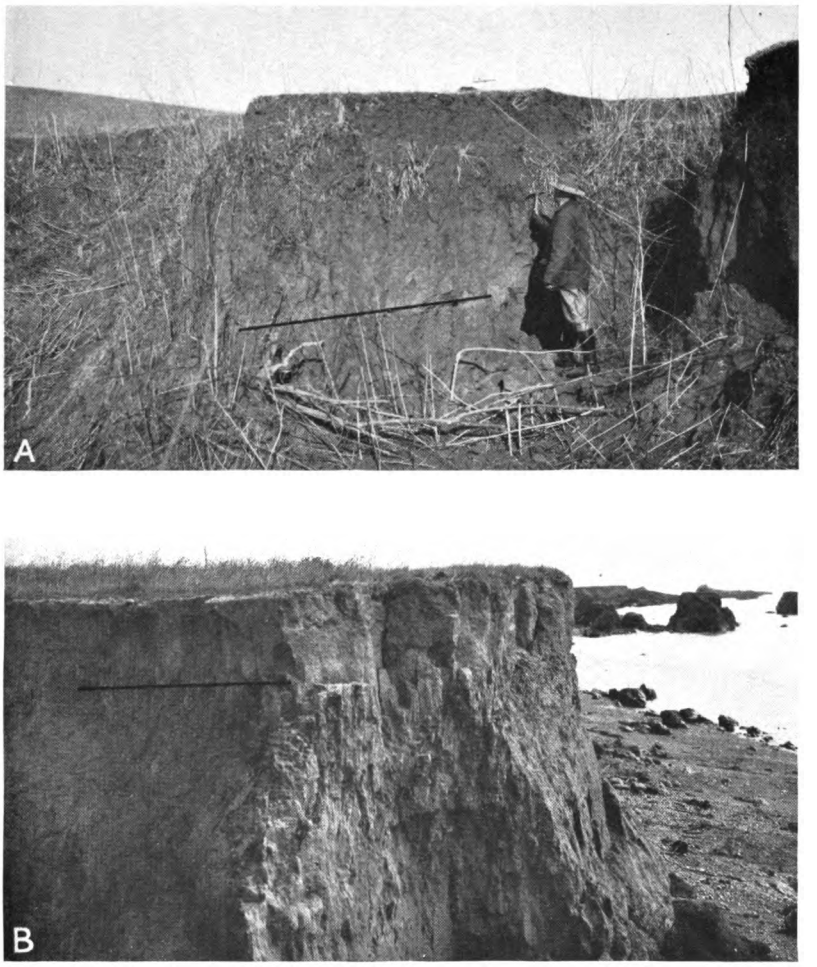
brown, extremely heavy and tough, with a well-defined solonetz-like character. The faces of the angular soil particles of the solonetzlike layer are coated with reddish-brown colloidal material. The lower subsoil layer to a depth of 90 or more inches consists of less compact lighter-textured material with little or no colloidal deposition. This layer is in general lighter colored than the one above. The soils of the Hames series occupy alluvial fans and elevated terraces with well-developed drainage. They are of mixed origin and maturely weathered.

The surface soils of soils of the Lockwood series consist of dark-gray or dark brownish-gray material which in most places contains a varying quantity of angular shale gravel. The subsoil, to a depth ranging from 45 to 50 inches, consists of an upper slightly compact layer of dull-gray or dark grayish-brown material which grades into very compact material of similar color but of heavier texture. This layer is somewhat indurated but has none of the characteristics of a solonetz horizon. The underlying material is lighter in color and texture and is only moderately compact. The soils of this series are derived from the weathering of old unconsolidated deposits having their source in siliceous shale materials. The soil material in most places is well weathered, though, as mapped, some included areas show little modification of the profile caused by weathering agencies. The soils are well drained.

A small area of Lockwood gravelly fine sandy loam joins with Diablo gravelly loam of the Santa Maria area. The Lockwood soils had not been recognized at the time of the earlier survey, in which they are inextensive, and were included with the Diablo soils. Another area joins with rough broken and stony land of the Santa Maria area, in which the Lockwood areas of rough relief and little agricultural significance were not differentiated.

The Garey series includes soils having light-brown or light grayish-brown surface soils overlying upper subsoil layers of similar or pale reddish-brown color, but having irregularly occurring seams of iron cementation. The lower subsoil layers are light reddish-brown moderately compact material, of about the same texture as the surface soils, which contains a great number of iron-cemented rust-brown seams. The soils of this series are developed on weathered marine deposits reworked and in part, at least, accumulated by wind action. They are well weathered. The surface relief is hilly or hummocky, and drainage is well developed.

The soils of the McClusky series are characterized by dull-brown or dark-brown surface soils that overlie upper subsoil layers of about the same color but with entirely different physical characteristics. At a depth ranging from 12 to 18 inches a well-defined heavy and seemingly indurated horizon is reached, having all the features of a solonetz horizon without the presence of the overlying gray layer. The material in this layer is brownish drab or dull brown, and it is not so much mottled with yellow and rust brown as the material directly overlying it. The underlying material, to a depth of 90 or more inches, is dull-brown compact material of lighter texture, containing appreciable colloids. The soils of this series occupy marine terraces and are well weathered. (Pl. 1, B.) Drainage is restricted by the tight heavy-textured subsoils.



A, Profile of Clear Lake clay adobe. Note old buried (fossil) surface soil at depth indicated by line. B, Soil profile of McClusky fine sandy loam exposed on low marine terrace. Note columnar heavy clay layer at depth indicated by line

The Montezuma series is characterized by soils having dark-gray or black surface soils, over upper subsoil layers of about the same color, which are slightly compact and contain a few lime-carbonate nodules or accumulations. The lower subsoil layers, to a depth of 74 or more inches, are light-brown or light grayish-brown lighter-textured material which contains considerable colloidal material and numerous lime-carbonate mottlings or nodules in the upper part. The mottlings decrease in number with depth. Below this layer and continuing to a depth of 90 or more inches, the subsoils contain no lime and little or no colloidal material. The soils of this series occupy elevated terraces and alluvial fans with well-developed drainage. They are of mixed mineralogical character and are well weathered.

A small area of Montezuma clay adobe joins with an area of Diablo clay loam adobe of the Santa Maria area. These two soils are similar in appearance, and differentiation in the field is in places difficult. This particular soil area is now thought to more nearly conform to the Montezuma soils.

In the following pages of this report the soils of the San Luis Obispo area are described in detail and their agricultural adaptabilities are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in Table 3.

TABLE 3.—*Acreage and proportionate extent of the soils mapped in the San Luis Obispo area, Calif.*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Los Osos fine sandy loam	23,872	5.1	Baywood fine sand	4,480	1.0
Los Osos gravelly clay loam	3,392	.7	Botella clay loam	4,480	1.2
Los Osos loam	2,368	.9	Light-textured phase	960	
Gravelly phase	1,792		Clear Lake fine sandy loam	1,984	.4
Los Osos clay loam	16,896	3.6	Clear Lake clay loam	3,904	.8
Arnold sandy loam	24,064	5.8	Clear Lake clay adobe	9,920	2.1
Reddish-brown phase	320		Hames fine sandy loam	2,432	.5
Heavy-textured phase	2,880		Hames clay loam	1,472	.9
Cayucos clay adobe	18,048	3.8	Heavy-textured phase	448	
Cayucos gravelly loam	1,088	.2	Dark-colored gravelly phase	2,240	
Zaca clay loam, brown phase	2,240	.5	Lockwood gravelly fine sandy loam	2,176	.9
Zaca gravelly clay loam adobe	1,920	.4	Dark-colored phase	1,536	
Yolo loam	1,728	.5	Dark heavy-textured phase	576	
Poorly drained phase	576		Garey fine sand	960	.2
Elder fine sandy loam	5,824	1.2	McClusky fine sandy loam	5,376	1.1
Dublin fine sandy loam	832	.2	Montezuma clay adobe	6,016	1.4
Dublin clay adobe	2,688	.6	Brown phase	448	
Metz fine sandy loam	5,312	1.3	Rough mountainous land	283,200	60.3
Heavy-textured phase	896		Rough broken and stony land	10,112	2.1
Metz loam	1,344	.3	Coastal beach and dune sand	1,472	.3
Agueda fine sandy loam	1,216	.3	River wash	2,304	.5
Agueda clay loam	1,408	.3	Tidal marsh	320	.1
Agueda clay loam adobe, poorly drained phase	960	.2	Total	469,760	
Elkhorn loamy sand	1,280	.3			

LOS OSOS FINE SANDY LOAM

The surface soil of Los Osos fine sandy loam, to a depth ranging from 6 to 10 inches, consists of brown, grayish-brown, or rather dull grayish-brown fine sandy loam of low organic-matter content. In virgin areas the topmost inch or two consists of granular soil material resting on soil which is slightly compact or puddled by trampling

of livestock in wet weather. The upper subsoil layer, to a depth ranging from 14 to 20 inches, consists of dull-brown or light-brown slightly compact loam or fine sandy loam, which breaks up when disturbed to a small cloddy structure. This material is very porous and contains many small threadlike cavities left after the decay of plant roots. The lower subsoil layer, to a depth ranging from 26 to 34 inches, is brown or lighter grayish-brown moderately compact loam, fine sandy loam, or clay loam, which is readily permeable to water, air, and plant roots. When exposed to the sun and air this material checks into medium or coarse clods. Brown or light-brown compact fine sandy loam, loam, or clay loam containing numerous fragments of the parent rock underlies the lower subsoil layer. This material grades into bedrock at a depth ranging from 40 to 50 inches. This soil has weathered in place from light-brown or light grayish-brown fine-textured sandstone or shale.

As occurring in this area, this soil departs somewhat from the typical Los Osos soils, in that the surface soil is grayer. In this characteristic it approaches somewhat the soils recognized in previous surveys in California as members of the Hugo series.

A few small bodies of this soil, in which the parent material, or bedrock, consists of feebly cemented sandstone, are mapped in the northern part of the area bordering the coast. Such areas have a somewhat higher water-holding capacity than the typical soil. Here and there some areas of clay loam texture are included in mapping. Most of the areas of this character occur on hill slopes or on saddles where subdrainage is somewhat restricted, such as the areas just south of Harmony and in the vicinity of San Simeon.

Los Osos fine sandy loam is comparatively extensive, a great number of bodies, aggregating 37.3 square miles, being developed in association with other residual soils throughout the area surveyed. A large area of this soil occupies the lower foothills extending northwest of San Simeon for a distance of about 8 miles and extending southeast for a distance of about 3 miles. An important area extends southeast from Cambria for a distance of 8 or 9 miles. Large typical bodies occupy the low rolling hills southeast of San Luis Obispo, and a great number occur in the San Luis Mountains and in other mountainous or hilly parts of the area.

Los Osos fine sandy loam has a rolling or hilly surface relief. Some bodies in the western part of the area have spots with steep surface relief on which cultivation would be difficult. However, the surface of most areas is smooth and little marked by erosion. Except in small local areas, drainage is well developed.

In the western part of the area surveyed this soil is largely grass covered, but some bodies occurring in the San Luis Mountains and in the southeastern part of the area are forested with oaks and brush. About 5 per cent of the land is forested, and a small part is cleared and used for bean or barley production. Grass-covered areas of this soil are used mainly as grazing land in connection with the dairy or beef-cattle industries. Barley and oats are grown on the cultivated areas to supply hay and grain for dairy or beef cattle.

The yields of beans are somewhat lower than on Los Osos clay loam. Barley and oats yield from 1 to 1½ tons of hay to the acre,

or when harvested for grain about 15 sacks[3] of barley and slightly more of oats.

The grass-covered areas are valued highly for dairy purposes as well as for beef-cattle production, and it is doubtful if they could be put to more useful or profitable use than for dairy purposes. Dairymen could grow a higher percentage of their grain feed, and in areas protected somewhat from the cold fogs along the coast, it would seem that Sudan grass might furnish a valuable green feed for cows that are fresh during the summer months.

Most of the ranches situated on this soil are large, averaging 500 acres or more to individual holdings.

LOS OSOS GRAVELLY CLAY LOAM

The 8 to 12 inch surface soil of Los Osos gravelly clay loam consists of brown or grayish-brown friable gravelly clay loam. The upper subsoil layer, to a depth ranging from 24 to 34 inches, consists of grayish-brown or dull-brown moderately compact gravelly clay loam or clay. The subsoil is readily permeable to plant roots and contains numerous small root cavities. The deeper part of the subsoil overlying bedrock consists of brownish-gray or grayish-brown friable gravelly loam, gravelly clay loam, or clay, which grades into bedrock with increase in gravel content and increased friability. The gravel in this soil consists of flat angular fragments of sandstone or shale and constitutes from 15 to 35 per cent of the soil mass. The gravel is light colored and gives the surface soil a grayer color than that characterizing the fine soil material.

As mapped, this soil includes some dark-colored areas which resemble soils of the Santa Lucia series mapped in previous soil surveys in the coast region (*4*). Soils in such areas are generally weathered from siliceous shale, and, if extensively developed, would have been correlated as Santa Lucia soils.

This soil is most extensively developed along Suey Creek, in Los Berros Canyon, and near the headwaters of Coon Creek 6 miles north of Avila. A number of unimportant areas, ranging in size from 50 to 160 acres, lie east of Huasna Valley and in the foothills southeast of San Luis Obispo. A comparatively large body borders Little Pico Creek 2 miles east of San Simeon, and smaller areas border Islay Creek south of Los Osos Valley.

A small area of this soil joins with an area of Altamont fine sand of the Santa Maria area. The Los Osos series has only recently been established, and the soils were included with the Altamont soils at the time the Santa Maria area was surveyed. Conflict in textural classification is due to gradation in texture in the material in the vicinity of the boundary between the two areas.

Areas of Los Osos gravelly clay loam are hilly or mountainous, and drainage is well developed.

This soil occupies a total area of 5.3 square miles in the San Luis Obispo area, of which about 5 per cent has been cleared of its virgin cover of oaks and brush and is now used for barley, oats, and bean production. The baby Lima bean is grown on this soil in the

[3] A sack of barley on the California markets ranges in weight from 100 to 150 pounds. An average-sized sack contains about 2 bushels.

eastern part of the area, though by far the greater part of the land devoted to beans is used in the production of the small white bean. The average acre yield of beans is 5 sacks of 100 pounds each. Barley and oats yield somewhat less than on Los Osos fine sandy loam.

LOS OSOS LOAM

The 8 to 10 inch surface soil of Los Osos loam consists of brown or dark-brown loam which in most places is rather friable to a depth of 1 or 2 inches but is somewhat run together or cemented below this depth when dry. In many places it contains a rather large quantity of fine sandy material and may include, as mapped, some fine sandy loam areas. The subsoil, to a depth ranging from 24 to 30 inches, consists of brown slightly compact heavy loam or clay loam, containing numerous root cavities and pore spaces. The deeper part of the subsoil, to a depth ranging from 36 to 40 inches, consists of a brown or reddish-brown friable fine sandy loam or loam, which is more friable and contains numerous small rock fragments above the point where it grades into bedrock. This soil is developed by the weathering in place of sandstones and shales or partly metamorphosed sandstones which locally are very siliceous.

As mapped the soil includes some bodies developed on basic igneous rocks, but such areas are of very irregular occurrence and of small extent and could not be mapped separately. The soil also includes some areas having local variations in texture, including areas of fine sandy loam, and others of clay loam texture, but most of such inclusions are small and agriculturally unimportant.

Los Osos loam is most typically and extensively developed in the foothills southeast and northwest of San Luis Obispo. An area of 600 or more acres occupies a ridge 4 miles northwest of San Simeon, and a smaller body is in the foothills west of Los Osos School.

Under virgin conditions about 10 per cent of the land is forested with oaks and brush, and the remainder is grass covered. Little or none of the forested land has been cleared, and less than 500 acres of the grass-covered land is under cultivation. Dairying is the chief industry on this soil, the native grasses being used for feed. Cultivated areas are used for barley and bean production, with smaller acreages of oats or wheat. Beans yield from 5 to 7 sacks, or an equivalent of 500 to 700 pounds an acre. Barley yields an average of 15 sacks an acre.

A crop rotation, which includes beans every second year, with oats or barley will aid in maintaining this soil in a productive state.

Los Osos loam, gravelly phase.—The surface soil of the gravelly phase of Los Osos loam, to a depth of 8 or 10 inches, consists of rich-brown, reddish-brown, or brownish-red loam containing a great quantity of sharp angular basaltic or diabase gravel. The subsoil, to a depth ranging from 24 to 32 inches, is compact gravelly loam or clay loam of similar or of only slightly redder color than the surface soil. A transitional zone, in most places from 4 to 6 inches thick, underlies the subsoil, in which the content of gravel increases materially and the soil becomes very friable where it grades into bedrock. This soil is residual from a local formation known as Osos basalt or diabase (*6*).

Soil of this phase is inextensive. If more prominently developed it would have been mapped under a separate soil series. A large number of small bodies, ranging from 10 to 20 acres in extent, have been included with other residual soils of the area due to the impracticability of differentiating them on the map. They are developed on intrusions of igneous rocks, and most of them occur as knolls or slight elevations over the hill slopes.

Important areas of this gravelly soil surround Islay Hill, southeast of San Luis Obispo and in this general vicinity; an area of appreciable size is 3 miles north of Piedras Blancas Point; and smaller bodies occur at the mouth of Morro Creek and near the headwaters of San Bernardo Creek.

Land of this kind has a low water-holding capacity and is not valued highly for agriculture. It is largely grass covered and used as grazing land in connection with the dairy industry. About 80 acres are under cultivation in connection with better soils. Barley is the principal crop grown, but the yields are generally unsatisfactory.

LOS OSOS CLAY LOAM

The surface soil of Los Osos clay loam, to a depth ranging from 6 to 10 inches, consists of dark-brown or dark rich-brown clay loam of small cloddy structure. The upper subsoil layer, to a depth ranging from 18 to 24 inches, consists of dark-brown slightly compact clay loam which has a faintly developed columnar structure when dry. When broken from an exposed bank this material has a coarse cloddy structure and is very resistant to crumbling. The deeper subsoil layer, to a depth ranging from 30 to 44 inches, is dull yellowish-brown compact clay or sandy clay containing a large quantity of colloidal material. Colloidal coatings give a glazed yellow cast to the faces of joints. The subsoil material grades into parent bedrock with little change in texture or structure. Bedrock consists of sandstones, shales, conglomerates, and metamorphosed sedimentary rocks belonging to the San Luis geologic formation (*6*).

Associated with the sedimentary rocks giving rise to this soil are a large number of intrusions of igneous rocks consisting of basalt or diabase. These intrusions give rise to reddish-brown soils which are in general shallower than the typical soil and closely resemble soils of the Olympic and Konokti series as mapped in many other areas of the State. Most areas of this character are small, ranging in size from 1 to 30 acres, and they are of very irregular occurrence, precluding the feasibility of consistent differentiation on the soil map.

As mapped, the soil also includes small undifferentiated areas of darker-colored soils. Such areas are widely scattered and are of little agricultural significance.

Los Osos clay loam is one of the more extensive residual soils of the area. It is prominently developed in the foothills bordering Los Osos and Chorro Valleys, and it borders all the larger valleys north of Morro Bay as far as China Harbor. An area of 3 or more square miles is in the foothills north of San Simeon.

The surface relief is hilly, some areas being too steep for successful cultural operations. Streams ramify to all sections of this land, affording complete drainage.

This soil occupies a total area of 26.4 square miles, of which less than 5 per cent is under cultivation, the remainder being grass covered and used as grazing land for dairy or beef cattle. The cultivated land is used in the production of barley as feed for dairy cattle and to less extent for beans, oats, or wheat. The yields of barley average about 18 sacks an acre, and bean yields range from 500 to 700 pounds.

The greatest agricultural value of this soil under present economic conditions is its use as grazing land for dairy cattle. In connection with the dairy industry more grain and grasses used as feed for livestock could be produced on the land.

ARNOLD SANDY LOAM

Arnold sandy loam is characterized by a light brownish-gray or dull dark brownish-gray surface soil, from 10 to 20 inches thick. The subsoil consists of light grayish-brown or, in places, of dull grayish-brown or dark brownish-gray sandy clay loam, or sandy clay, which rests on bedrock usually at a depth ranging from 30 to 40 inches.

Locally the surface soil is darker than typical, consisting of dark-gray or dark brownish-gray material. Such variations occur in areas of restricted drainage or where slight quantities of lime are present, as in an area south of Huasna School. Areas having the lighter-textured or heavier-textured subsoils are interspersed over the hill slopes with no regularity of occurrence and were not differentiated. In general the heavier-textured subsoil occurs in the flatter areas having poor subdrainage or in areas that receive seepage water from higher slopes. Some of the areas having heavy subsoils and a dark color approach in character the soils of the Tierra series of previous surveys (*2*). The greater part of this soil bordering San Simeon Creek, both on the north and south, has a heavy-textured subsoil.

Arnold sandy loam is residual from light-colored sandstone. Throughout the southeastern part of the area the sandstone bedrock is firmly consolidated, but bordering the coast most of it is softly consolidated material that can be bored into with a soil auger.

This soil typically occupies undulating or rolling hill slopes having well-developed surface drainage, but many areas have poor subdrainage. Under cultivation the soil erodes severely, and many swales and gullies occur, so that the lighter-colored subsoil is exposed on the crests of many interswale ridges.

Arnold sandy loam is extensive, occupying a total area of 37.6 square miles in this area. It is especially well developed in a belt of low hills southeast of Edna and on the rolling or undulating terracelike land north of Cambria. The greater part of the agricultural hills bordering the Huasna Valley are occupied by this soil, and a small body is at the mouth of Islay Creek south of Morro Bay.

Areas of this soil bordering the coast are largely grass covered and used as grazing land in connection with the dairy and beef

cattle industries. Other areas are forested under virgin conditions with oaks and brush and are of little value as grazing land. About 40 per cent of the forested areas have been cleared and are used in the production of barley, wheat, beans, and all kinds of garden vegetables. A very small acreage of the soil is used for wheat production in the southeastern part of the area where summer fogs are not so frequent as to cause rust. Yields of wheat average about 7 sacks to the acre. Barley is produced in rotation with beans and yields from 10 to 12 sacks to the acre. Most of the barley is used locally as feed for dairy cattle or for fattening beef cattle. Beans yield from 5 to 8 sacks to the acre. The small white bean is grown along the coast, but the baby Lima bean is grown almost exclusively in areas free from summer fogs.

Cultivated areas of this soil southeast of Edna are used in the production of general farm crops, as well as for small fruits and vegetables. Yields of fruits and vegetables are generally low.

Arnold sandy loam is generally considered a poor soil, though owing to its light texture it is locally valued for the production of early maturing fruits and vegetables. The addition of organic matter would increase the fertility of the soil and also aid in the control of erosion. Care must be exercised under cultivation to prevent erosion, though even with the greatest care erosion may occur on unprotected slopes during prolonged rainy spells.

Arnold sandy loam, reddish-brown phase.—The surface soil of the reddish-brown phase of Arnold sandy loam, to a depth ranging from 6 to 15 inches, consists of reddish-brown or light reddish-brown friable sandy loam. The subsoil, to a depth ranging from 20 to 30 inches, is somewhat redder than the surface soil but of similar or only slightly heavier texture. A transitional zone, in most places ranging from 3 to 6 inches in thickness and consisting of loose friable light reddish-brown sandy loam, mottled slightly with rust brown owing to the presence of partly weathered rock fragments, overlies the parent bedrock which consists of loosely cemented reddish-brown sandstone. Locally the soil is weathered to a depth of 6 or more feet and closely resembles the soils of the Moro Cojo series as mapped in the Salinas area (*2*).

This reddish-brown soil is inextensive, occupying only 320 acres in the area on the crest of a ridge a short distance northwest of Cambria. None of this soil is under cultivation, but it is forested with a scattered growth of pines and is valued only as grazing land or for the forest growth.

Arnold sandy loam, heavy-textured phase,—The surface soil of the heavy-textured phase of Arnold sandy loam consists of an 8 or 10 inch layer of dull brownish-gray or light brownish-gray material low in organic matter. The subsoil consists of light brownish-gray moderately compact clay loam which rests on bedrock of light-colored sandstone at a depth ranging from 34 to 45 inches. The texture of the surface soil differs appreciably within short distances. Areas of very fine sandy loam texture generally occupy the crests of the ridges, and areas of clay loam and loam texture occur in the swales and on the slopes.

This heavy-textured soil occurs in only one area, including 4.5 square miles, 1 mile west of Avila. The land is hilly, and cultural operations would be difficult on many of the slopes.

None of this soil is under cultivation, but it is largely open and grass covered. A few oaks grow in areas having the better moisture supply. The land is valued for the grazing it affords, and it is used in connection with the production of beef cattle. Under cultivation it should be more productive of general farm crops than the typical soil.

CAYUCOS CLAY ADOBE

The surface soil of Cayucos clay adobe, to a depth ranging from 9 to 12 inches, consists of dark-gray or black clay of adobe structure. This material shrinks and checks into blocks and fragments which become resolved into small clods when dry. The soil is well supplied with organic matter and on account of its adobe structure may be easily worked into a friable seed bed if handled when at the proper moisture content. The subsoil, to a depth ranging from 34 to 45 inches, is dark-gray or black compact clay containing some grayish-drab mottlings due to partly weathered rock. Free lime carbonate is seldom, if ever, found in this soil. The subsoil grades into parent bedrock with little change in texture or color other than an increase in the content of rock fragments. The soil is weathered in place from sandstone and shale.

This soil is largely uncultivated. It occurs in a rolling hilly district in which variations in texture from clay loam to clay adobe may occur associated with certain topographic forms. Such variations could not be economically differentiated and, as at present used, have little agricultural significance. Some undifferentiated areas of Los Osos clay loam and Los Osos fine sandy loam are also included with this soil as mapped.

This soil is comparatively extensive, occupying 28.2 square miles in the area. It is especially extensive bordering Santa Rosa Creek east of Cambria. Numerous bodies, ranging in size from 20 to 1,000 acres, border other creeks south of that place as far as Los Osos Valley. Other areas, of no particular importance from the standpoint of agricultural development, occur at different places in the hills and mountains of the area, particularly at Serrano and south of Santa Manuela School.

Cayucos clay adobe occupies rolling or steep hilly country having well-developed drainage.

Not more than 1,200 acres of this soil are under cultivation. Bordering the coast the land is grass covered and a few oaks dot the hill slopes, but in the southeastern part of the area it is largely forested with oaks, with a few open grass-covered areas. Bordering the coast the native grasses, consisting largely of wild oats, spring up with the first fall rains and by spring have attained a height of 2 or more feet and completely cover the ground. The grass-covered areas are valued highly as grazing land for dairy and beef cattle, and the cultivated areas are rotated to beans and barley. Barley is grown both for hay and grain and when cut for grain yields from 12 to 18 sacks an acre. Beans also produce well on the land, returning yields ranging from 6 to 8 sacks an acre, with higher yields reported in favorable years under good cultural practices.

The ranges are fenced, and on ranches where beef cattle are raised, and, less extensively, dairy cattle, the grasses are allowed to

seed one year and are pastured the next. The range is otherwise well managed and little or no overgrazing is apparent. The common practice among dairymen on the coast is to allow most of the cows to become dry late in the spring after the grasses have turned brown and to become fresh in the fall after the fall rains have started the grass. The cows are usually dry for a period of three or four months. This practice is an ingenious adaptation to natural conditions, but it has disadvantages in the matter of retaining hired help. The dairymen are prosperous, however, and rather welcome the respite from their arduous duties. A better seasonal distribution of labor and somewhat greater prosperity would result if green feed, such as Sudan grass, were grown so that milking could be continued throughout the year. Most dairymen on this soil could produce more barley and oats for feed, which would result in greater profit. On ranches where only the cream is sold the feeding of hogs offers a substantial source of revenue.

CAYUCOS GRAVELLY LOAM

The surface soil of Cayucos gravelly loam consists of a 10 to 14 inch layer of dark brownish-gray or black gravelly loam or gravelly sandy clay loam, moderately supplied with organic matter. The soil has a tendency to become baked and hard on drying. The subsoil, to a depth ranging from 18 to 30 inches, or to an average depth of about 24 inches, consists of light-brown or dull-brown compact gravelly clay loam or gravelly sandy clay loam, which has a shade of yellow in many places. The subsoil rests on consolidated hardpan-like material which is underlain at a depth of 6 feet or deeper by extremely compact unconsolidated material. The gravel in this soil consists of waterworn chert, shale, or granite material and constitutes from 15 to 30 or more per cent of the soil mass.

As occurring in this area the soil differs somewhat from the typically developed soils of the Cayucos series, both in the less well consolidated character of the parent material and in the lighter and somewhat more yellowish-brown or yellow color of the subsoil. It may represent a distinct soil series but was included with the Cayucos soils, owing to its limited extent and minor agricultural importance.

Cayucos gravelly loam occupies a total of 1.7 square miles in a rolling or hilly area in the southern part of the San Luis Obispo area, 3 miles east of Edna. It represents a terrace which is now greatly eroded and cut by drainage ways, as a result of which the present surface relief has developed. Drainage is good or excessive.

Under virgin conditions the land supports a scattered growth of oaks, with grasses occupying the intervening spaces. It is not cultivated and is valued only for grazing, for which the soil is best adapted.

ZACA CLAY LOAM, BROWN PHASE

Typical Zaca clay loam was not recognized in this area, but the brown phase represents a soil conforming to soils of the Zaca series in profile and occurrence, although it is somewhat browner.

The 6 to 10 inch surface soil of Zaca clay loam, brown phase, consists of light reddish-brown or dark dull reddish-brown calcareous clay loam of medium granular structure. The subsoil is light red-

dish-brown or dull reddish-brown moderately compact calcareous heavy clay loam or clay, which breaks into coarse clods that crumble readily into coarse granules on drying. The subsoil rests on bedrock of parent calcareous shale or sandstone at a depth ranging from 30 to 45 inches. The soil is fairly well supplied with organic matter and is absorptive and highly retentive of moisture. In the San Luis Obispo area small local bodies are noncalcareous in the surface soil.

The surface relief of this soil is rolling or hilly, and ordinary cultural operations can be practiced without difficulty. Drainage is well established.

Zaca clay loam, brown phase, occupies a total area of 3.5 square miles. It is typically and extensively developed in the southern part of the area 5 miles south of Suey Creek School. Several bodies occur at Serrano north of San Luis Obispo. The only area near the coast is 2 miles north of Morro.

This soil is fertile, has a high water-holding capacity, and is valued highly for the production of all crops. About 60 per cent of the land is under cultivation, and the remainder is grass covered and valued highly as grazing land. Barley and beans, with smaller acreages of oats and peas, are grown. A 2-year rotation is in general practice, alternating beans and barley, as clean cultivation incident to the production of the bean crop leaves the fields in excellent condition for barley the following year. Barley is sown in the fall after the first fall rains have supplied moisture for germination. The crop is harvested late in May or June, after which the fields are pastured until time for fall plowing. The following spring, beans are sown on the fields after the danger of frost is past. They are cultivated once or twice during the season, to keep down weeds and to maintain a mulch, and are ready to harvest early in October. The yields of barley following beans are materially higher than where barley is grown on the soil year after year. Barley yields from 15 to 20 sacks to the acre, with higher yields reported in favorable years on well-managed ranches. Beans yield from 5 to 10 sacks an acre; the lower yields are generally from aphid-infested fields. Oats are grown only as individual requirements dictate. Peas are grown on a small area of the soil lying well up the side of a mountain where climatic conditions are such that little frost is experienced. The pea crop is sown early in the fall after the first fall rains, and, with a greater number of warm, sunshiny days than is experienced along the coast, the crop is ready to harvest several days earlier than in other parts of the area. Native grasses make a luxuriant growth and are valued as forage for dairy and beef cattle.

Continued practice of good cultural methods and strict adherence to a rotation to include a cultivated leguminous crop, such as peas or beans, will aid in maintaining the productiveness of this soil.

ZACA GRAVELLY CLAY LOAM ADOBE

The surface soil of Zaca gravelly clay loam adobe, to a depth ranging from 10 to 14 inches, consists of dark-gray or black calcareous heavy clay loam or clay adobe, containing various quantities of flat angular fragments of the underlying parent bedrock. The fragments range in size from an inch to several inches in diameter and in some places constitute from 20 to 40 per cent of the soil

mass, but in other places they are not present in sufficient quantity to interfere with cultural operations. The subsoil consists of dark-gray or black moderately compact calcareous gravelly clay. Just above the point where the subsoil material grades into bedrock, at a depth ranging from 30 to 44 inches, it becomes more friable and somewhat lighter textured as well as lighter in color and contains a larger proportion of rock fragments than the overlying material. This soil is residual from highly calcareous light-colored sandstone and shale. The parent material is very fragmental in the upper part but becomes more firmly consolidated with depth.

Included in mapping are some areas which are lighter colored than typical, such as the one occurring 1 mile west of Edna, in which the color of the surface soil is dull gray or light brownish gray.

This soil occupies low rolling hills of favorable surface relief for cultural operations. Drainage is well established.

Zaca gravelly clay loam adobe occupies a total area of 3 square miles in the San Luis Obispo area. Several bodies whose continuity is broken by drainage ways, are 2 miles east of Edna, and other bodies occur in the vicinity of Bellevue School, Avila, and just west of the point where Pismo Creek leaves the area.

Approximately 80 per cent of the land is under cultivation, largely to beans and barley, with smaller acreages devoted to oats, peas, and cantaloupes. Under virgin conditions, the soil was sparsely forested with oaks and a luxuriant growth of grass carpeted the ground during the moister seasons of the year. Barley and beans are grown in rotation and are handled in the same manner and return about the same yields as are obtained on Zaca clay loam, brown phase. Areas of this soil devoted to cantaloupe or pea production are located along the coast. The yields are generally good.

This soil is well supplied with organic matter, has a high water-holding capacity, and is inherently fertile. Under good cultural practices it can be maintained in a productive state indefinitely. The practice of a rotation, turning under crop residues or other forms of organic matter, and care in cultivation to prevent puddling or the formation of a plow sole, are factors to be considered in its management.

YOLO LOAM

The surface soil of Yolo loam, to a depth ranging from 8 to 12 inches, consists of brown or rich-brown loam of rather light texture and approaching or including some areas of fine sandy loam. The subsoil, to a depth of 72 or more inches, is brown or rich-brown loam stratified with fine sandy loam or clay loam. A very pronounced compact layer is present in most areas of this soil, generally between depths of 4 and 12 inches. In many places this compact layer is extremely difficult to dig into with a shovel or to penetrate with a soil auger when dry, and it greatly retards the penetration of air, water, or plant roots. The soil has a moderate supply of organic matter and is absorptive and retentive of moisture under cultivation if in good physical condition.

Yolo loam occupies 2.7 square miles in the area surveyed. The bodies are widely scattered, occurring in the upper end of Los Osos

Valley 2 miles southwest of San Luis Obispo and in the lower end of that valley north of Sunnyside School. Other areas occur in several of the stream bottoms several miles northeast of Morro, in the vicinity of Cambria, and bordering Arroyo de la Cruz northwest of San Simeon.

The soil occupies first bottoms and is subject to overflow at irregular intervals. Varying currents during overflow have left the surface somewhat uneven, but otherwise the land is well adapted to cultural practices. The soil is unweathered and consists of recently transported materials derived largely from sandstones and shales.

About 30 per cent of this land is under cultivation, and the remainder is grass covered and used as grazing land. The principal crops grown are beans, barley, and alfalfa. Alfalfa fields are irrigated and used largely as pasture land for dairy cattle during the summer when the range grasses are dry and brown. When cut for hay the yields average between 4 and 5 tons an acre. Beans yield 10 or more sacks if not attacked by aphids, but complete failure of the bean crop sometimes occurs in badly infested fields. Barley yields from 12 to slightly more than 20 sacks an acre.

Areas of this soil which have a well-defined compact layer can be improved very materially by subsoiling to a depth of 15 or 20 inches to break up the compact layer. This will allow the free rooting of plants and facilitate the movement of moisture and air. Larger areas of this soil can be irrigated and used in the production of alfalfa in connection with the dairy industry. Areas adjacent to the coast are adapted to the production of artichokes and other vegetables. This soil is fertile and under good management can be maintained in a productive state.

Yolo loam, poorly drained phase.—The surface soil of the poorly drained phase of Yolo loam, to a depth ranging from 9 to 12 inches, consists of brown or dull-brown friable loam. The subsoil, to a depth of 72 or more inches, is dull-brown stratified loam or clay loam, which is slightly mottled with rust brown in the upper part. The mottling becomes more pronounced with depth, and during winter and late spring the water table in areas of this soil lies at a depth ranging from 2 to 4 feet.

A poorly drained area of silty clay loam texture, near the mouth of Morro Creek, is included with soil of this phase in mapping, because of its small extent. Two small poorly drained bodies of loam texture occur in the area, one in Morro Creek bottom 3 miles north of Morro and the other 4 miles northwest of San Luis Obispo.

Areas of this poorly drained soil are smooth and well adapted to cultural operations. Practically all the land is under cultivation, and more than 65 per cent of the cultivated acreage is in artichokes, the remainder being used for alfalfa, grain, or vegetable production. High average yields of grain and vegetables are obtained.

Suggestions given for the improvement and utilization of the typical soil are applicable to soil of this phase.

ELDER FINE SANDY LOAM.

The surface soil of Elder fine sandy loam consists of dark grayish-brown or dark dull brownish-gray friable fine sandy loam. The subsoil is slightly lighter colored than the surface soil and consists of

variously stratified materials of about the same texture. The soil material, as occurring in this area, is derived from unweathered deposits of mixed geologic origin but is recognized as being largely derived from siliceous material.

A few small bodies of this soil, occurring in the canyons southeast of Edna, have lighter brownish-gray or gray surface soils and subsoils and would be recognized as members of the Laguna series if more extensively developed. These bodies join with bodies of Laguna soils in the previously surveyed Santa Maria area (*8*).

A number of gravelly areas included with mapped areas of this soil are shown on the map by gravel symbols. Such areas do not differ essentially in characteristics from the typical soil, though the gravel interferes somewhat with cultivation and tends to make the soil of lower water-holding capacity than the nongravelly areas. The texture of the gravelly areas ranges from loam to sandy loam, the heavier-textured areas having somewhat better moisture-holding capacity. An included poorly drained area, comprising about 60 acres, along Morro Creek about 3 miles above its mouth, is of loam texture. The subsoil here is slightly mottled with rust brown, and ground water stands at a depth ranging from 3 to 4 feet during the rainy season.

Elder fine sandy loam is one of the more extensive recent-alluvial soils and occurs in a great number of creek bottoms throughout the area. Bodies of this soil occur along nearly all the small streams in the southern part of the area in the vicinity of Edna. This soil also occupies the bottoms of many of the creeks tributary to Huasna River. In the northern part of the area bodies of this soil occupy parts of the bottoms of Pico, Little Pico, and San Carpoforo Creeks.

Areas of this soil are still in the process of accumulation and are overflowed at irregular intervals. The surface relief is in general smooth and gently sloping, and the land is well suited to cultural operations.

About 65 per cent of Elder fine sandy loam is under cultivation and used in the production of practically all crops grown in the area. The greater acreage is devoted to beans, and smaller acreages are in barley, alfalfa, fruit, and vegetables. Uncultivated areas have a growth of willows along the stream courses and a few oaks scattered over the bottoms, with grass occupying the more open places.

On this soil in the southeastern part of the area, baby Lima beans are produced almost exclusively, and along the coast and in the interior valleys, the small white or pink Mexican bean is grown. The different varieties yield an average of about 7 sacks an acre, but yields of 10 or 12 sacks are not uncommon in favorable seasons on well-prepared land. As a rule the crop is injured to greater or less extent by the attacks of aphids.

Alfalfa is produced on irrigated areas of this soil, in connection with the dairy industry. The alfalfa fields are generally pastured, though when the crop is cut for hay an average of about 4 tons to the acre is obtained. Barley yields from 8 to 15 sacks an acre. Small plantings of apples, peaches, pears, strawberries, and other fruits are found in favorable locations. The trees and vines are in general healthy and well loaded with fruit in season. Though the yields are generally good the profits are not always certain, as

the fruits are not produced in sufficient quantities for commercial shipments and the growers must depend on local markets. Squashes, pumpkins, melons, corn, peas, and a variety of other vegetables are produced commercially and give fair yields.

The growing of intertilled leguminous crops and the turning under of organic matter will do much toward maintaining the fertility of this soil. The practice of a crop rotation is essential in any permanently successful agricultural program.

DUBLIN FINE SANDY LOAM

The surface soil of Dublin fine sandy loam, to a depth ranging from 9 to 14 inches, consists of dark-gray or black friable fine sandy loam rich in organic matter or humus. The subsoil, to a depth of 72 or more inches, is dark-gray or black stratified material, generally somewhat lighter in color than the surface soil. The texture of the different strata composing the subsoil ranges from fine sand to sandy loam, loam, and in places to clay loam.

This soil occupies slightly more than 1 square mile in the San Luis Obispo area. It is typically developed in a number of places in the Huasna district, especially near Huasna School, east of the Park ranch, and near the Tar Spring ranch. Areas near the coast occur in the lower end of Clark Valley south of Los Osos Valley, and in the bottom of a small tributary of Santa Rosa Creek northeast of Cambria.

The land is largely under cultivation. The untilled areas are covered with oaks and brush and are of little value as grazing land. Beans are grown on the greater part of the cultivated land, and the remainder is devoted largely to barley production. The baby Lima bean is grown on this soil in the southeastern part of the area and yields from 5 to 8 sacks an acre. Small white beans are grown along the coast and yield about the same as the Limas. Barley yields from 15 to 20 sacks an acre.

Dublin fine sandy loam is a productive soil, is easily tilled, and is generally well farmed. The practice of a rotation to include a leguminous crop and the turning under of organic matter will aid in maintaining this soil in a productive state. It should prove well adapted to vegetable production.

DUBLIN CLAY ADOBE

The surface soil of Dublin clay adobe consists of a 12 to 14 inch layer of dark-gray or black clay having a tendency to check into blocks which develop into small cubes or granules on drying. The structure is commonly referred to as adobe. This layer is underlain by a dark-gray or black clay subsoil which is in many areas mottled with rust brown, owing to poor subdrainage. Owing to the small cloddy or granular structure of the soil, it is comparatively easy to cultivate and can be worked under a somewhat wider range of moisture conditions than can most clay soils. If plowed when dry the material breaks up into coarse clods and lumps, but it slakes down under the first good rain to a fine-granular seed bed.

Because of their small extent, five small areas of clay loam texture comprising a total of about 300 acres, are included with this soil in

mapping. These bodies can be worked somewhat more easily than the typical soil, otherwise they are similar in agricultural value and in other respects. Three such bodies occupy small drainage ways midway between San Simeon and Cambria, one is 4 miles southeast of Edna, and the fifth is 1 mile north of Huasna School.

Typical areas of Dublin clay adobe are widely scattered throughout the area surveyed. A large typical area is in the Los Osos Valley, several smaller bodies border San Luis Obispo Creek, and an important area is 3 miles east of Edna. Near the coast, a number of bodies lie along small drainage ways north of San Simeon and along small drainage ways tributary to San Simeon Creek.

More than 60 per cent of the land is under cultivation, largely to beans and barley. These crops are rotated and occupy approximately equal acreages from year to year, except when prospects of an unusually good price for one or the other causes a deviation from established practice. Beans ordinarily yield an average of about 6 sacks an acre, though failures are not unknown in seasons of bad aphid infestation. Barley yields from 12 to 20 sacks, and yields of 36 sacks have been reported in unusually favorable seasons.

Suggestions for the improvement of this soil are the same as those given for Dublin fine sandy loam.

METZ FINE SANDY LOAM

The surface soil of Metz fine sandy loam, to a depth ranging from 10 to 14 inches, consists of brown, light-brown, or light yellowish-brown calcareous fine sandy loam which is rather low in organic-matter content but is loose and friable. The subsoil, to a depth of 72 or more inches, consists typically of light-brown or light yellowish-brown stratified calcareous fine sandy loam. However, areas in which the profile appears to have been modified somewhat by weathering are included in mapping. In these areas the subsoil, to a depth ranging from 40 to 48 inches, consists of light-brown or brown slightly compact fine sandy loam that breaks into coarse or medium clods which are readily crumbled in the hand under moderate pressure. The lower part of the subsoil, to a depth of 80 or more inches, is dull-brown or light-brown calcareous loam or very fine sandy loam, mottled in places with rust brown or yellow. In many places the surface soil is leached of lime.

The texture of this soil is somewhat variable within short distances, and some areas having sandy loam or, in places, a loam, texture may be included. Gravelly areas, which are shown on the accompanying soil map by gravel symbols, have a rather low water-holding capacity, and the gravel interferes to some extent with cultural operations. Such areas are of less agricultural value than the gravel-free areas.

Two small bodies having poor subdrainage are also included with mapped areas of this soil, as their total area of only about 80 acres does not warrant separation. In these areas the subsoil is waterlogged during the rainy season, and the deeper part of the subsoil especially is mottled with yellow and rust brown. The body of this character 5 miles west of Cayucos contains a slight quantity of alkali and is used only for grazing. The other poorly drained

body is on the southern boundary of the area near the coast at the point where Pismo Creek leaves the area.

Typical areas of Metz fine sandy loam are extensively developed along Huasna and Cuyama Rivers and Alamos Creek in the southeastern part of the area. Two small bodies border San Luis Obispo Creek, one-half mile north and 2 miles north of Bellevue School, respectively.

This soil occupies stream bottoms and low terraces, lying only slightly above overflow from the bordering streams. Some of the areas are subject to overflow at intervals, and most of these areas are slightly gullied by varying stream currents in time of overflow. Otherwise the land is well adapted to cultivation.

Under virgin conditions the land is sparsely forested with oaks and sycamore, and willow and brush grow along the streams. Grasses occupy the open spaces and are valued for grazing. Only a small part of the land is now under cultivation, and it is used largely for barley or oat production in connection with the beef-cattle industry. Some baby Lima beans are grown and yield from 6 to 8 sacks an acre. Barley yields from 10 to 20 or more sacks an acre, depending on the season and the care taken in the preparation of the land. Parts of the poorly drained areas of this soil along Pismo Creek are used for alfalfa and vegetable production, and very good yields are obtained.

Metz fine sandy loam is in good physical condition for plant growth. Low yields on the soil are generally attributable to a poor moisture supply, carelessly prepared seed bed, or some plant pest or disease. After being cropped for several seasons, the soil is generally low in content of organic matter and must be built up for best results.

Metz fine sandy loam, heavy-textured phase.—The surface soil of the heavy-textured phase of Metz fine sandy loam consists of an 8 or 10 inch layer of brown or light-brown friable clay loam or, in places, loam. The upper subsoil layer, to a depth ranging from 45 to 50 inches, is light-brown slightly compact clay loam which breaks up when disturbed to a medium or coarse cloddy structure. The lower subsoil layer, to a depth of 80 or more inches, is light-brown or dull-brown calcareous stratified clay loam or loam.

Soil of this phase has a higher water-holding capacity than the typical soil, and crop yields are correspondingly higher. The soil is easily handled if worked at the proper moisture content. Various crops are grown successfully on the soil, including alfalfa, vegetables, apricots, other fruits, and grains.

This heavy-textured soil occupies a total of 896 acres in the area surveyed. It is developed principally on San Luis Obispo Creek north and south of San Luis Obispo, and a small body is just east of Cambria.

The land is productive and can be so maintained if good farm practices are observed.

METZ LOAM

The surface soil of Metz loam, to a depth ranging from 9 to 12 inches, consists of light-brown or rather dull grayish-brown calcareous loam, in places having a shade of yellow and being of rather light fine

sandy texture. The soil is low in organic-matter content but is absorptive and retentive of moisture under cultivation. The subsoil, to a depth of 72 or more inches, is light-brown or dull grayish-brown calcareous stratified loam or very fine sandy loam. Both surface soil and subsoil are mildly calcareous, but no evidence of weathering or accumulation of lime is apparent in any part of the soil.

About 100 acres of poorly drained soil of clay loam texture are included with this soil as mapped. The surface soil of these areas is somewhat more plastic than that of the typical soil and can not be worked under so wide a range of moisture conditions as can typical Metz loam. The subsoil is mottled with yellow and rust brown, owing to poor drainage, and the water table stands at a depth of about 3 feet from the surface during the rainy season. One of the largest bodies of this character is at the mouth of Chorro Creek, a second occurs near the mouth of Los Osos Creek, and another is on San Luis Obispo Creek near Santa Fe School.

Metz loam occupies first bottoms, having gently sloping surface relief, which are slightly gullied by overflow but are well drained. Although the soil material is of mixed origin, it is recognized as coming largely from sedimentary rocks. Typical bodies are along San Luis Obispo Creek, Chorro Creek, and in the bottom of a small creek 1½ miles north of Piedras Blancas Point.

About 50 per cent of the land is under cultivation, and the remainder is covered with grass or willows and is used as grazing land. Under cultivation the soil is productive of nearly all crops grown in this region. Beans occupy the larger acreage, and smaller acreages are devoted to alfalfa, barley, corn, vegetables, and fruit. Beans yield from 8 to 11 sacks an acre, barley from 10 to 18 sacks, and the yields of other crops are equally satisfactory.

The chief need of this soil is the addition of organic matter and the adoption of good cultural practices. If properly handled it may be retained in a highly productive state for many years.

AGUEDA FINE SANDY LOAM

Agueda fine sandy loam is characterized by a dull dark brownish-gray or dark-gray calcareous fine sandy loam surface soil extending to a depth ranging from 9 to 12 inches. The subsoil consists of stratified material of similar, or only slightly lighter, color. The lime in the soil is evenly distributed, with no tendency toward accumulation. Locally some gravel, consisting of chert, shale, or broken fragments of massive fossilized shells, are scattered over the surface. The soil is well supplied with organic matter and is readily absorptive of moisture, retaining it well under cultivation.

About 60 acres of soil of loam texture have been included with this soil as mapped. The heavier-textured soil is similar in all essential respects to the typical fine sandy loam, except that it is somewhat harder to handle under cultivation and has a higher water-holding capacity than the typical soil. Heavier-textured areas border San Luis Obispo Creek 1½ miles north of Bellevue School, and Santa Rosa Creek 5 miles east of Cambria.

Bodies of typical Agueda fine sandy loam occur along Potrero and Saucelito Creeks and other tributaries of Arroyo Grande Creek

in the southeastern part of the area, and along tributaries of Huasna River south and east of Huasna School.

The soil occupies first bottoms only slightly higher than the normal flow of the bordering streams, and in time of high water the soil is overflowed for short periods. The land is smooth, except for a few gullies and intrenched streams, and it is well adapted to cultural operations.

This soil is inextensive, occupying only 1.9 square miles in the area surveyed. It is of no particular agricultural importance, as less than 5 per cent of the land is under cultivation. The principal crops grown are beans and barley. Some grapes and vegetables are produced on the cultivated areas, and the remainder is used as grazing land. The yields of beans and barley are slightly less than on Agueda clay loam.

This soil should prove well adapted to alfalfa production in localities where water can be developed for irrigation, as it is fertile and adapted to a wide range of crops.

AGUEDA CLAY LOAM

The surface soil of Agueda clay loam, to a depth ranging from 10 to 14 inches, consists of dull-brown, dark grayish-brown, or dark brownish-gray calcareous clay loam which is moderately well supplied with organic matter and of good moisture-holding capacity. The subsoil is stratified calcareous dull-brown or dull grayish-brown clay loam. The soil has a rather high content of fine and medium sand and if worked at the proper moisture content can be easily handled.

This soil occupies a total area of 1,408 acres in the area surveyed, the greater part of which occupies the bottom of Santa Rosa Creek just east of Cambria; a comparatively large body occurs along a small tributary of the same creek south of Cambria; two areas are southeast of Edna; and others are at Avila, near Bellevue School, and southeast of Morro Beach.

Agueda clay loam occupies first bottoms, that are overflowed at irregular intervals, or low terraces that lie just above high water. During the rainy season, subdrainage in some areas of this soil east of Edna is poorly developed and the soil is affected with slight accumulations of alkali, but elsewhere drainage is fairly well developed.

Probably 60 or more per cent of the land is under cultivation, and the remainder is grass covered and valued as grazing land for dairy cattle. Irrigated areas of the soil are used in the production of alfalfa, about 300 acres being devoted to this crop. As with other soils of the area, however, beans and barley occupy the largest acreages. Some corn, apples, peaches, pears, and other fruits are successfully produced. The small white and pink beans are grown and yield from 6 to 10 sacks an acre. In most seasons, aphids do much damage to the bean crop, reducing the yield materially. Barley yields from 15 to as much as 25 sacks an acre. Dairymen on this soil are in general prosperous. They produce alfalfa and corn for summer feed and utilize the adjoining hills for pasture land. Alfalfa, when cut for hay, yields from 4 to 6 tons an acre. Fruits

yield well and are of good quality, but the local market is rather poor.

Agueda clay loam is a productive soil and is generally well farmed. In any permanently successful agricultural enterprise a system of farming must be followed that will return plant food to the soil, keep the fields free of weeds and insect pests, and maintain a soil structure favorable to plant and bacterial life. The turning under of organic matter, the practice of a crop rotation, and good cultural practices are factors to this end.

AGUEDA CLAY LOAM ADOBE, POORLY DRAINED PHASE

Typical Agueda clay loam adobe is not developed in this area but is represented by a poorly drained phase.

The surface soil, to a depth ranging from 10 to 14 inches, consists of dark-gray or black clay loam having an adobe structure. The subsoil is dark brownish gray or dark gray, in places black, and of similar or of somewhat lighter or heavier texture than the surface soil. Some mottling of iron stains, caused by poor drainage, occurs in places in the lower part of the subsoil. Soil of this phase is differentiated from the related Dublin soils because both the surface soil and subsoil range from mildly to highly calcareous.

Mapped with this soil are small areas, including about 80 acres, which are essentially similar to the soil under discussion in color, lime content, and origin, but they have sandy loam surface soils. The lighter-textured areas are much easier to cultivate, but they have a lower water-holding capacity. Bodies of this character occur in the vicinity of the Park ranch north of Huasna School in the southeastern part of the area.

Areas of the poorly drained Agueda clay loam adobe occur along Pismo Creek at Edna, 3 miles southeast of that point, and along Chorro Creek just east of Hollister Peak.

The soil is unweathered and has little or no tendency toward accumulation of lime in the subsoil. It occupies first bottoms subject to overflow at irregular intervals. Surface drainage in most areas is good, though subdrainage is restricted.

About 20 per cent of the land is under cultivation, largely to beans and barley. Some alfalfa is grown in connection with plantings on adjoining soils, but the yields obtained are somewhat lower than on Agueda clay loam. Uncultivated areas are grass covered, and willows grow adjacent to stream courses. Such areas have a high value for grazing.

Suggestions given for the improvement and utilization of this soil are the same as those given for Agueda clay loam.

ELKHORN LOAMY SAND

The 7 to 12 inch surface soil of Elkhorn loamy sand consists of brown or dull dark-brown loose slightly coherent loamy sand or light sandy loam. The upper subsoil layer, which extends to a depth ranging from 24 to 32 inches, is brown or rich dark-brown slightly compact loamy sand, or sandy loam, which grades imperceptibly into light-brown moderately compact sandy loam or loamy sand having a shade of red. This material continues to a depth

ranging from 38 to 44 inches, where it is underlain by distinctive pale reddish-brown compact sandy loam or loamy sand containing a number of reddish-brown iron seams, an inch or less thick, forming an irregular pattern through the subsoil to a depth of more than 6 feet. The seams are firmly cemented with iron and occur as lenses or plates without a pattern conformable to existing or past surface configuration.

This soil occupies low terraces of rolling or hummocky relief. The soil is developed on a moderately weathered marine deposit which has been modified and added to by wind deposition since its uplift. Drainage ranges from good to excessive.

The only areas of this soil in the San Luis Obispo area occupy the low terraces adjacent to the ocean. A total area of 1,280 acres is mapped. The soil is prominently developed on Piedras Blancas Point, 5 miles north of that place, and on San Simeon Point. Other bodies occur near the mouths of San Simeon and Pico Creeks and bordering the coast midway between San Simeon Point and Piedras Blancas Point.

The land is grass covered and is used only for grazing in connection with the dairy and beef-cattle industries.

BAYWOOD FINE SAND

The surface soil of Baywood fine sand, to a depth ranging from 10 to 15 inches, consists of brown, dark dull-brown, or, in places, dark-brown loose slightly coherent fine sand. The subsoil, to a depth of 72 or more inches, is brown or dark grayish-brown very slightly compact fine sand. When digging in the soil with a shovel there appears to be no zone of clay accumulation, though exposed cuts show a zone from 10 to 15 inches thick, at a depth of about 30 inches, in which the soil resists erosion or crumbling to a slightly greater degree than the material elsewhere throughout the profile.

A part of the land has been planted to eucalyptus, and in such areas the soil is more plentifully supplied with organic matter and is darker than elsewhere.

Areas of this soil occur only in the vicinity of Morro Bay where they occupy a total area of 7 square miles. The soil is derived from materials of marine deposition now occupying coastal terraces and in part carried from the beaches to their present position by wind.

The surface relief ranges from undulating to rolling or hummocky, and drainage is excessive.

Virgin areas of this soil are partly brush covered and partly open and grass covered. About 100 acres are planted to beans or barley, depending on the season, but yields are low. Some grapes have been planted on this soil, and about 500 acres are devoted to eucalyptus trees. The trees protect the soil from blowing and in time will provide an income from the sale of wood. The greater part of the land in the vicinity of Morro Bay has been subdivided, and the soil is valued higher as building sites than its agricultural value warrants.

Baywood fine sand is not considered of high agricultural value. Under future development it should prove best adapted to the production of vines and early maturing annual crops or to the production of eucalyptus for wood.

BOTELLA CLAY LOAM

The 8 to 12 inch surface soil of Botella clay loam consists of dull dark grayish-brown or dark brownish-gray clay loam of granular structure. The upper subsoil layer, continuing to a depth ranging from 26 to 34 inches, is dull grayish-brown or dark grayish-brown slightly compact clay loam that contains numerous pore spaces and when disturbed breaks down to a granular structure. The deeper subsoil layer, to a depth ranging from 60 to 65 inches, consists of moderately compact heavy clay loam. This material contains fewer pore spaces than the layer above, and, when broken from an exposed soil section, it breaks into coarse or medium clods. A faintly developed columnar structure is apparent in this layer. Below the deeper subsoil layer the material is lighter-brown slightly compact stratified clay loam or clay, that is apparently structureless.

Gravelly bodies of this soil are shown on the soil map by gravel symbols. The gravel consist of rounded or subangular shale, sandstone, or granite rock fragments, which constitute from 15 to 35 per cent of the soil mass and interfere with many cultural operations, as well as render the soil more droughty than typical. The yield of various crops on the gravelly areas is slightly less than on the typical soil. A number of gravelly areas occur in the vicinity of San Luis Obispo, one a mile north and a second 3 miles southwest of the city. An area occurs on Chorro Creek west of Goldtree, one a mile north of Edna and another 2 miles northeast of Santa Manuela School on Arroyo Grande Creek.

Typical bodies of this soil occur along tributaries of San Luis Obispo Creek, north, south, and east of San Luis Obispo. Smaller areas lie along Chorro Creek and bordering the ocean, in the bottoms of a number of creeks, including Morro, Toro, Santa Rosa, and San Simeon Creeks. A few small bodies are along minor drainage ways northwest of San Simeon.

Botella clay loam is developed on a slightly weathered alluvial deposit of mixed origin, which occupies low terraces slightly above overflow of the bordering streams. The surface relief is smooth, and the land slopes gently toward the drainage ways. Surface drainage and underdrainage are well developed.

Botella clay loam occupies 7 square miles in the area surveyed, of which about 70 per cent is under cultivation. Irrigated areas of this soil south of San Luis Obispo are used for the production of vegetables; elsewhere irrigated areas are used largely for alfalfa production in connection with the dairy industry. More than 50 per cent of the cultivated land, however, is devoted to barley or bean production. Some fruit and corn are grown on small acreages.

On areas bordering the coast alfalfa is cut three or four times a season, and yields average about 1 ton to the acre at each cutting. Corn grown for silage yields from 10 to 15 tons an acre, or when matured for grain yields from 30 to 40 bushels. Beans yield about 8 sacks an acre in normal seasons, though better yields are reported under favorable conditions. Other crops grown yield proportionately well.

Botella clay loam is a productive soil where properly managed, and it is adapted to a wide range of crops where climatic conditions

are favorable. Yields will probably remain satisfactory as long as beans or alfalfa are rotated. Turning under barnyard manure or the residue from leguminous crops will do much to keep the soil in a productive state.

Botella clay loam, light-textured phase.—The surface soil of the light-textured phase of Botella clay loam, to a depth ranging from 9 to 12 inches, consists of dull grayish-brown or dark grayish-brown loam of granular structure. The upper subsoil layer is of similar color but is more compact and grades, at a depth ranging from 30 to 34 inches, into slightly darker heavy loam or clay loam, which is noticeably compact. The unweathered material, occurring at a depth ranging from 60 to 65 inches, is light-brown slightly compact stratified loam or sandy loam.

This soil is developed on an immaturely weathered alluvial deposit which occupies low terraces or stream bottoms slightly above overflow. It occupies a total area of 960 acres in the area surveyed. Several bodies are along Arroyo Grande Creek and its tributaries. Areas near the coast lie along San Simeon Creek, in Clark Valley, and near its mouth south of Sunnyside School.

The surface relief of this light-textured soil is smooth and gently sloping, and the land is well adapted to irrigation or cultural operations. Drainage is good.

About 60 per cent of the land is under cultivation, practically all of which is devoted to the production of barley, oats, or beans. Yields are about the same as on typical Botella clay loam.

Where water can be developed for irrigation this soil would be of value in the production of alfalfa in connection with the dairy industry, but a pumping lift of more than 50 or 60 feet is generally considered not economical in the production of alfalfa.

CLEAR LAKE FINE SANDY LOAM

The 8 to 12 inch surface soil of Clear Lake fine sandy loam consists of dark-gray or black fine sandy loam rich in organic matter. Under cultivation the soil has a tendency to develop a plow sole, and in many cultivated fields a tight compact layer occurs at a depth of 4 or 6 inches. The upper subsoil layer, to a depth ranging from 28 to 36 inches, is dark-gray or black friable fine sandy loam of similar or only slightly lighter shade than the surface soil. The lower subsoil layer is distinctive and consists of dull-gray or very dull brownish-gray slightly compact calcareous fine sand, fine sandy loam, or loam. This material continues uniform in character, except for variations in texture, to an undetermined depth.

As mapped the soil includes some bodies closely resembling in color the soils of the Salinas series as mapped in the Salinas area of this State (*2*). In such areas the surface soil is dark grayish brown or dark brownish gray, and the dark brownish-gray subsoil includes a zone of lime accumulation similar to that occurring in the Salinas soils, but even the lighter-colored areas are somewhat darker than typical Salinas soils. The soil, as mapped, also includes some areas of gravelly texture, that are shown on the accompanying soil map by gravel symbols. In these areas the gravel constitutes from 10 to 30 per cent of the soil mass and interferes to a varying degree with cul-

tural operations. The gravel also tends to reduce the water-holding capacity of the soil, making such areas more droughty than the gravel-free areas.

This soil is prominently developed along Arroyo Grande Creek, occupying most of the bottom land adjacent to the creek. It is also extensive along Huasna Creek both north and south of Huasna School. Four bodies lie along San Luis Obispo Creek, two just west of Santa Fe School, and two 2 miles north of Bellevue School.

Areas of this soil occupy low terraces or stream bottoms no longer subject to overflow. The soil material is immaturely weathered. The surface relief is smooth and gently sloping, rendering the soil well adapted to cultural operations or irrigation. Although most of the soil areas are well drained at the present time, some areas have weathered in part under poor drainage conditions.

This soil occupies a total area of 3.1 square miles in the area surveyed, of which less than 25 per cent is under cultivation, principally to beans, barley, and oats. The yields of barley and oats each average about 15 sacks an acre and beans about 7 sacks of 100 pounds each.

Areas of this soil are generally not sold alone, but they have a higher value than the hill lands with which they are associated. The soil is naturally productive where properly handled. Subsoiling to break up the plow sole common to cultivated areas would result in better yields.

CLEAR LAKE CLAY LOAM

The surface soil of Clear Lake clay loam, to a depth ranging from 10 to 14 inches, consists of dark-gray or black heavy-textured clay loam of high organic-matter content. The upper subsoil layer, to a depth ranging from 24 to 34 inches, consists of dark-gray, black or, in places, dark brownish-gray slightly compact clay loam or clay, which may be slightly calcareous locally. The lower subsoil layer, to a depth of 72 or more inches, is dull-gray or light brownish-gray compact calcareous loam or clay loam, which, when dry, has a slightly developed columnar structure and breaks into coarse clods that are not readily broken down.

As mapped, the soil includes some areas that are dull brown or dull grayish brown, in this respect being similar to soils of the Salinas series as mapped in other areas of the State, but in general the areas average somewhat darker than soils of the Salinas series and could not be differentiated from typical Clear Lake materials. Areas of somewhat lighter texture, closely approaching a loam in character, are also included because of the comparatively small area of their occurrence. The lighter-textured areas can be cultivated somewhat more easily than the typical soil, otherwise they are similar both in profile and in crop-producing power. Areas of the lighter texture occur 1 mile east and 2 miles northeast of Bellevue School, 1 mile south of Edna, and near the mouth of San Simeon Creek bordering the coast.

Areas of this soil, which contain from 10 to 30 or more per cent of gravel scattered through the soil, are shown on the accompanying map by gravel symbols. Soils of this character are more droughty,

and crops suffer from lack of moisture more quickly than on the typical soil.

A large gravelly area occupies a creek bottom north of Edna, and a number of areas of typical soil are in the same vicinity. A great number of small widely scattered bodies of typical soil, ranging from 10 to 60 acres in size, occur in various other parts of the surveyed area, in association with other alluvial soils.

This soil occupies low terraces and stream bottoms no longer subject to overflow. The surface relief is smooth and gently sloping, affording good drainage and rendering the land well adapted to cultural operations, and to irrigation where water is available.

This soil occupies a total area of 6.1 square miles in the area surveyed, of which about 80 per cent is under cultivation. About 35 per cent of the cultivated acreage is irrigated and used for alfalfa production in connection with the dairy industry, and the remainder is used largely for bean and grain production. Some alfalfa hay is sold from the fields to local dairymen, though the greater part is fed on the ranches where grown. Yields of 4 or 5 tons an acre are obtained. Beans yield 7 or 8 sacks an acre, though yields ranging from 10 to 14 sacks, from fields free from pests and well farmed, are reported. Barley yields an average of 16 sacks an acre, but yields of more than 40 sacks are not unknown when conditions are unusually favorable. Corn, vegetables, and fruits grown on this soil return good yields.

This soil is of high agricultural value and is, in general, well farmed. Plowing to a depth of 8 or 10 inches at intervals or subsoiling will prevent the formation of a plow sole and keep the soil in good physical condition. The dairy industry can be extended wherever water for irrigation can be obtained. The keeping of poultry and hogs, as well as a few dairy cattle, in connection with general farming, is highly recommended.

CLEAR LAKE CLAY ADOBE

The surface soil of Clear Lake clay adobe consists of dark-gray or black clay or heavy clay loam of adobe structure to a depth ranging from 10 to 14 inches. The upper subsoil layer, to a depth ranging from 20 to 30 inches, is dark-gray or black moderately compact clay loam or clay, which has a fairly well developed jointed or columnar structure and breaks from an exposed section into medium-sized clods. The lower subsoil layer, to a depth ranging from 35 to 42 inches, is dull-brown or dull grayish-brown compact clay of pronounced jointed structure. The faces of the joints are usually coated with a dark-brown colloidal deposition which gives them a glazed appearance when moist. The deeper subsoil layer is distinctive and consists of light brownish-gray compact highly calcareous clay or clay loam. (Pl. 1, A.)

On drying, the surface soil tends to check into small granules or cubes, so that if plowed when dry or when slightly moist it will crumble after the first good rain into a loose friable seed bed. This structure makes the soil easier to handle than other heavy-textured soils.

In places the soil as mapped includes some areas of slightly lighter color than typical, but owing to their small extent differentiation under another series was not warranted.

Clear Lake clay adobe occurs in various-sized bodies in nearly every stream bottom bordering the coast, from Cambria south to Morro Bay. It is also one of the more extensive soils in the stream bottoms issuing from the foothills southeast of San Luis Obispo. It is especially prominent in the valley southwest of San Luis Obispo and in Los Osos Valley.

This soil occupies stream bottoms and low terraces no longer subject to overflow. The soil is derived from mixed rock materials and is immaturely weathered. It has a smooth gently sloping surface, little marked by erosion, that is favorable to cultural operations and to irrigation where water is available. Some areas have poor subdrainage, though in general the soil is well drained.

This soil occupies a total area of 15.5 square miles in the area surveyed, of which about 600 acres are under irrigation by pumps or by gravity water diverted from the near-by streams. The principal crop grown under irrigation is alfalfa which is in demand as feed for dairy cattle. Some garden truck is also grown under irrigation. Beans occupy about half the cultivated acreage from season to season, the extent of their planting depending somewhat on the prospect of a favorable price and on seasonal factors. Beans may be grown on the same field for several consecutive seasons, though the general practice is to plant barley every other year. Oats take the place of barley on small acreages as best suits the individual or seasonal requirements. Corn grown on this soil is used largely for silage, though some grain is harvested each year. The grain is fed largely to fattening beef cattle or to hogs.

The average yield of beans is about 8 sacks an acre, though yields of 12 or more sacks are obtained under favorable conditions. Barley yields from 12 to 25 sacks an acre, with a maximum yield of 48 sacks reported. Other crops produced generally return satisfactory yields.

Clear Lake clay adobe is a well-farmed soil and under good cultural practices returns high average yields. The dairy industry offers as good a prospect of profit over a period of years as any type of farming. In connection with this industry it is important that records be kept of the production of individual animals, and animals of poor quality should be disposed of without delay. The keeping of better breeds of dairy animals, including purebred bulls, will generally prove more profitable than the present practice of most dairy ranches of the area. The keeping of a few dairy cattle, hogs, and poultry on ranches devoted to general farming allows the use of waste land or other land poorly adapted to crop production for grazing land. Stubble fields can also be pastured to advantage, and screenings and other waste products incident to other farm operations can be used. One of the important features in diversification of this character, however, is that in seasons of failure of one crop other sources of income are available.

HAMES FINE SANDY LOAM

The surface soil of Hames fine sandy loam, to a depth ranging from 7 to 10 inches, consists of light-brown or pale reddish-brown

slightly compact fine sandy loam. The upper subsoil layer, to a depth ranging from 26 to 34 inches, is light-brown or pale reddish-brown firm fine sandy loam of vesicular structure, which breaks up under light pressure to a crumbly or fine-granular mass. The deeper subsoil layer, to a depth of 50 or 60 inches, is brown or dull-brown extremely compact gravelly heavy fine sandy loam or loam, in which the joints and gravel are coated with a dull-brown glazed colloidal deposit. The soil material in this layer is dense and without structural form. The deeper subsoil layer, to a depth of 90 or more inches, is light-brown compact gravelly loam or clay loam.

The surface soil is low in organic-matter content and tends to bake or run together if not cultivated soon after a rain. It also has a tendency to form a plow sole rather easily, and care must be exercised to plow at different depths from year to year. Some large areas of this soil, which contain varying amounts of gravel in the surface soil and subsoil, are shown on the soil map by gravel symbols. The gravel consists of rounded or subangular small or medium-sized fragments of sedimentary and igneous rocks, which constitute from 10 to 35 per cent of the soil mass and in some places interfere very considerably with cultural operations. The gravelly areas have a low water-holding capacity and are droughty, otherwise they do not differ from the typical soil.

The gravel-free areas are most prominently developed along Huasna River, and most of the gravelly areas occupy terraces adjacent to Cuyama River. A few small bodies of the typical soil border the ocean west of Port San Luis, and an unimportant area occupies a small drainage way 3 miles west of San Luis Obispo.

This soil is unimportant agriculturally, as only about 10 per cent of its area is under cultivation. Barley is the principal crop grown, though small acreages are devoted to beans and corn. Barley yields from 10 to 20 sacks an acre, depending on the season and the care taken in the culture of the crop.

The practice of a rotation to include a cultivated crop every other year would increase the yields of barley on this soil and otherwise prove advantageous. Organic matter should be added as conditions warrant.

HAMES CLAY LOAM

Under virgin conditions, the superficial layer of the surface soil of Hames clay loam consists of 1 or 2 inches of brown or rich-brown granular loam or fine sandy loam, containing small grass roots in various stages of decay. The deeper layer of the surface soil, to a depth ranging from 9 to 12 inches, is brown or dull-brown slightly compact clay loam which breaks from an exposed section or plow sole into coarse clods that are very firm when dry. Numerous hair-like root cavities penetrate this layer, allowing easy penetration of air and moisture. The upper subsoil layer, to a depth ranging from 20 to 30 inches, is dull-brown or dull yellowish-brown extremely compact gravelly clay loam or clay that is mottled slightly with rust brown and yellow, due to incomplete weathering of included fragments of rock. As a rule, this zone is without structural form. The deeper subsoil layer, to a depth ranging from 60 to 70 inches, is dull

yellowish-brown or dull-brown fine sandy loam, loam, clay loam, or clay, containing gravel. This material is compact, dense, and amorphous. The gravel occupy about 50 per cent of the soil mass and are coated with a dull-brown glazed colloidal deposit. When bored into, partly decayed gravel give the material a mottled appearance. The lower subsoil layer, to an undetermined depth below 84 inches, is light yellowish-brown or light-brown moderately compact material which is not so dense and compact as the overlying material. No appreciable colloidal coating is present on the gravel, showing that this zone is relatively unweathered.

Small areas of this soil occur in which the surface soil is dull-brown, and on small areas gravel occurs over the surface, but such variations are of slight extent and of no particular agricultural importance.

A total of 1,472 acres of this soil occurs in the area surveyed, lying mostly on the headwaters of San Luis Obispo Creek west of San Luis Obispo. A few small bodies are in Los Osos Valley, and an area borders Cuyama River in the southeastern part of the surveyed area. Less than one-third of this soil is under cultivation, and the remainder is grass covered and used as grazing land. About 50 per cent of the cultivated area is used for bean production, and the remainder is largely devoted to barley. A 2-year rotation of beans and barley is in general practice. Small acreages of oats, corn, and other general farm crops usually occupy less than 100 acres of the soil.

Beans are attacked by aphids to a varying extent. Almost every year the yield is cut down materially. Fields free of aphids yield from 10 to 12 sacks an acre under good management, and yields from fields that have been attacked by aphids range from failure to 8 sacks an acre. Barley yields from 12 to 20 sacks an acre.

Most areas of this soil can be improved by the addition of organic matter. Greater diversification of farming operations, to include the raising of some dairy cattle, poultry, hogs, or sheep, will generally prove profitable. Strict adherence to a rotation including a cultivated crop, such as beans, will keep this soil in a productive state for many years.

Hames clay loam, heavy-textured phase.—The surface soil of the heavy-textured phase of Hames clay loam, to a depth ranging from 9 to 12 inches, consists of brown or rich-brown clay of somewhat adobelike structure. The upper subsoil layer, to a depth of 20 or 24 inches, is dull-brown or brown compact gravelly clay or gravelly clay loam, and the deeper subsoil layer, to a depth ranging from 60 to 70 inches, is dull-brown or dull yellowish-brown extremely compact gravelly clay or clay loam. The gravel in this layer is coated with colloids as are also the faces of joints or cavities in the soil. The lower part of the subsoil, to a depth of 90 or more inches, is lighter-colored less compact gravelly clay loam without appreciable colloidal deposits.

Areas of this heavy-textured soil include some bodies which are only slightly heavier than clay loam. Many of the heavier areas more nearly resemble clay loam, owing to the adobe structure.

Soil of this phase is derived from a variety of rock materials, and it occupies elevated terraces of undulating or rolling surface relief, where drainage is well developed.

Only 448 acres of this soil occur in the area surveyed. It is confined entirely to the upper ends of Los Osos and San Luis Valleys west of San Luis Obispo.

The soil is used in the production of the same crops as those grown on typical Hames clay loam, and the yields are about the same. Practically all the land is under cultivation.

Care must be exercised in handling this soil to prevent puddling. Suggestions for the improvement and utilization of the typical soil are applicable to the heavy-textured soil.

Hames clay loam, dark-colored gravelly phase.—The surface soil of Hames clay loam, dark-colored gravelly phase, to a depth ranging from 6 to 9 inches, consists of dark-gray, very dark brownish-gray, or black gravelly clay loam or clay, which, under cultivation, breaks to a small cloddy structure. The subsoil, to a depth ranging from 20 to 26 inches, is dark-gray or black compact heavy gravelly clay containing much colloidal material. The lower part of the subsoil, to an undetermined depth below 84 inches, is light yellowish-brown or brownish-yellow extremely tight compact gravelly clay loam or gravelly loam. The gravel in this soil constitute about 40 per cent of the soil mass, and they are weathered to a greater or less degree, many of them being easily cut through with a shovel or soil auger.

Three bodies of clay texture, comprising a total area of about 300 acres, are included with this soil as mapped. These bodies have a slightly better moisture-holding capacity than soil of the dark-colored gravelly phase and are harder to handle under cultivation, owing to their heavy texture. One area of this character borders the ocean 1½ miles west of Port San Luis, and the other two are 2 miles northeast of Bellevue School.

Soil of this phase is developed in a number of bodies, comprising a total area of 3.5 square miles. The most typical and important areas are just south of Islay Hill and southeast of San Luis Obispo. Other areas are 1 mile north of Bellevue School, 1 mile east of Edna, and near the junction of Alamos Creek and Cuyama River. A part of the city of San Luis Obispo is located on this soil.

Hames clay loam, dark-colored gravelly phase, is developed on maturely weathered alluvial deposits of mixed origin. The soil occupies alluvial terraces which have been eroded to such an extent that the resulting surface relief is rolling or undulating. Drainage is well developed at the present time, though it is probable that the soil has been weathered in part under conditions of restricted drainage.

Under virgin conditions the soil is grass covered and valued only for grazing, for which it has a comparatively low value. About 10 per cent of the land is under cultivation and is used almost exclusively for bean and barley production. These crops are grown in a 2-year rotation. Yields of barley average about 12 sacks an acre, and beans return 6 or 7 sacks. When barley is grown year after year the yields are materially lower than if grown in alternate years with beans.

The soil is not valued highly for agriculture. A more diversified type of farming is suggested, including the keeping of a few dairy cattle, poultry, hogs, or sheep.

LOCKWOOD GRAVELLY FINE SANDY LOAM

The 6 or 8 inch surface layer of Lockwood gravelly fine sandy loam consists of dark dull brownish-gray or dark dull grayish-brown gravelly fine sandy loam of granular structure. The lower part of the surface soil, to a depth of 14 or 16 inches, is dark dull brownish-gray slightly compact gravelly fine sandy loam or gravelly loam. The upper part of the subsoil, to a depth ranging from 20 to 24 inches, is dull-gray granular gravelly fine sandy loam or gravelly loam. This material is firm but contains many small pore spaces which are favorable to the penetration of air, roots, and moisture. The next lower subsoil layer, extending to a depth ranging from 45 to 55 inches, is dull grayish-brown or dark grayish-brown very compact gravelly loam, gravelly clay loam, or gravelly clay, containing few or no pore spaces. The lower part of the subsoil, to a depth of 75 or more inches, is lighter-brown or light yellowish-brown compact gravelly loam or gravelly sandy loam.

Lockwood gravelly fine sandy loam occupies a total area of 2,176 acres in the area surveyed. It is most typically developed along Tar Spring Creek several miles southeast of Edna. Several small bodies are along the upper branches of Pismo Creek 3 miles east of Edna, and a number of areas border drainage ways in the San Luis Mountains north of Avila.

This soil is derived from the weathered alluvial deposits having their source entirely in siliceous shales. The soil is maturely weathered and occupies elevated terraces, as a rule, though as mapped in this area, some immaturely weathered bodies, occurring in stream bottoms only slightly above overflow, are included.

The land is rolling, hilly, or gently undulating, and numerous drainage ways contribute to a well-drained condition of both surface soil and subsoil.

Part of this soil is used for barley production, and only a slightly smaller acreage is devoted to beans. In the San Luis Mountains a rather large acreage is used for growing fruit, including apples, pears, peaches, plums, and strawberries.

The yields of barley and beans average rather low, between 5 and 7 sacks of beans and about 15 sacks of barley an acre. Fruit is grown under irrigation, and good yields of an excellent quality are produced. Most of the fruit is marketed locally and prices are not always the best. Strawberries seem to offer considerable promise on this soil.

The soil has a rather poor water-holding capacity and this factor, rather than a deficiency of plant food, limits its productivity. Under cultivation the organic matter must be maintained and care used to prevent the formation of a plow sole. Greater diversification, including the keeping of more dairy cattle, hogs, and poultry, is strongly recommended.

Lockwood gravelly fine sandy loam, dark-colored phase.—The surface soil of the dark-colored phase of Lockwood gravelly fine sandy loam, to a depth ranging from 9 to 12 inches, consists of granular very dark gray or very dark brownish-gray gravelly fine sandy loam. The upper part of the subsoil, to a depth ranging from 24 to 30 inches, is moderately compact dark-gray or dull

brownish-gray gravelly fine sandy loam or gravelly loam. The next lower layer, to a depth ranging from 55 to 65 inches, is very compact dull-gray or dull brownish-gray gravelly loam or clay loam. Dark-brown colloidal stains are common over the gravel of this layer. The lower part of the subsoil, to an undetermined depth below 6 feet, is dull-brown or dull grayish-brown moderately compact gravelly loam or gravelly sandy loam.

All the land of this kind lies along the ocean at the foot of the San Luis Mountains, except one body in the northern part of the area just south of the point where San Carpofora Creek empties into the ocean. This area contains a somewhat wider variety of parent materials, though it is similar in other respects to the other areas.

About 75 per cent of this land is under cultivation, principally to peas, cantaloupes, squashes, and other truck crops. Most of the truck farms are worked by Japanese or Filipinos. Peas occupy more than 60 per cent of the cultivated acreage and are grown both with and without irrigation. Under irrigation they may be planted at any season of the year to meet special markets or to fit in with other labor programs, but as a rule the fall crop is planted somewhat earlier than the nonirrigated crop. With the earlier plantings the soil is given a good wetting just before the peas are planted, and the crop needs no further irrigation if the fall rains are seasonable. The peas are ready to pick about Christmas. Areas not irrigated are plowed during the summer and left until the first fall rains when they are worked down and the crop planted. The peas are ready for harvest early in the spring. After the crop is harvested, the fields may be planted to a summer crop of grain or beans. Melons and other crops less hardy than peas are sown in the spring on irrigated land. Good yields of all crops grown are generally obtained.

As this soil is well supplied with organic matter, as well as with other plant-food elements, good yields are assured under the good cultural practices prevalent. The growing of peas, beans, and other leguminous crops on the soil will aid in maintaining it in good physical condition and in a highly productive state.

Lockwood gravelly fine sandy loam, dark heavy-textured phase.—The surface soil of the dark heavy-textured phase of Lockwood gravelly fine sandy loam, to a depth ranging from 10 to 14 inches, consists of dark-gray or very dark brownish-gray gravelly clay loam. The upper part of the subsoil, to a depth ranging from 24 to 30 inches, is dark brownish-gray moderately compact gravelly clay loam. This material is underlain, to a depth of 45 or 50 inches, by a more compact and heavier-textured layer in which the gravel constitutes 40 per cent or more of the soil mass and is generally coated with dull-brown colloidal stains. The deeper part of the subsoil, to a depth of more than 6 feet, is light grayish-brown or dull grayish-brown moderately compact clay loam or loam containing a high proportion of gravel.

Only a small acreage of this soil is mapped in the area surveyed. The land occupies high terraces or alluvial fans bordering the ocean at the base of the San Luis Mountains. One area is at the mouth of Diablo Canyon, and a larger body borders the ocean from Mallagh Landing south to the boundary of the area surveyed.

The soil is developed on maturely weathered alluvial deposits derived from siliceous shale materials. Deeply intrenched drainage ways issue from the bordering mountains and cut deep narrow ravines through the soil to the edge of the bluff bordering the ocean. Otherwise the land is smooth, being little marked by erosion, and it is excellently adapted to cultural operations and irrigation.

Under cultivation this land is used in the production of the same crops as are grown on the dark-colored phase of Lockwood fine sandy loam. It is handled in the same manner and gives approximately the same or somewhat higher yields.

This soil has a good water-holding capacity and is highly valued for crop production. Suggestions given for the improvement of Lockwood fine sandy loam, dark-colored phase, are equally applicable to soil of this phase.

GAREY FINE SAND

The 8 or 10 inch surface soil of Garey fine sand consists of light-brown or light grayish-brown loose slightly coherent fine sand. The subsoil, to a depth ranging from 20 to 28 inches, is light grayish brown or pale reddish-brown fine sand with a few seams of reddish-brown iron cementation. The lower part of the subsoil, to a depth of 72 or more inches, is light reddish-brown moderately compact fine sand containing a great number of iron-cemented seams, an inch or slightly more in thickness, running through it. The seams of iron cementation are of irregular occurrence and without continuity or conformity to one another or to the surface configuration.

This soil occurs in only one body, including 960 acres, at the base of the San Luis Mountains south of Morro Bay. The land is hummocky or slightly rolling, and drainage is excessive.

This soil is developed on marine terrace deposits and marine sediments carried to their present position or redistributed by the wind. The soil material consists largely of rounded quartz grains with few finer soil separates.

About 80 acres of this land have been planted to eucalyptus trees, and the remainder is covered with low-growing brush. The soil has little agricultural value and is best utilized in the production of eucalyptus for fuel. Beans and barley are produced on similar soils in other sections of the State, but the yields are in general light and unsatisfactory. The steeper areas are unsuited to cultivation, owing to their tendency to erode.

McCLUSKY FINE SANDY LOAM

The 7 to 10 inch surface soil of McClusky fine sandy loam consists of dull-brown or dark-brown fine sandy loam with a purple or red cast. The material tends to bake somewhat when dry. The upper subsoil layer, extending to a depth ranging from 15 to 20 inches, is dull-brown slightly compact fine sandy loam mottled slightly with gray. To a depth ranging from 26 to 32 inches, the next deeper layer of the subsoil is light grayish-brown, light yellowish-brown, or dull-yellow very compact heavy fine sandy loam mottled with yellow, gray, and rust brown. The material in the lower subsoil layer is brownish-drab or dull-brown plastic waxy clay of very high colloidal content, and it has a somewhat columnar structure, becoming

more pronounced in the underlying layer which extends to a depth ranging from 70 to 76 inches. On drying, the columns tend to check into a coarse cubical or nut structure. In places the transition to this heavy-textured layer is abrupt and the tops of the columns are somewhat rounded. Joints or cracks in this material are coated with a brown glazed colloidal deposit. The deeper material, to a depth of 90 or more inches, is dull-brown or dull yellowish-brown compact heavy fine sandy loam or sandy clay. The joints in this material also are coated with colloidal material. (Pl. 1, B.)

McClusky fine sandy loam areas include variations in color, ranging from dull gray to light brown. As occurring in this area the soil is somewhat mixed with alluvial-fan deposits carried on to the marine terraces from the bordering mountains. Many bodies are slightly less weathered or contain less colloidal material in the subsoil than typical. Such variations are of irregular occurrence and of slight agricultural importance and do not warrant separation in mapping.

This soil occupies the greater part of the alluvial terraces bordering the ocean and comprises a total area of 8.4 square miles in the area surveyed. From the northern boundary of the area south to Point Estero the continuity of the areas is broken only by areas of wind-blown sand and by the pinching out of the terraces by mountains or the entrance of drainage ways from the mountains into the ocean. Several bodies border the higher terraces or hills in the lower part of Los Osos Valley.

This soil is developed on a marine terrace deposit of mixed origin. The surface is prevailingly smooth, except where cut by drainage ways entering the ocean.

Under virgin conditions the soil is grass covered and is valued highly for grazing. Less than 15 per cent of the land is cultivated, and it is used in the production of such general farm crops as barley, beans, oats, or corn. Yields of barley range from 10 to 20 sacks an acre, oats yield slightly better, and the yield of beans is generally good when the crop is not attacked by aphids.

Plowing to a depth of 8 or 10 inches occasionally will tend to prevent the formation of a plow sole and maintain the soil in better condition for crops. The organic-matter supply of the soil under cultivation must be maintained. Strict adherence to a rotation which includes beans or other cultivated leguminous crops will maintain the fertility of the soil to a large degree.

MONTEZUMA CLAY ADOBE

Under virgin conditions the 1 or 2 inch surface layer of Montezuma clay adobe consists of dark-gray or dull-gray heavy clay loam or clay of small granular structure. The subsurface layer, to a depth ranging from 15 to 18 inches, is dark-gray or black clay which is of jointed structure when dry and tends to check into small cubes or granules. The upper subsoil layer, to a depth ranging from 36 to 40 inches, is dark-gray or black compact clay with a few nodules and gray mottlings of lime-carbonate accumulation in the lower part. The material of this layer grades abruptly into dull-brown or light grayish-brown clay or heavy clay loam having a great number of gray lime-carbonate nodules or soft accumu-

lations. At a depth ranging from 46 to 54 inches the second subsoil layer gradually passes into lighter-brown or light grayish-brown clay of pronounced jointed structure, that checks into medium-sized cubes. Lime accumulations in this layer are of infrequent occurrence. The lower subsoil layer, extending from a depth of 70 or 80 inches to an undetermined depth below 90 inches, is structureless light-brown or light grayish-brown fine sandy loam or clay loam.

This type of soil occurring elsewhere in the State generally contains well-defined cemented nodules of lime carbonate instead of soft accumulations as occur in this area. The dark-colored upper subsoil layer is also generally free of lime and the accumulations do not extend to a depth of more than 50 inches.

Gravelly areas of this soil are indicated on the soil map by gravel symbols. Most of the gravel are large and occur mainly on the surface. They interfere somewhat with cultural operations but otherwise have no agricultural significance.

Included with this soil in mapping is an area of clay loam texture, comprising about 30 acres, lying southeast of Cayucos. This body is at present uncultivated, but would be easier to handle under cultivation than the typical soil.

Several areas of this soil border the foothills south of San Luis Obispo, northwest of Edna, and occur in both Los Osos and Chorro Valleys, where they occupy many of the higher terraces adjacent to the foothills or mountains. A few areas occur on the terraces bordering the ocean, particularly north of Morro and in the vicinity of Cayucos.

The soil is maturely weathered and of undetermined origin. It is probable that, in this area at least, the parent materials are in part of marine deposition. The soil occupies gently undulating terraces having well-developed surface drainage, though subdrainage is somewhat impeded by the heavy subsoil.

Under virgin conditions the soil is grass covered and valued highly for grazing. Cultivated areas are devoted largely to the production of small white or pink beans, and some grains, including oats and barley, are also grown. The yields are as good as, or slightly higher than, those obtained on McClusky fine sandy loam.

This soil is productive, though rather hard to handle. In dry seasons crops suffer from lack of moisture sooner than on lighter-textured soils. The land is best adapted to general farming, with dairying, poultry raising, or hog raising as side lines.

Montezuma clay adobe, brown phase.—The 8 or 10 inch surface soil of the brown phase of Montezuma clay adobe consists of light-brown or light grayish-brown clay loam. The upper subsoil layer, to a depth ranging from 28 to 36 inches, is slightly compact light grayish-brown clay loam that breaks up into medium-sized clods when disturbed. This material grades abruptly into a very compact layer of grayish-brown or brownish-gray heavy clay loam or clay that contains numerous gray lime-carbonate nodules or accumulations. This layer, in turn, is underlain, at a depth of 45 or 50 inches, by structureless light-brown or light grayish-brown loam or clay loam, containing no lime.

The brown phase of Montezuma clay adobe consists of material similar to soils of the Antioch series as mapped in other areas of the

State, and, if more extensively developed, would be recognized here as a type of that series.

Subdrainage is restricted by the heavy subsoil, but otherwise drainage is good. The soil is derived from mixed geologic materials.

Soil of this phase occupies terraces bordering the ocean between Morro and Cayucos, and a few areas are 2 miles southeast of San Luis Obispo.

About 20 per cent of the land is under cultivation, principally to barley, which is produced both for hay and grain in connection with the dairy industry. The yields are good, averaging slightly more than a ton of hay to the acre and from 10 to 20 sacks of grain. Some beans and other general farm crops are successfully produced.

Suggestions given for the improvement and utilization of typical Montezuma clay adobe are also applicable to soil of the brown phase.

ROUGH MOUNTAINOUS LAND

Bordering the eastern boundary of the area surveyed and all the larger valleys are areas of steep mountainous land on which cultural operations would be extremely difficult and in most places impractical. Such areas have been mapped as rough mountainous land and are recognized as including locally some bodies of agricultural land which may be cultivated under future more intensive development. At the present time such areas are comparatively inaccessible, and the time and expense necessary for mapping them in detail was not warranted.

Most of the soils included in this classification are shallow, and under cultivation they would erode badly. Rock outcrops over large bodies of the land and landslides on the steeper areas are not uncommon.

Bordering the coast the areas of rough mountainous land are grass covered and valued highly for grazing. More or less forest and brush covers this land along the crest of the Santa Lucia Range and in the lower foothills in the southern part of the area. The land in the San Luis Range is also largely brush or oak covered and has little value for grazing.

ROUGH BROKEN AND STONY LAND

Rough broken and stony land embraces two classes of material, both of which are entirely nonagricultural. Rough broken land is composed of areas associated with developed agricultural lands which are too steep, eroded, and dissected to be of agricultural value. Most of these areas are covered with grass and have fair value for grazing. Rough stony land consists of rough land, in which rock outcrops occur over extensive areas and fragmental stones and bowlders cover the shallow droughty soils. This class of land is entirely nonagricultural and is of little value for grazing, as grasses are sparse and soon dry up after the close of the rainy season. The line of buttes lying between the Chorro and Los Osos Valleys are largely of this character. Other bodies occur at intervals throughout the area surveyed, in association with the agricultural land.

COASTAL BEACH AND DUNE SAND

Bordering the ocean in places are long stretches of wave-washed beach. These areas are composed largely of gray quartz sand of different degrees of fineness. When exposed to the sun and wind the surface deposits soon dry and the finer material is carried by the wind onto the adjoining bluffs and terraces, where it accumulates around brush or trees, forming hummocks and dunes of various sizes. The sand composing the dunes is unstable and is shifted about by the wind, preventing the growth of grass or other vegetation. These sandy areas are valueless for grazing or other forms of agriculture. They have been mapped as coastal beach and dune sand.

RIVER WASH

Bordering the larger streams of the area surveyed are areas of coarse sand, gravel, and cobbles, on which little or no vegetation grows. Such areas lie only a few feet above the normal flow of the streams which they border, and, following heavy rains, flood waters sweep down the channels, inundating the land for varying periods of time. During the dry season the sands dry out and are shifted about to greater or less extent by the winds. Areas of this character have no agricultural value other than for the grazing afforded by the grasses that spring up in the more protected places. They have been classified as river wash.

Bodies of this character border Huasna and Cuyama Rivers, Alamos Creek, Arroyo Grande Creek, San Simeon Creek, and Arroyo de la Cruz.

TIDAL MARSH

Two small areas of tidal marsh lie along the inner coast of the lagoon behind the long Morro Bay sand bar.

SOILS AND THEIR INTERPRETATION

The San Luis Obispo area is situated in western California, in the Pacific coast soil region. This general region is characterized by cool, moist winters and warm, dry summers.

Along the coast and for several miles inland, however, the climate is modified by fogs which are of daily occurrence throughout the summer. The cool, moist air is favorable to vegetal growth and the accumulation of organic matter. During late fall, winter, and spring native grasses form a rank vegetal growth, where unpastured frequently standing knee-high to a horse. Late in the spring the grasses dry up, forming a carpet of brown withered vegetation over the soil. This carpet of grasses, together with the moderating influence of the ocean and fogs, protects the organic matter and humus of the soils from oxidation.

All the well-drained soils, except those on the higher elevations, are dark, ranging in color from rich brown to black. The immature soils on the mountain slopes in this area and in the western part of the southern Coast Range are dominantly dark and are covered with brush and small trees. As a rule these soils do not effervesce in acid except in places where the underlying rocks are calcareous.

The reason for the dark color of the mountain-slope soils, except those lying on the lower slopes where the rainfall is low, is not clear. In many, if not in most, places where the dark-colored soils are now covered with brush and small trees it is not yet clear that they are rendzinas. The latter occur, but they do not seem to include all the higher-lying dark-colored soils, or those developing under the influence of relatively high rainfall. The Soil Survey is not in possession of any data indicating that these mountain slopes have ever been covered with a grass vegetation. No information of any kind whatsoever regarding the character of the vegetation previous to the occupation of the region by white man has been accumulated by the Soil Survey. About the only thing that can be said at the present time is that considerable areas of soils in the Coast Range, now covered with brush and small trees, are not typical podzolic forest soils.

In the southeastern part of the area the winter rainfall is somewhat heavier than along the coast, though the summers are hot and dry. Under virgin conditions the soils here are very largely forested with a number of species of oak and brush. Grasses grow in the more open places and between the trees. With the coming of the first warm days of summer, transpiration from plants and direct evaporation from the soil proceeds at a rapid rate, with the result that herbaceous vegetation soon withers and dies and is more or less oxidized under the hot dry climatic conditions. Although the climate is more favorable to the accumulation of organic matter than in strictly arid regions, the rate of accumulation here is much slower than along the coast.

The character of the natural vegetation in the lowland belts, especially in the southern half of California, has been well known for a long time. These lowland belts, such as the San Luis lowland in this area, were grasslands, with or without a thin cover of trees. The lower rainfall of these belts, compared with that on the higher areas, and the long dry season with its high temperature supply sufficient reasons for the absence of a heavy timber cover. The soils of the lowlands are not forest soils but are typical grassland soils developed under the influence of a moderate or low rainfall.

The soils present the features of imperfectly developed chernozemlike soils, developed from materials differing considerably in texture and composition, with and without the presence of sufficient salt content to cause the development of solonetzlike profiles. Practically, if not entirely, all the moderately well-drained soils of the San Luis Obispo area lying below an elevation of approximately 1,200 feet belong in the chernozem group, but true chernozems, such as those of the Great Plains of North America or the steppes of Asia and eastern Europe do not seem to be present.

The soils at the highest elevations, those above 1,800 feet, are faintly podzolic forest soils, and those at intermediate elevations are very young brown or very dark gray brush-covered soils, already briefly mentioned.

The effects of such climatic differences are apparent in the soil development of the two regions. Bordering the coast the hill soils are represented very largely by the dark-gray or black clay adobe type of the Cayucos series. Although many areas of browner or

lighter grayish-brown soils grouped in the Los Osos series are developed here, most of them are slightly heavier in texture and slightly darker than areas in the more arid part of the area surveyed. The dark-gray or black soils of the Montezuma, Clear Lake, and Dublin series are developed here to a greater extent than in other parts of the area. The dark-colored phases of the Lockwood soils are developed almost exclusively bordering the ocean.

The gray soils of the Arnold series are developed largely in the southeastern part of the area. Where occurring along the coast they are darker and represent a dark-colored inclusion. Light-colored soils are developed in the southeastern part of the area to a much greater extent than are the darker soils. The presence of the darker soils in this section can generally be accounted for on the basis of local drainage conditions or variations in the moisture supply.

Table 4 shows the results of mechanical analyses of representative samples of soil occurring in the San Luis Obispo area. The relative content of total clay and colloid as related to stage in weathering and development of soil profile horizons is significant.

TABLE 4.—*Mechanical analyses and moisture-equivalent content of several soils from the San Luis Obispo area, Calif.*[1]

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Total clay	Colloid [2]	Moisture equivalent
Los Osos fine sandy loam:	*Inches*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
577443	0 - 7	0.9	1.8	6.1	26.1	25.3	21.7	18.4	10.6	19.3
577444	7 -16	.4	3.3	6.3	28.0	23.0	19.6	19.7	12.0	18.4
577445	16 -30	.8	1.9	6.9	23.6	25.5	19.0	22.8	13.6	20.0
577446	30 -42	4.7	5.8	7.4	22.2	21.3	21.5	17.7	23.4	26.0
Los Osos gravelly clay loam:										
577495	0 -10	6.9	6.5	3.0	10.6	19.9	22.3	31.1	14.5	28.1
577496	10 -30	5.6	3.8	3.0	7.2	20.2	22.0	38.6	21.2	27.8
577497	30 -36	3.9	3.8	1.6	7.4	18.0	20.6	45.2	27.5	29.8
Los Osos clay loam:										
577466	0 - 7	1.5	2.4	3.8	28.4	18.2	21.7	24.3	12.2	23.1
577467	7 -20	1.2	3.1	2.3	31.2	15.5	20.8	26.5	16.3	22.7
577468	20 -36	.6	1.5	2.4	19.4	19.1	23.2	32.8	19.6	31.0
Cayucos clay adobe:										
577473	0 -12	1.2	2.4	1.6	7.6	15.6	34.4	37.5	19.2	29.3
577474	12 -36	1.8	3.1	1.6	8.1	17.8	32.0	36.5	19.0	25.5
Cayucos gravelly loam:										
577414	0 -12	5.0	6.2	7.5	33.3	15.1	13.1	20.4	14.8	23.7
577415	12 -20	2.5	7.6	5.7	33.9	13.2	8.7	28.6	21.7	25.3
Zaca gravelly clay loam adobe:										
577412	0 -12	.9	1.9	2.3	14.1	16.3	35.5	29.6	14.8	43.1
577413	12 -40	1.1	1.6	2.6	11.5	13.2	38.2	32.0	19.2	42.3
Elder fine sandy loam:										
577408	0 -10	2.9	6.6	4.2	44.3	21.0	10.0	11.1	6.3	13.9
577409	10 -72	3.2	5.9	4.6	45.5	22.7	7.8	9.9	6.3	11.9
Dublin fine sandy loam:										
577416	0 -10	.6	1.4	4.5	48.7	21.9	10.2	12.4	8.9	17.5
Dublin clay adobe:										
577454	0 -12	1.4	.8	1.2	3.2	9.7	41.1	43.2	13.9	46.4
577455	12 -72	.8	1.3	.7	.4	12.8	40.1	44.3	25.6	46.7
Metz fine sandy loam:										
577428	0 -10	.4	3.3	11.8	21.9	38.2	15.7	9.2	4.6	14.7
Agueda fine sandy loam:										
577437	0 -10	5.6	7.6	6.9	30.9	27.3	10.6	11.3	5.9	16.0
Agueda clay loam:										
577406	0 -12	3.0	5.3	4.1	16.7	21.8	23.9	25.9	15.9	29.7
577407	12 -72	1.1	1.0	2.0	8.3	14.5	38.4	35.6	18.2	-------
Baywood fine sand:										
577461	0 -10	.1	1.1	8.2	74.4	7.7	3.4	5.2	3.6	7.1
577462	10 -72	.6	.6	10.2	73.9	6.7	3.2	5.1	3.7	5.3

[1] Mechanical analyses and moisture-equivalent determinations made in the soil technology laboratory, University of California.

[2] Colloid includes materials less than 0.002 millimeter in diameter (included in total clay).

TABLE 4.—*Mechanical analyses and moisture-equivalent content of several soils from the San Luis Obispo area, Calif.*—Continued

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Total clay	Colloid	Moisture equivalent
Botella clay loam:	*Inches*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
577487	0 –10	0.3	0.9	1.8	13.2	26.0	32.6	25.3	13.0	27.4
577488	10 –30	.0	.7	.8	10.1	27.2	35.3	26.0	13.7	29.1
577489	30 –65	.2	.3	.8	10.7	25.3	34.8	28.0	17.3	29.8
Clear Lake fine sandy loam:										
577418	0 –10	3.9	3.8	3.5	28.5	30.9	13.8	15.5	10.1	21.3
577419	10 –30	2.2	4.0	3.1	39.1	24.3	12.1	15.1	10.1	19.9
577420	30 –70	5.7	5.0	4.9	42.6	21.9	7.8	12.0	8.7	16.1
Clear Lake clay adobe:										
577481	0 –10	.4	.3	.9	7.5	21.3	41.5	28.9	13.7	29.7
577482	10 –24	.1	.5	.6	6.9	20.3	45.6	25.6	14.4	29.3
577483	24 –36	.0	.5	1.3	10.2	25.2	27.5	36.1	15.9	27.2
577484	36 –72	.4	.4	.9	6.6	35.7	34.3	22.4	13.5	25.1
Hames fine sandy loam:										
577424	0 – 9	.9	1.0	1.1	16.0	48.2	22.2	10.5	5.2	18.7
577425	9 –30	.8	1.4	.9	18.1	44.1	22.3	12.8	7.4	19.3
577426	30 –60	2.9	3.6	1.8	18.4	33.2	18.5	22.5	13.9	27.0
577427	60 –90	5.5	2.8	2.7	12.9	32.1	21.2	23.7	14.9	30.9
Hames clay loam:										
577449	0 – 1½	2.3	2.8	5.0	16.5	29.0	25.3	20.1	11.1	22.6
577450	1½–10	2.0	2.3	4.9	18.0	24.2	23.9	25.7	14.2	23.2
577451	10 –22	1.8	3.9	5.4	14.1	14.8	16.5	44.6	28.7	30.4
577452	22 –68	8.7	7.3	8.6	19.8	16.5	13.9	25.9	15.9	27.2
Lockwood gravelly fine sandy loam:										
577432	0 – 6	3.0	3.9	2.9	24.4	27.9	24.1	14.2	6.6	20.5
577433	6 –15	2.5	2.9	3.9	24.2	29.5	21.8	15.6	8.2	19.7
577434	15 –20	3.7	4.1	3.7	24.4	26.5	21.4	16.4	9.7	20.0
577435	20 –45	1.8	3.3	3.4	20.9	16.9	13.2	41.4	32.0	32.4
577436	45 –76	7.7	14.5	7.9	26.9	16.5	11.9	15.0	-------	-------
Garey fine sand:										
577463	0 – 9	.1	.9	5.1	78.4	6.9	4.3	4.2	2.4	5.8
577464	9 –24	.1	.4	6.8	74.4	7.6	5.7	4.9	3.3	6.5
577465	24 –72	.1	.9	5.2	77.5	5.2	5.2	5.9	4.7	7.2
McClusky fine sandy loam:										
577456	0 – 8	1.2	1.6	3.9	35.8	24.2	18.3	14.8	10.1	18.6
577457	8 –18	1.9	1.6	4.8	36.8	22.1	17.4	15.4	10.5	17.6
577458	18 –29	.3	.8	4.2	35.5	20.0	17.2	22.7	21.5	21.7
577459	29 –72	.6	1.4	3.7	25.6	8.4	8.7	52.4	37.4	50.2
Montezuma clay adobe:										
577475	0 – 2	1.0	1.3	2.7	18.0	18.0	24.7	34.9	21.7	27.5
577476	2 –18	.6	1.2	1.4	14.8	13.2	21.0	48.2	35.9	44.6
577477	18 –40	.8	.7	2.0	12.8	13.2	20.4	50.8	41.0	59.2
577478	40 –48	.3	.6	1.2	37.3	10.9	15.6	34.6	24.7	29.5
577479	48 –74	.2	.5	1.0	22.3	28.9	15.3	32.2	25.3	29.1

The soils of the Hames series have developed on gently sloping alluvial fans under conditions of good drainage and are representative of the more maturely weathered normally developed soils of the region. Under virgin conditions, the A_1 horizon of Hames clay loam, in which the typical profile is best developed, to a depth of 1 or 2 inches, consists of brown or rich-brown granular loam or heavy fine sandy loam, containing slight quantities of partly decayed organic matter. The granules are rounded and about the size of, or slightly larger than, bird shot. This horizon is sharply separated from the A_2 horizon which consists of brown or dull-brown slightly compact clay loam containing many root cavities rendering the material readily permeable to water, air, and root penetration. When disturbed it breaks into coarse clods that can be pulverized under slight pressure. The A_2 horizon extends to a depth ranging from 9 to 12 inches where it gradually changes to dull-brown or dull yellowish-brown extremely compact gravelly clay loam or clay, the B_1 horizon, which contains appreciable accumulated colloidal material. More

than 60 per cent of the clay in this horizon is of colloidal size, and joints and gravel in the lower part are coated to some extent with dull-brown colloidal deposits. The B_1 horizon has a faintly developed columnar structure, the columns ranging from 2 to 5 inches in diameter and being of angular pattern with from 5 to 8 or more faces. When the material is dry the columns check horizontally, giving rise to medium-sized angular clods. This horizon extends to a depth ranging from 20 to 30 inches, and the line of demarcation between it and the B_2 horizon is very indistinct. The B_2 horizon continues to a depth ranging from 60 to 70 inches and consists of dull-brown, dull yellowish-brown, or reddish-brown extremely compact material of medium texture, containing more or less gravel. Although of lower clay content, a distinguishing feature of this horizon is the pronounced dull-brown or dull reddish-brown colloidal coating on the gravel and on the faces of joints or cracks. The coating is of waxy appearance when the soil is moist. The columnar structure continues throughout this horizon, and the columns differ in no essential respect from those in the horizon above. This material gives way without a distinct line of demarcation to light-brown or light yellowish-brown amorphous material which is only moderately compact and of about the same texture as the surface soil. This is the slightly modified parent material, or the C horizon.

Hames fine sandy loam also shows a very pronounced accumulation of clay in the subsoil, or B horizon, which, in this soil, owing probably to coarser texture and greater permeability to percolating waters, has extended into the deeper soil material.

Typical profile characteristics of these soil types and others are represented diagrammatically on the soil map.

Other maturely weathered soils of the area are represented by the Montezuma series, which includes dark-gray or black soils, having a layer of lime accumulation in the light-colored subsoil or substratum; and by the McClusky series, which includes dull-brown or dark-brown soils, developed on old marine deposits, differing from the soils of the Hames series in having a tight heavy-textured columnar lower subsoil layer of high colloidal content, that continues to bedrock or other base on which the parent soil materials were deposited. The transition to the heavy-textured columnar layer is in many places very abrupt, the tops of the columns tend to be somewhat rounded, and the layer is of solonetzlike structure. (Pl. 1, B.) In this soil also the layer of maximum clay content occurs at, and extends to, a greater depth than in soils having heavier-textured surface soils.

The soils of the Garey series are also maturely weathered, and they consist of light-brown or light grayish-brown surface soils over light reddish-brown subsoils containing numerous seams of iron cementation. The seams are an inch or less thick and resemble a hardpan formation, except that they have no conformity with the surface relief or with each other. They continue to an undetermined depth. Owing to the light texture and siliceous character of the material, there is little accumulation of the finer soil materials in the B horizon, though the total clay and the colloidal clay content are slightly greater in the deeper layers in which the proportion of colloid to

total clay becomes progressively greater with depth. Where more maturely weathered, soils of this character develop numerous iron-cemented nodules or fragmental hardpan formations, such as occur in soils of the Tangair series, mapped elsewhere in the State (*3*).

The soils of the Lockwood series are also maturely weathered, having dull grayish-brown, dark grayish-brown, or brownish-gray surface soils over subsoils of similar color. These soils are normally developed and differ from soils of other series of this group in the mineral character of the soil and parent soil material which is derived entirely from siliceous shale.

Montezuma clay adobe, of the maturely weathered group, has a profile distinct from other soils of this group. The A_1 horizon, to a depth of 1 or 2 inches, consists of gray or dull-gray heavy clay loam or clay of small granular structure. The A_2 horizon, to a depth ranging from 15 to 18 inches, is dark-gray or black clay that assumes an adobe structure on drying. The B_1 horizon, to a depth ranging from 36 to 40 inches, is dark-gray or black compact clay containing a few nodules and mottlings of lime carbonate. About four-fifths of the clay of this horizon is of colloid size. This horizon has a faintly expressed jointed structure that becomes more pronounced in the lower two B horizons, the joints being vertical and the columns having from 5 to 7 or more faces. Horizontal joints or cracks occur at intervals of several inches. The B_2 horizon consists of dull-brown or light grayish-brown heavy clay loam or sandy clay containing numerous nodules or soft accumulations of lime carbonate. Numerous horizontal joints are faintly developed, occurring at intervals of an inch or slightly more. This horizon continues to a depth ranging from 46 to 54 inches and is distinguished from the B_3 horizon only in the less numerous lime-carbonate accumulations and in the marked horizontal jointing that results in a regular pattern of cubes with faces 1 inch or less in diameter. The faces of the joints are coated with brownish-drab colloidal material which has a glazed waxy appearance when moist.

This horizon is underlain, at a depth ranging from 70 to 80 inches, by light-brown or light grayish-brown amorphous material devoid of lime. The lighter-colored material of this profile may possibly represent a substratum unrelated to the surface soil, as the typical Montezuma soils have a calcareous C horizon, or parent material.

The profile of Los Osos clay loam is typical of soils developed from material accumulated by decay of consolidated rocks in place. The A_1 horizon is dark rich-brown clay loam material of small cloddy structure to a depth ranging from 6 to 10 inches. In most virgin areas a superficial layer of granular material containing partly decayed organic matter is present. The B_1 horizon is slightly compact porous material of similar texture, which breaks into coarse clods that are readily crumbled. The B_2 horizon is dull-brown or dull yellowish-brown very compact material which is somewhat glazed with slight accumulations of apparent collodial material. Above the depth where the material grades into bedrock, from 30 to 40 or more inches from the surface, the material in this horizon is friable, of lighter texture, and contains numerous fragments of partly weathered rock. The C horizon consists of sandstone or shale bedrock.

Mechanical analyses of the Cayucos soils show but slight accumulation of the clay material in the B horizon, except in the gravelly clay loam type. The soils of the Arnold series are distinguished from the Los Osos soils in having much grayer surface soils, and those of the Cayucos series are dark gray or black. The C horizons are similar in the soils of all these series. The soils of the Zaca series are dark gray or black and are calcareous throughout the profile. The C horizon consists of calcareous sandstone or shale. The soils are well flocculated and are of granular structure when dry.

The profiles of the immaturely weathered soils developed on the younger valley-filling materials of the area are best illustrated by the profile of Clear Lake clay loam. In this soil the surface soil, to a depth ranging from 10 to 14 inches, consists of dark-gray or black heavy-textured clay loam which breaks up cloddy but is readily pulverized, under slight pressure, to a granular mass. The B_1 horizon, to a depth ranging from 24 to 34 inches, is dark-gray, black, or dull grayish-brown slightly compact clay loam or clay, which is very porous and crumbles to a granular mass when disturbed. The B_2 horizon, to a depth ranging from 48 to 54 inches, is light grayish-brown or light brownish-gray moderately compact calcareous clay loam. The C horizon consists of slightly calcareous dark-brown or dull-brown moderately compact material of clay loam or clay texture. There is no laboratory data on a sample of this soil type, as the sample was considered not quite typical. The soils of the Botella series are dark grayish brown, noncalcareous, and have youthful, or only slightly developed profiles. The soils of the Elkhorn and Baywood series of this group are developed largely on sandy coastal-terrace and wind-blown materials high in silica. The surface soils are brown or dull dark brown and overlie subsoils of somewhat lighter color. The Baywood soils show very little modification in the profile since deposition, but the Elkhorn soils are characterized by a number of softly cemented seams of iron deposits in the lower part of the subsoil.

The recent-alluvial soils are unweathered and show no consistent modification in their profile since deposition. The subsoils of this group are generally stratified, and calcareous members have the lime uniformly distributed through the soil profile. The Elder and Agueda soils have dull dark grayish-brown or dull brownish-gray surface soils and subsoils. The soils of the Agueda series, however, are calcareous. The soils of the Dublin series have dark brownish-gray or nearly black surface soils and subsoils, which are noncalcareous. The soils of the Yolo series have brown or rich-brown surface soils and subsoils containing no lime. The soils of the Metz series are characterized by calcareous light-brown or light grayish-brown surface soils and subsoils.

Subsoil samples of some of the recent-alluvial soils were omitted from the mechanical analyses, because these subsoils consist of unmodified stratified materials of variable texture and of little significance when considered in regard to soil profile development.

Chemical reaction of certain samples of soils of this area were also checked, by determination of the pH value, in the laboratories of the Bureau of Chemistry and Soils. Table 5 gives the results of the pH value determinations.

TABLE 5.—*pH determinations of soils in the San Luis Obispo area, Calif.*

(1:2 soil water ratio)

Sample No.	Soil type	Depth in inches	pH value	Sample No.	Soil type	Depth in inches	pH value
577401	Hames clay loam, dark-colored gravelly phase	0-6	5.74	577459	McClusky fine sandy loam	29-72	6.55
577402	do	6-20	5.91	577460	do	72-90	6.05
577403	do	20-84	6.09	577461	Baywood fine sand	0-10	5.99
577404	Agueda clay loam adobe, poorly drained phase	0-10	7.84	577462	do	10-72	5.87
577405	do	10-72	8.05	577463	Garey fine sand	0-9	5.20
577406	Agueda clay loam	0-12	7.87	577464	do	9-24	5.25
577407	do	12-72	7.92	577465	do	24-72	6.40
577416	Dublin fine sandy loam	0-10	5.87	577466	Los Osos clay loam	0-7	7.03
577417	do	10-70	6.85	577467	do	7-20	6.30
577443	Los Osos fine sandy loam	0-7	6.02	577468	do	20-36	6.91
577444	do	7-16	6.13	577469	Elkhorn loamy sand	0-10	6.92
577445	do	16-30	6.35	577470	do	10-28	6.11
577446	do	30-42	6.92	577471	do	28-40	6.43
577454	Dublin clay adobe	0-12	6.98	577472	do	40-72	6.45
577455	do	12-72	7.52	577495	Los Osos gravelly clay loam	0-10	5.02
577456	McClusky fine sandy loam	0-8	5.62	577496	do	10-30	4.69
577457	do	8-18	5.81	577497	do	30-36	4.73
577458	do	18-29	6.22	577498	Los Osos loam	0-10	5.59
				577499	do	10-28	5.80
				5774100	do	28-38	5.83

Examination of Table 5 reveals that the soils, although developed under moderately low rainfall, range from slightly to distinctly acid in reaction, particularly in the upper horizons. Los Osos gravelly clay loam is distinctly acid, having a pH value of only 5.02 in the surface soil and a still lower value in the underlying materials. The soils of the Agueda series are the only soils (shown in Table 5) which are characteristically alkaline in reaction, and field samples usually effervesce from mildly to freely with dilute hydrochloric acid.

SUMMARY

The San Luis Obispo area lies in the western part of California about midway between the cities of Los Angeles and San Francisco. The area includes the coastal terraces bordering the Pacific Ocean from the Monterey-San Luis Obispo County line on the north to San Luis Obispo Bay on the south. Parts of the Santa Lucia Mountains and bordering foothills are included on the east. The area covers 734 square miles, or 469,760 acres.

San Luis Obispo is the principal town of the area and is the county seat of San Luis Obispo County. Transportation facilities are provided by the Southern Pacific Railroad, and the Pacific Coast Railroad (narrow-gage).

Dairy products, grain, beans, and vegetables, in excess of local consumption, are marketed in Pacific coast cities or in cities farther east.

Bordering the coast, summer fogs are a distinguishing feature of the climate, but in the districts farther inland the summers are hot and dry. The mean annual rainfall at San Luis Obispo is 20.61 inches. The average length of the frost-free season at that place is 286 days, and bordering the coast killing frosts are of rare occurrence.

The soils of the San Luis Obispo area are placed in two main groups for the purpose of classification, namely, soils developed on consolidated materials, and soils developed on transported materials.

The soils developed on consolidated rocks are classified in the Los Osos, Arnold, Cayucos, and Zaca series, depending on differences in color, underlying materials, lime content, or other chemical or physical characteristics developed in the soil profile.

The soils developed on transported materials are subdivided on the basis of age or degree of weathering, as reflected in the soil profile, into mature old valley-filling soils, immature young valley-filling soils, and unweathered recent-alluvial soils.

The old valley-filling soils are classified in the Hames, Lockwood, Garey, McClusky, and Montezuma series; soils of the Elkhorn, Baywood, Botella, and Clear Lake series constitute the young valley-filling group; and the recent-alluvial soils are grouped in the Yolo, Elder, Dublin, Metz, and Agueda series.

The old valley-filling soils are maturely weathered, usually have compact heavy-textured subsoils, and have appreciable accumulations of lime carbonate, iron compounds, or colloidal material. The young valley-filling group is slightly weathered to produce slightly heavier textured subsoils, of slight or moderate compaction, which may contain small quantities of accumulated lime or other materials. The recent-alluvial soils are unweathered, and most of them are still in the process of accumulation.

The early agriculture of the San Luis Obispo area consisted of the production of beef cattle. A period of dry years resulted in the breaking-up of the large landholdings of the stockmen and their sale to settlers who engaged in the production of dairy products, grain, and fruit. At the present time the agriculture of the area consists of the production of dairy products, beef cattle, barley, beans, and vegetables.

Barley and beans are produced in a 2-year rotation. Beans are subject to attack by aphids, and the yields are not always certain. Barley yields are materially higher when produced in rotation with beans than when grown on the same field year after year.

The dairymen are in general prosperous, and present high prices for beef cattle indicate a period of prosperity for the cattlemen. Dairy cattle are of mixed breeds, but most of them have a high percentage of Shorthorn blood. Beef cattle are largely of the Hereford breed.

Dairy farms average 800 acres in size, general farms about 500 acres, and beef-cattle ranches 10,000 or more acres.

In 1930, 62 per cent of the farms in the county were operated by the owners and the remainder largely by tenants. When the tenant furnishes everything the owner receives one-fourth of the crop.

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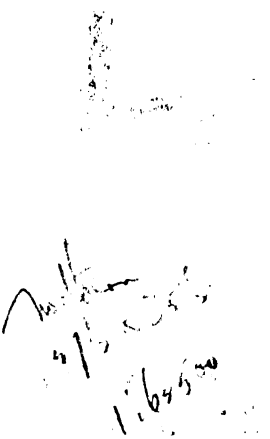

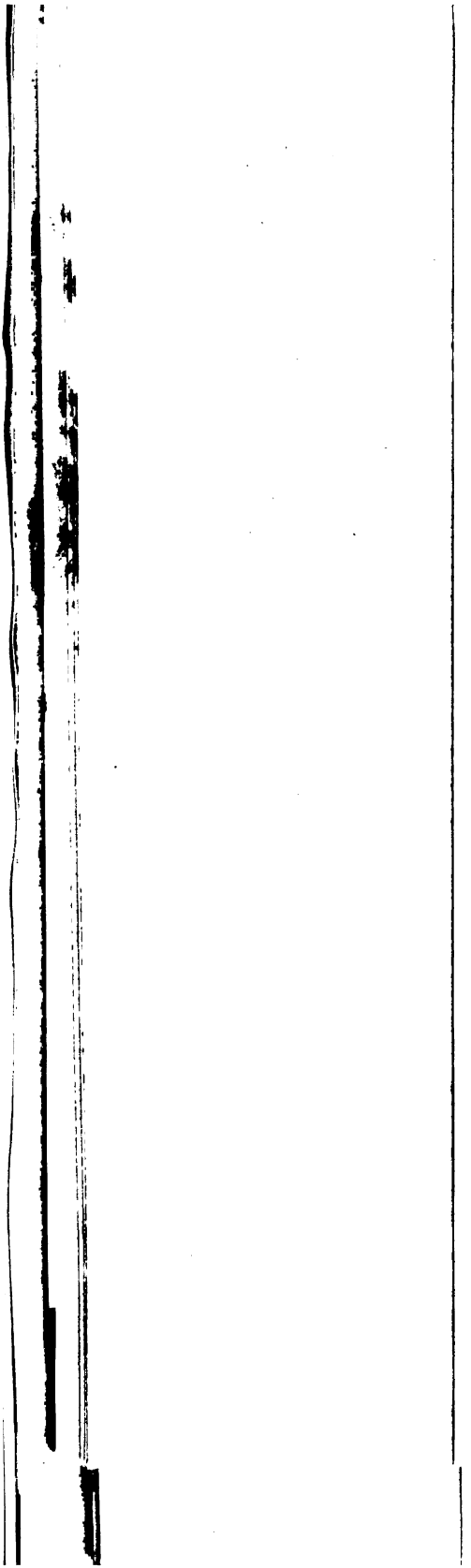

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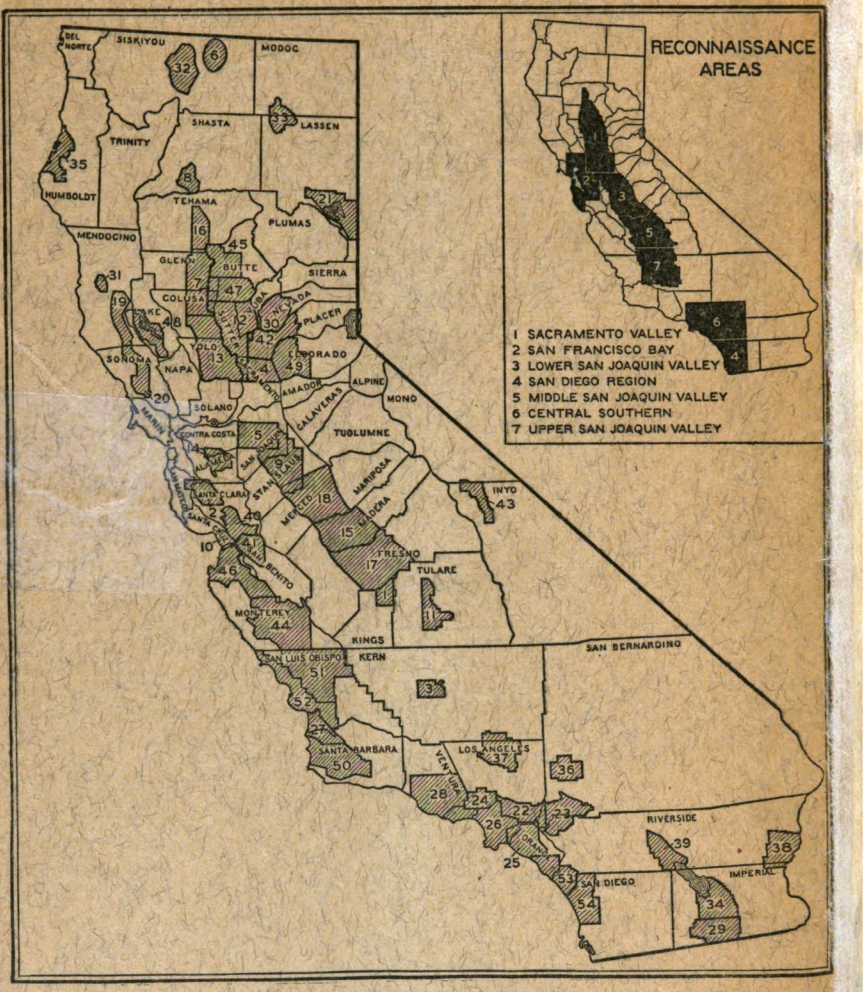

Areas surveyed in California, shown by shading

1. Hanford
2. San Jose
3. Bakersfield
4. Sacramento
5. Stockton
6. Butte Valley
7. Colusa
8. Redding
9. Modesto-Turlock
10. Pajaro Valley
11. Portersville
12. Marysville
13. Woodland
14. Livermore
15. Madera
16. Red Bluff
17. Fresno
18. Merced
19. Ukiah
20. Healdsburg
21. Honey Lake
22. Pasadena
23. Riverside
24. San Fernando
25. Anaheim
26. Los Angeles
27. Santa Maria
28. Ventura
29. El Centro
30. Grass Valley
31. Willits
32. Shasta Valley
33. Big Valley
34. Brawley
35. Eureka
36. Victorville
37. Lancaster
38. Palo Verde
39. Coachella Valley
40. Gilroy
41. Hollister
42. Auburn
43. Bishop
44. King City
45. Chico
46. Salinas
47. Oroville
48. Clear Lake
49. Placerville
50. Santa Ynez
51. Paso Robles
52. San Luis Obispo
53. Capistrano
54. Oceanside

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