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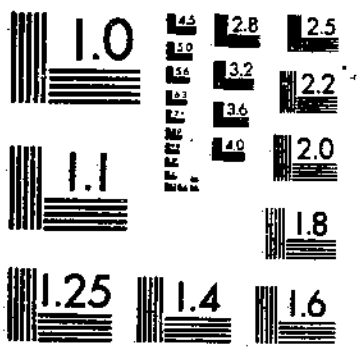

MICROCOPY RESOLUTION TEST CHART
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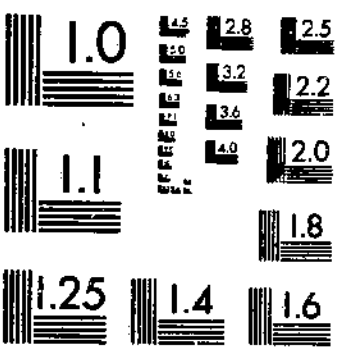

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WASHINGTON, D. C.

SOIL SURVEY (RECONNAISSANCE) OF ST. CROIX ISLAND, VIRGIN ISLANDS

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AREA SURVEYED

St. Croix, the largest of the American Virgin Islands, lies in the Tropical Zone, between 64° 34′ and 64° 54′ west longitude, with a mean north latitude of 17° 44′. (Fig 1.) It is slightly more than 22 miles long in a nearly east-west direction and includes a land area of about 82 square miles. The western half of the island averages nearly 6 miles in width, but the eastern half tapers to a point. St. Thomas, the nearest large island, lies 40 statute miles to the north.

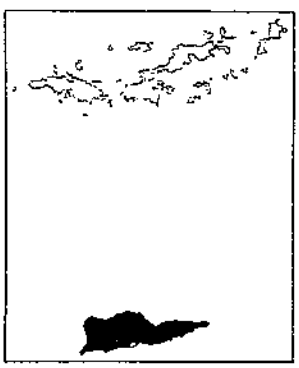

FIGURE 1.—Sketch map showing location of St. Croix Island, Virgin Islands

The island may be roughly divided into four principal physiographic divisions as follows:[1] (1) The northwestern mountainous area, (2) the southwestern and south-central coastal plain, (3) the north-central hilly area, and (4) the eastern mountainous area. These areas will not be further delineated as the reader may readily gain a full understanding of them by consulting the accompanying topographic and soils map.

The mountainous areas include some lands that have sufficiently gentle slopes to allow cultivation, and, in the northwestern mountainous section, they also include small alluvial valleys which abut

[1] KEMP, J. F. INTRODUCTION TO THE GEOLOGY OF THE VIRGIN ISLANDS. *In* Scientific Survey of Porto Rico and the Virgin Islands. N. Y. Acad. Sci., v. 4, pt. 1. 1927.
MEYERHOFF, H. A. PHYSIOGRAPHY OF THE VIRGIN ISLANDS AND OF THE PORTO RICAN ISLANDS, VIEQUES AND CULEBRA. *In* Scientific Survey of Porto Rico and the Virgin Islands. N. Y. Acad. Sci., v. 4, pts. 1 and 2. 1927.

on the sea or on the adjacent coastal plain. The coastal plain is prevailingly flat and has a gentle seaward slope. A few rounded limestone hills interrupt the smooth topography. The inner margin of the plain is covered by a series of broad alluvial fans extending out from the mountains. The north-central hilly area consists chiefly of rounded limestone hills and narrow flat valleys. Most of the small valleys and some of the hillsides are under cultivation, but much of this hillside land is too steep for the economic production of crops except forest trees and pasture grasses.

Natural drainage in the mountainous areas ranges from good to excessive, but in some places on the flat coastal plains drainage is rather poor. Where the soils are underlain by soft marly limestones local underdrainage is sufficient to take care of all normal precipitation. In scattered places along the seacoast are many areas of land, most of them bordering lagoons, which have very poor natural drainage and which, as a consequence, have accumulated harmful quantities of soluble salts.

The general level of the mountain tops of St. Croix is between 600 and 800 feet above sea level. Mount Eagle, the highest peak, extends to an altitude of 1,165 feet. The central hilly part of the island has a maximum elevation of nearly 600 feet. The coastal plain, where it abuts against the mountains, ranges in altitude from 100 to 200 feet and has a long flat seaward slope. In a few places on the seaward edge of the coastal plain are low sea-cut cliffs, few of which exceed 20 feet in height.

The natural vegetation of the island varies somewhat in different parts. The northwestern mountainous region supports a fairly dense tropical forest in the areas that have never been cleared. The individual trees are not large, but the undergrowth of thorny bushes and shrubs is so dense that penetration is extremely difficult. A large amount of the original timber has been cut and made into charcoal. Uncultivated parts of the coastal plain are either grown up to thorny brush or have been planted to pasture grasses. "Hurricane grass," which is considered of inferior feeding quality, has recently been spreading rapidly over the southwestern coastal plain and adjacent mountainous regions. Unless checked it bids fair to choke out other valuable grasses and perhaps may even replace some of the timber. In the eastern mountainous part of the island is a vast area of land that is so densely covered with thorny bushes and cacti that it can be penetrated only by goats. The brush has been cleared away in some places and the land planted to pasture grasses, but the brush retakes the land within a few years unless the owner wages a constant battle against the young bushes which rapidly shoot up. The chief vegetation in the central hilly part of the island consists of thorny brush with here and there groves of mahogany trees which were introduced into the island a long time ago.[2]

St. Croix Island was discovered by Christopher Columbus, who landed at the mouth of Salt River in 1493. It was subsequently owned by the Dutch, British, and Spanish. In 1651 it was taken by the French and presented in 1653 to the Knights of Malta. Denmark

[2] BRITTON, N. L., and WILSON, P. DESCRIPTIVE FLORA—SPERMATOPHYTA. *In* Scientific Survey of Porto Rico and the Virgin Islands. N. Y. Acad. Sci., v. 5, pt. 2, 1924; v. 6, pt. 1, 1925.

purchased it in 1737, and from that country it, with the other American Virgin Islands, was purchased by the United States in 1917. For a long time all the labor of the island was performed by negro slaves, but slavery was abolished in 1848 after a violent insurrection.[3] The natives were granted full citizenship in 1927.

According to the 1930 census report, 84 per cent of the inhabitants of St. Croix Island are negroes, 12.1 per cent are of mixed blood, and 3.6 per cent are white. In 1930, St. Croix Island had a total population of 11,413, a decrease of 3,488 since 1917. The decrease is chiefly owing to emigration to the United States. There are only two cities on the island, Christiansted (locally known as Bassin), with a population of 3,767, and Frederiksted (locally known as Westend), with a population of 2,698.

The Virgin Islands, from the time of their purchase until the spring of 1931, were governed by the United States Department of the Navy. Since that time the Department of the Interior has taken over the government, and a civilian governor has been appointed by the President. Laws for the municipality of St. Croix Island are made by the colonial council which consists of a majority of elected members and a minority of appointed members.

A very good system of public roads, most of which have been surfaced with gravel, spreads over the island. Most of the sugarcane is hauled from the fields in small carts drawn by oxen, mules, or donkeys, loaded on trucks and trailers, and hauled to the mill. Vegetables, fruits, and small articles of merchandise are hauled in small 2-wheeled carts drawn by donkeys or small mules. A bus line carries passengers between the two cities, and there are several privately owned motor cars. Most of the roads are in fairly good repair. One steamship a week brings passengers and mail from Puerto Rico and St. Thomas. Several ocean freighters and passenger vessels stop at irregular intervals at Frederiksted for passengers and freight. Many sloops and schooners ply between St. Croix and the neighboring islands, carrying mail, cattle, freight, and passengers.

There are no factories of great importance on St. Croix Island. At present (1931) one factory at La Grange is producing sugar, and a small factory at Orangegrove produces commercial alcohol from molasses. In the cities a few joiners make very beautiful furniture from mahogany and other tropical woods, but this industry is carried on in a very desultory fashion. Fishing for fish, sea crawfish, turtles, and other sea food is carried on, and this industry could well be extended. Many kinds of excellent fish abound, which should provide a larger proportion of the food of the people than at present.

CLIMATE

Climatic data have been collected intermittently over a long period of years, but there are so many gaps in the records that it is impossible to obtain an accurate idea of average figures for the different parts of the island. Table 1 gives the available climatic data for Christiansted, and Table 2 gives the mean precipitation for other stations on the island.

[3] Encyclopedia Britannica. Ed. 14, v. 19, p. 825; and v. 23, p. 190–191, illus.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Christiansted, St. Croix Island*

[Elevation, 25 feet]

Month	Temperature, mean	Precipitation		
		Mean	Total amount for the driest year (1922)	Total amount for the wettest year (1927)
	°F.	*Inches*	*Inches*	*Inches*
December	77.5	2.44	3.57	1.32
January	73.4	2.28	1.69	2.43
February	73.0	1.54	2.55	1.59
Winter	74.6	6.26	7.81	5.34
March	74.5	1.62	1.95	2.49
April	76.8	1.58	.35	2.49
May	78.8	2.64	.49	5.85
Spring	76.7	5.84	2.89	10.74
June	80.4	2.06	3.00	1.59
July	81.6	3.14	1.44	5.40
August	82.8	4.69	2.21	2.01
Summer	81.6	9.89	6.65	9.00
September	81.6	6.75	4.83	10.74
October	81.0	5.04	3.91	8.88
November	78.4	4.93	.72	6.09
Fall	80.3	16.72	9.46	25.71
Year	78.3	38.71	26.81	50.79

TABLE 2.—*Mean monthly, seasonal, and annual precipitation at Annaly, Experiment Station, Frederiksted, Bonne Esperance, and King's Hill, St. Croix Island*

Month	Annaly	Experiment Station	Frederiksted	Bonne Esperance	King's Hill
	Inches	*Inches*	*Inches*	*Inches*	*Inches*
December	3.70	2.79	3.82	2.87	2.72
January	3.60	2.70	2.79	2.68	2.50
February	3.01	1.99	2.58	1.94	2.44
Winter	10.31	7.48	9.19	7.49	7.66
March	2.46	2.35	2.57	1.83	2.10
April	3.19	1.77	2.23	1.85	1.98
May	3.57	2.60	3.28	2.53	2.78
Spring	9.22	6.72	8.08	6.21	6.86
June	2.93	2.09	2.53	2.40	2.76
July	4.48	3.39	4.18	3.22	3.06
August	5.85	4.62	4.49	4.36	3.88
Summer	13.26	10.10	11.20	9.98	9.70
September	6.39	6.78	6.50	6.72	5.90
October	7.51	5.09	5.90	5.56	4.64
November	5.20	4.76	5.78	5.34	4.95
Fall	19.10	16.63	18.18	17.62	15.49
Year	51.89	40.93	46.65	41.30	39.71

The total amount of precipitation varies greatly from place to place and from year to year. The rainfall is fairly well distributed throughout the year, but the average for the fall is greater than for any other season. The precipitation is heavier in the western end of the island, especially in the mountainous country near Annaly, than it is in the central and eastern parts. The precipitation rapidly decreases toward the eastern point of land, and the vegetation in that part of the island is very similar to the bushy growths characteristic of the arid regions of the southwestern part of the United States. The prevailing winds are slightly north of east. This is indicated by the direction in which the bushes and trees on exposed slopes have been forced to grow on account of the nearly constant trade winds. The branches and tops of the majority of these trees and bushes point nearly due west.

AGRICULTURE

In the early days St. Croix Island was a very important center for the manufacture of sugar, molasses, and rum, and it was mainly to these products that she owed her wealth. Since the passing of the eighteenth amendment the commercial manufacture of rum has ceased. The curtailment of its production probably has little effect on the income of the islanders at present, as rum prices have been so low during the last few years that neighboring islands have been able to make little or no profit. During the World War good profits were made on sea-island cotton, but the pink bollworm and recent low cotton prices have driven the production of this commodity entirely from the island. At the present time (1931) agricultural production seems to have struck the lowest possible ebb other than the total abandonment of the island.

The descendants of the negro slaves furnish the labor necessary for the production of agricultural crops. The common wage ranges from 50 to 60 cents a day, but skilled laborers are paid somewhat higher prices. At present there is much unemployment on the island, owing to the fact that many of the estates are not in operation and to the decline of the sugar industry.

Of the total land area of the island 87.4 per cent is included in 193 farms. The average size of farms is 244.3 acres. In 1930, owners operated 47.2 per cent of the farms; tenants, 35.7 per cent; and managers, 17.1 per cent. The greatest number of farms (77) are in the group ranging in size from 3 to 9 acres. Only 11 holdings include 1,000 or more acres at the present time.

Many of the larger estates were established long ago. The owners built beautiful and substantial palatial homes of stone and surrounded them with well-built quarters for their slaves. On most estates, two or three large windmills were used for grinding sugarcane, and there was a building in which to boil the juice. Most of these old estates are now in ruins. All that remains of the old windmills are the massive stone towers, which so far have defied the elements. A few of the estates are kept in good repair by their resident owners, but it may safely be said that unless there is a revival of agriculture in the near future, most of the farm buildings and equipment will be beyond reclamation.

Among the agricultural products in 1929, sugarcane occupied the largest acreage. (Pl. 1, A.) Guinea grass is the principal grass grown. (Pl. 1, B.) In 1929, only 19 acres were devoted to corn, 14 to sweetpotatoes and yams, and 19 acres to onions. Other vegetables grown for sale include cabbage, eggplant, green beans, okra, peppers, squash, and tomatoes.

Much of the farming is done by hand labor, partly because of the prevalence of low-priced labor and partly because the operators of small farms are unable to buy machinery. Some modern machinery is being used in connection with the production of sugarcane. Draft animals include oxen, donkeys, mules, and a few horses.

The island is well supplied with churches and schools. Native teachers are employed chiefly.

The principal agricultural industry of the island is the raising of cattle. The animals are chiefly of the breed introduced by the Spaniards into Puerto Rico and other West Indian Islands. These animals are used for work animals and to a certain extent for dairy purposes. On many estates they are being crossed with Brahman cattle which are immune to tick fever. The bullocks are used for work animals on the island, and some are shipped to Puerto Rico for the same purpose. Many cattle are sold to Puerto Rico dealers to be used for beef. Extensive areas of hill land in the eastern part of the island have been cleared and planted to pasture to support the cattle industry, and there are also large areas of good pasture land in the southern and southwestern parts of the coastal plain and in the hills near Two Williams. The cattle industry could be greatly extended without greatly disturbing the arable lands by clearing off brushy areas in the eastern and other hilly parts of the island. At present, the dairy industry is unimportant, but it probably could be profitably extended.

A few horses for riding and mules for working are bred, but this industry is not important. There are a great many donkeys on the island. They are used for pulling small carts, for packing, and for riding to a limited extent. Most farmers have a few chickens and hogs, which are raised mainly for home consumption. One fair-sized herd of sheep was observed. These animals are raised for food and produce a good quality of mutton. There are many goats in the eastern part of St. Croix Island and on Buck Island.

If all parts of the sugarcane plant except the commercial product, sugar, could be returned to the soil, there would be very little need for the use of fertilizers on most sugarcane soils, as sugar itself removes very little from the soil, being composed only of carbon, hydrogen, and oxygen, none of which comes from the soil.[4] However, molasses, which is sold, bagasse which is burned, tops which are fed or burned, and leaves, which in St. Croix are generally burned, all contain plant-food elements removed from the soil. Thus, it is apparent, constant depletion of the soil of the island is in progress.

In past years it has been the practice to apply from 20 to 30 tons of farmyard manure an acre each time a new crop of sugarcane is planted. The manure included cane trash or leaves, weeds, the re-

[4] Information on fertilization and preparation of the land on St. Croix Island is furnished by M. S. Baker, former agronomist at the Virgin Islands Agricultural Experiment Station, St. Croix.

mains of grass, and cane tops hauled to the pens for feed, in addition to the excreta of the animals. Farmyard manure applied at this rate will supply adequate plant food, but, with the advent of tractors and modern farm machinery, there is not sufficient manure to meet the demand. It has been suggested that the cane growers buy manure from the cattlemen, but the cattlemen do not pen their livestock but allow them the run of the pastures which need the manure thus supplied. The planter should use all the available manure because it contains the essential plant foods, acts as an indirect fertilizer in liberating plant food already in the soil, and adds humus to the soil, thereby improving the physical condition and increasing the water-holding capacity, a factor of much importance in the Virgin Islands.

Naturally when the supply of farmyard manure is not available in sufficient quantities, the question of substitutes arises. The only substitute for farmyard manure is a green-manure crop, preferably a leguminous crop, to be plowed under. However, the practice of growing such crops is not followed by St. Croix planters, largely because of weather conditions, which have not been considered suitable for the planting of such crops before cane-planting time. Depending on rainfall, there are from three to five months during which green-manure crops could be planted. Probably the sugarcane planter would eventually be much better off if he rotated his cane with such crops, even though he were to lose the use of a small part of his acreage during one planting season.

Crotalaria juncea, cowpeas, velvetbeans, jack beans, and pigeon peas, named in the order of their importance, are all good green-manure crops that could and should be grown. *C. juncea* is ready for turning under 60 days after planting, with 8½ tons of green matter an acre; cowpeas and velvetbeans in 75 days, with 10 to 14 tons an acre; and jack beans in 90 days, with 7½ tons. Several native leguminuous plants, that promise to be of value, are under observation.

Experiments with fertilizers carried on at the experiment station several years ago indicated that the use of commercial fertilizer was not profitable, owing to the prevailingly dry weather, and at present commercial fertilizers are not used by St. Croix sugar planters. If irrigation were practiced, commercial fertilizers would undoubtedly prove profitable. Near-by cane-growing areas are benefiting from applications of commercial fertilizers.

When the final crop of cane has been removed from the land, preparation begins for the next planting which is to remain on the land for at least 32 months. All trash left on the land, together with what little vegetable matter there may be, is generally burned. This is bad practice, because it destroys plant food and humus. After the trash has been burned, the land is turned to a depth of 8 or 10 inches. A large part of this work is still done with oxen, usually 8 oxen drawing an ordinary moldboard plow. Two teams a day, morning and afternoon, are required, making 16 oxen and three men a day for each plow used. This outfit will turn from one-half to three-fourths acre a day. On the holdings of the West Indian Sugar Co., tractors, as well as oxen, are used for this work, but the equipment of these farms does not allow all the land to be broken with tractors. Renters of small plots turn and prepare their land by hand, using spading forks.

After breaking, the land is harrowed and then either thrown into a series of high ridges, called banks, or marked off with shallow furrows. The last method, which is the most desirable, is becoming more and more popular. The rows are spaced 4½ or 5 feet apart and the cane cuttings planted 2½ or 3 feet apart in the bottom of the furrows in single rows.

Most of the cane is planted between September and December, but it may be profitably planted until the middle of January. During the normal planting season, September to December, practically the whole cane is used for planting. Each stick or cane is cut into pieces having from two to four eyes. If cane is planted during the dry season so-called "tops" are preferred. These consist of the upper four or five joints of the cane stick from which the growing point has been cut away. From 3,600 to 5,000 of these cuttings are planted to the acre. The "plant tops," as these pieces of cane are called, are planted by hand, the workman using either a pickax or a crowbar with which to open a hole in the bottom of the furrow. Into these holes he slips the plant tops. One man will plant about 3,000 tops a day.

SOILS AND CROPS

Since the first settlement by white men, St. Croix has been almost entirely an agricultural island. For a long time sugarcane was the only commercial crop of importance. It was used for the manufacture of sugar and rum. The cane juices were extracted by mills operated by wind power, and the raw sugar was extracted from these juices in old-fashioned open pans. Later, more efficient machines were introduced, but even these are now out of date, according to present standards of efficiency. Although the soils are admirably adapted to sugarcane, the comparatively dry climate and persistent droughty weather over a period of years has greatly reduced the yields, and recent low sugar prices have prevented capitalists from investing their money in new machinery or in the production of cane on a large scale. In consequence, the cane-growing industry is rapidly diminishing in volume. The soils of the island are well suited to sea-island cotton, and good yields can be produced with much less water than can sugarcane, but the appearance of the pink bollworm, together with reduced prices for the staple, have forced the planters to abandon this crop temporarily. Very recent investigations by entomologists have shown the bollworm to have been so nearly exterminated by closed seasons on cotton growing that an attempt is to be made by the Federal experiment station, cooperating with the planters, to produce a crop of cotton on a small acreage in the near future.

Many different vegetables and tropical fruits have been successfully grown and could be produced in large quantities if a profitable market could be found. Tomatoes, beans, peppers, bananas, sapodillas, avocados, pineapples, and citrus fruits do well in certain parts of the island. A number of thrifty-looking date trees were observed in various parts of the island. These trees are said to produce a fair quality of fruit, and it would seem advisable to experiment with different proved varieties with a view to growing dates on a larger scale. Dates thrive in moist soil and are resistant to moderate con-

A, Young sugarcane growing on Fredensborg clay. Slob estate headquarters at the left. Mount Eagle and Blue Mountain in the background; B, Guinea grass pasture on Descalabrado clay and its steep phase near Lowry Hill, St. Croix Island. Note the dense growth of thorny brush on the mountain in the background

centrations of salts. They would probably flourish in some of the poorly drained areas of the coastal plain where the salt accumulations are not too strongly concentrated. Alfalfa would probably thrive in many parts of the island where there are no salt accumulations and might prove to be a valuable addition to the forage supply for cattle and horses.

At the present time there is no way to ship perishable crops to the markets of the United States or Europe, but it is reasonable to suppose that steamers with refrigerator compartments would operate if a steady business were in prospect. Of the perishable crops, tomatoes, peppers, and green Lima beans seem to be the most promising. The production of pineapples, as will be shown, will of necessity be very limited. The chief limits to the quantities of other crops which can be grown will be set by the amount of rainfall available in a given year and by the local or export demand, together with the degree of aggressiveness of the people who produce the crops.

Many parts of the island are so hilly or so stony that they are suited only for forestry or pasture. A fairly large cattle-raising industry is thriving on such lands.

In view of the prevailing low sugar prices, poor facilities for sugar production, and the comparatively dry climate of St. Croix Island, it seems likely that the cane industry is doomed to ultimate extinction unless sufficient water be found for irrigation. If the sugar industry becomes extinct it will be necessary to adopt new crops and produce new products to take its place.

Nearly all the arable soils of the island will produce good crops of vegetables and fair crops of corn, and many soils are well adapted to a large variety of fruits. The untillable hilly lands will produce excellent pasturage which is sufficient for enough animals to provide milk and meat for the populace and for a good export trade as well. It is easily possible, therefore, for the island to produce nearly everything the people need to eat and have a comfortable surplus of many of the food crops. The mountainous and rocky land will produce excellent mahogany and other tropical woods on the slopes that are sheltered from the trade winds and, with proper forestry methods, after a period of years would furnish a steady cash crop. For more immediate returns it would seem that the production of dry beans for the Porto Rico market should prove highly profitable. There are tremendous areas of soils suited to this crop. If the pink bollworm and other pests can be kept under control the production of sea-island cotton should provide a substantial export item. Pineapples and citrus fruits have been suggested as possible export crops, but it is not likely that either crop can be grown in greater quantities than are sufficient for local demands. Especially is this true of pineapples. This crop prefers distinctly acid soils, and no soils were observed in St. Croix that were more than slightly acid. The citrus-fruit outlook is brighter, but the fruit would have to come into competition with that from Puerto Rico and Florida. Fresh vegetables for the winter markets of New York might prove profitable provided transportation could be obtained. A few cacao trees are scattered over the island, and they seem to thrive in the northwestern mountains and valleys. It would probably be well to experiment with the production of cacao in this region with a

view to possible expansion. With the increased consumption of cashew nuts in the United States, there is increased possibility of commercial production of this crop in the American Tropics.

The possibility of growing certain important insecticidal plants on the island is also under consideration by scientists of the Bureau of Chemistry and Soils.

In the past, the soils of the island have been classified loosely from a geological point of view. Two chief geological formations have been recognized. The first is known as the "older series," or "blue beach" in more common language, and the second is known as the "younger series," or "marl" formation. The blue beach consists of a great series of highly stratified extrusive volcanic tuffs and shales, with many dikes and sills of intrusive hard igneous rocks. These are interstratified here and there with hard limestones and limy shales, which also include some volcanic materials. Soils from materials that have been washed out from the blue beach have been classified with this series. Marl soils are those which have been derived from any of the harder or softer layers of the younger series of marls and limestones.

TABLE 3.—*Acreage and proportionate extent of the soils mapped on St. Croix Island, Virgin Islands*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Fredensborg clay	1,984	3.8	Barrancas clay	64	0.1
Diamond clay	512	1.0	Cornhill clay loam	2,368	4.5
Diamond clay, deep phase	832	1.6	Lavallee clay loam	576	1.1
Sion clay	960	1.8	Orangegrove loam	128	.2
Sion silty clay	512	1.0	San Anton loam	3,136	6.0
Coakley clay loam	2,088	5.1	Descalabrado clay	5,888	11.2
Aguilita clay	4,096	7.8	Descalabrado clay, steep phase	14,720	28.0
Aguilita clay, shallow phase	512	1.0	Descalabrado clay, shallow phase	2,176	4.1
Aguilita clay, steep phase	1,600	3.1	Parasol clay loam	448	.9
Hesselberg clay	1,856	3.5	Serrano clay loam	768	1.5
Hope clay	2,368	4.5	Jaucas sand	896	1.7
Santa Isabel clay	1,792	3.4			
Granard clay	512	1.0	Total	52,480	
Glynn clay loam	1,088	2.1			

Following a reconnaissance soil survey, the soils of the island were classified according to the following characteristics: (1) Color; (2) structure, or character of soil aggregates; (3) consistence, or degree of plasticity, friability, and other characteristics; (4) presence or absence of lime ($CaCO_3$); (5) presence or absence of harmful quantities of soluble salts; and (6) character of parent materials. Careful separations on the basis of texture were not recorded because the textures of the soils of the island are almost uniformly very heavy. This characteristic was, however, taken into consideration in a general way. The soils were examined to sufficient depth, wherever possible, to determine the characteristics of all horizons from the surface soil to the parent material. On the basis of these observations the soils are classified in soil series, types, and phases. Each type and phase is indicated on the map by an appropriate symbol. Nineteen soil series comprising 20 soil types and 5 phases are mapped. For convenience in discussion and in making practical use of this survey, these soils may be placed in four groups, as

follows: Group 1, soils underlain by limestone or marl, generally shallow, but fertile; group 2, soils underlain by alluvial deposits, generally deeper than those of group 1; group 3, soils derived from old volcanic rock material, mostly shallow and on rough topography; and group 4, miscellaneous recent deposits.

In subsequent pages of this report, the soils of St. Croix Island, Virgin Islands, are described in groups and in detail. The accompanying soil map shows their distribution over the island, and Table 3 gives the acreage and proportionate extent of each soil mapped.

SOILS OF GROUP 1

The soils of group 1 are all locally called marl soils, and they are the most important agricultural lands of the island from the point of view of the area involved, but there are other soils which are potentially more productive though less extensive. In this group of soils are placed seven soil types and three phases which are described in the order of their importance.

SUBGROUP A

Five of these soil types and one phase belong to a subgroup in which the soils have several characteristics in common. To a depth of 9 or more inches they have dark surface soils of granular structure and good tilth. Beneath the surface soil is a thin transitional zone of mixed organic soil and marl underlain by marl or soft limestone at a comparatively slight depth. In a few places are "slick spots," where a slight accumulation of sodium carbonate or other salts has rendered the soil unproductive. One of these is near the new well at Anna's Hope. The surface soils have good moisture-holding capacity, but the substratum is so porous that the subsoils do not hold moisture during very long dry periods. These soils are capable of producing excellent crops when moisture conditions are at all favorable. Many of the formerly prosperous sugar estates are located on these soils, and in favorable years good crops of cane may still be produced. (Pl. 1, A.) Many varieties of vegetables will grow and produce excellent yields. The soils are well adapted to the growing of dry beans of various sorts, and it seems likely that the bean crop would be one to be emphasized in a program of agricultural readjustment. Puerto Rico, which is within easy reach by sloop or steamship, offers a market for dry beans. Tomatoes, peppers, Lima beans, sweetpotatoes, corn, cotton, and many other crops are adapted to these soils.

The following brief descriptions indicate the differences between the different types of this subgroup of soils:

FREDENSBORG CLAY

The surface soil of Fredensborg clay is very dark gray granular clay which is plastic when wet. This layer, which ranges from 10 to 15 inches in depth, lies on a thin transitional zone of gray, mottled with yellow and white, clay which is, in turn, underlain by a very porous loose somewhat yellow marl or soft limestone. The soil throughout the entire profile is rich in lime carbonate. The granular structure of the surface material causes the soil to have excellent

tilth except immediately following heavy rains. A phase of Fredensborg clay, having a distinctly black surface soil, was recognized but not separately mapped because of its small total area. The occurrence of such an area was noted at Bethlehem, about midway between Christiansted and Frederiksted.

DIAMOND CLAY

Diamond clay is brown and granular but less plastic than Fredensborg clay. Marl occurs at a depth of about 1 foot. This soil is well adapted to vegetables and cane and would doubtless produce excellent yields of cotton. On the whole it is probably somewhat less productive than Fredensborg clay. Some salty spots occur near the seacoast.

DIAMOND CLAY, DEEP PHASE

The deep phase of Diamond clay is like the typical soil except that the brown surface layer in the phase extends to a depth of 2 feet. It is somewhat more productive than the typical soil because of the deep topsoil and the consequent greater moisture-holding capacity.

SION CLAY

Sion clay consists of medium-gray or dark brownish-gray granular friable clay to a depth of about 9 or 10 inches. It has the usual 3 or 4 inch transitional zone, and white or yellow marly lime occurs at a depth ranging from 12 to 15 inches. This soil is naturally very fertile, but it is more subject to droughty conditions than the more plastic Fredensborg and Diamond clays. There are some local "slick spots." The same crops as are grown on Fredensborg clay and Diamond clay do well on this land.

SION SILTY CLAY

Sion silty clay is similar to Sion clay but differs from that soil in that it contains a larger proportion of silt materials, and in many places many fragments of soft limestone occur. This is the most extensive soil on the flat areas of the Federal experiment station. It is probably somewhat less productive than Sion clay because its water-holding capacity is less and because it contains less organic matter.

COAKLEY CLAY LOAM

The surface soil of Coakley clay loam is granular friable dark brownish-gray or gray material which contains many soft limestone fragments. At an average depth of about 10 inches it is underlain by white semi-indurated chalky limestone. Cane crops on this soil show much chlorosis and are seriously stunted by droughty weather. However, many species of trees and several kinds of pasture grasses do very well. Guinea grass is especially fine. During moist seasons this soil is productive of many kinds of vegetables.

SUBGROUP B

Subgroup B of group 1 includes two soil types and two phases. The Aguilita soils are usually dark, rather thin, and lie at widely different depths on moderately hard or soft Tertiary limestones.

They are adapted to a mixed agriculture. The smoother areas, in which the soils are deeper, are suited to vegetables, dry beans, corn, cane, cotton, and pasture grasses, and the rougher and more stony areas are suited to pasture or forestry. Mahogany trees do very well on the hillsides occupied by these soils. Guinea grass is one of the best crops for pasturage. Hesselberg clay is alkaline in reaction, as are the Aguilita soils, but it differs in color. It is very stony in most places, which makes it difficult to cultivate. Nevertheless it produces good crops of vegetables and cotton. It also affords excellent pasture after the bushes are cleared off and the land planted to guinea or other pasture grasses.

AGUILITA CLAY

The surface soil of Aguilita clay is more or less friable dark brownish-gray clay loam or clay, which ranges from 5 to 20 inches in thickness. It is very limy. The lighter-colored friable limy subsoil is only a few inches thick and directly overlies moderately hard Tertiary limestone which has many cracks and fissures, so that it can be permeated by roots to great depths.

AGUILITA CLAY, SHALLOW PHASE

Aguilita clay, shallow phase, comprises areas of bare or nearly bare Tertiary limestone. In many places a thin surface coating of soil similar to the typical soil occurs. The land supports a natural growth of thorny bush, and where this is cleared off, scanty pasture for livestock is available. The agricultural value of this shallow soil will never be high.

AGUILITA CLAY, STEEP PHASE

The steep phase of Aguilita clay comprises areas of limestone hills most of which are too steep or too stony for cultivation. These areas furnish good pasturage when cleared or planted to grass. Mahogany trees flourish on this steep land.

HESSELBERG CLAY

Hesselberg clay occurs in the southern and southwestern parts of the so-called "marl belt." To a depth of about 1 foot it consists of reddish-brown or brownish-red calcareous granular somewhat stiff clay which has very good tilth. It overlies rather hard fragmental limestone having red clay in the interstices. Solid rock occurs at a depth ranging from 15 to 24 inches. The soil has good moisture-holding capacity and is a good crop producer. Its stony character makes cultivation difficult. Before the advent of the pink bollworm this soil was extensively used for growing cotton. Very little cane was seen growing on this soil.

SOILS OF GROUP 2

The soils of group 2 occur on the flat coastal plains, alluvial fans, and terraces. The soil materials are almost entirely of fluvial origin, but weathering has produced different profile characteristics, largely according to the length of time the materials have been exposed to its influence. The composition of the materials from which these fluvial

deposits have been washed also influences the characteristics of the soils. Nine soil types were recognized and mapped and included with this group. They have been placed in three subgroups.

SUBGROUP A

Soils of subgroup A have heavy dark-colored somewhat granular surface soils, heavy very stiff and hard clay upper subsoil layers, friable or plastic limy lower subsoil layers, and, with one exception, more or less gravelly parent materials. In many places, which are indicated on the map with stone and gravel symbols, the surface soils contain enough loose stone or gravel to interfere more or less with cultivation. The heavy stiff character of these soils makes them difficult to handle and impairs their productivity. In the past these soils have been devoted mainly to cane and pasture. Probably they would produce good yields of cotton if it proves practical to grow cotton on St. Croix Island. In many places these soils show evidence of slight or moderate accumulations of soluble salts and black alkali, which, if they become more concentrated, will seriously interfere with crop production. Concentration of alkali is not very likely to take place unless the land is irrigated, and then it will be necessary to provide subdrainage.

HOPE CLAY

Hope clay is the most extensive soil of this subgroup. It occupies an almost continuous strip of territory from Whim and Hope to Bethlehem and Fredensfeld. The surface soil consists of a layer of dark gray-brown granular or finely cloddy very stiff clay about 6 inches thick, which in many places contains gravel. The surface soil in most areas is slightly calcareous. Underlying this layer is a 1-foot layer of heavy dark gray-brown or black exceedingly stiff granular or cloddy clay which grades into a 12-inch layer of heavy cloddy olive-drab calcareous clay. The deeper part of the subsoil consists of mixed gravels, clays, and sands, with a heavy accumulation of lime, some of which is concretionary. When at the proper moisture content this soil breaks up fairly well under the plow, but otherwise tillage is difficult. Most of this land shows evidence of slight or moderate accumulations of alkali, especially in the subsoil. The alkali spots are especially abundant where there is a sudden change in slope.

SANTA ISABEL CLAY

Santa Isabel clay resembles Hope clay in several respects but has many points of difference. It is lighter colored than that soil; plastic, instead of stiff and cloddy; has good tilth; and the heavy layer of the subsoil is not so intractable. This soil is more calcareous and is as subject to alkali accumulation as Hope clay, but it averages much higher in productivity. In places near the seacoast enough salts have accumulated in the surface soil to interfere with the maintenance of good tilth. These places are indicated on the soil map by appropriate symbols. Santa Isabel clay should prove to be superior to Hope clay as a crop producer.

GRANARD CLAY

Granard clay is derived largely from the more or less gravelly marl which lies at the base of the Tertiary deposits. Few crops other than pasture grasses were observed on it. The differences between this soil and Santa Isabel clay are largely of a technical rather than a practical character and hence will not be discussed in this part of the report. Probably this soil will prove to be of about the same productivity as Santa Isabel clay.

GLYNN CLAY LOAM

Glynn clay loam occurs in a strip parallel to the areas of Hope clay, between areas of that soil and the mountains. It has a 10-inch granular dark gray-brown clay loam surface soil of good tilth, a 12-inch brownish-yellow moderately stiff clay loam upper subsoil layer, a brownish-yellow limy clay loam lower subsoil layer extending to a depth of 3 feet, and a gravelly and sandy substratum. This is an excellent soil in most respects, but it does not contain so much organic matter as do the soils of group 1. It is well adapted to nearly every kind of crop grown in the island and especially to vegetables, fruits, and cotton. Citrus fruits would undoubtedly do very well on this land if irrigation could be provided. Pineapples of good eating quality were observed on these soils, although the soil is not particularly well adapted to the present commercial varieties of pineapples.

BARRANCAS CLAY

Barrancas clay occurs in a few places on the coastal plain. It occupies low imperfectly drained areas between the alluvial-fan deposits and the soils of the marl group. It has a heavy nearly black waxy surface soil and a mottled rust-brown and gray plastic subsoil. This soil is calcareous, has fair tilth, and produces fair crops of cane, but its position makes it susceptible to accumulation of salts or alkali. The largest area lies just north of Fredensborg, and an area occurs just south of Lower Love. The agricultural value of this land is limited by poor natural drainage.

SUBGROUP B

Subgroup B includes three soil types derived from terrace or alluvial-fan materials, which have been washed from the volcanic or "blue beach" rocks. They have brown surface soils, more or less well-developed heavy upper subsoil layers, and gravelly substrata. Two of the soils of this subgroup have definite accumulations of lime in the subsoil.

CORNHILL CLAY LOAM

To a depth of about 4 inches the surface soil of Cornhill clay loam is dark gray-brown fine-granular friable loam or clay loam. It is underlain by a 6-inch layer of nearly black stiff and cloddy gravelly clay which tends to run together when wet. The subsoil is light yellowish-brown plastic clay and contains a large quantity of accumulated lime. The substratum material is a mixture of alluvial gravel, sands, and clays. Some variation in this soil occurs from place to place. Large areas of stony or gravelly soil are indicated

on the map by gravel and stone symbols. In several places, particularly near Great Pond and Southgate, enough sodium carbonate is present to affect crops adversely.

In the past this soil has produced excellent yields of cotton, but the climate in that part of the island where it occurs is so dry that cane has never been an important crop. At the present time the land is being devoted to pasture or has been allowed to revert to primitive conditions. It is very likely that good crops of dry beans could be produced on those areas of Cornhill clay loam which are not too badly affected by accumulations of alkali.

LAVALLEE CLAY LOAM

Lavallee clay loam occurs on alluvial fans on the north coast of the island, from Sugar Bay to Ham Bay, and on the south coast, from Rod Bay to East Point. As mapped the soil is somewhat variable and might be subdivided if a detailed survey were made. The surface soil consists of granular light-brown gravelly clay loam, and the upper subsoil layer is reddish brown, heavy, and sticky. There is an accumulation of lime in the lower part of the subsoil, and the substratum materials are stratified sands, gravel, and clays. Stony areas are indicated on the map by stone symbols. The area of Lavallee clay loam mapped near Ham Bay is very stony and does not show well-marked layers in the subsoil. Some of the areas near the east end of the island also differ somewhat from the typical soil. It was impossible to examine these soils in great detail in the time available. Near Lavallee this soil produces fair crops of beans and vegetables. An old planting of citrus trees has survived but, owing to lack of care, has not thrived. Areas of this soil include small strips of San Anton loam which is a very productive soil where not too gravelly.

ORANGEGROVE LOAM

Orangegrove loam occurs on high stream terraces near Annaly and Orangegrove. It is characterized by a deep brown surface soil underlain by a reddish-brown somewhat heavy subsoil, beneath which is the stratified gravel and sand substratum. As the soil is deep in most places, it should be very productive. The reaction of the surface soil is neutral or very slightly acid, and for that reason this soil might prove to be a fair soil for pineapples. Cane and vegetables grow well, and the rainfall is usually sufficient for the maturing of crops. As mapped, this soil includes areas of stream-bottom land and small areas of Descalabrado clay. This is one of the most promising soils for the production of citrus fruits. Along the adjacent stream bottoms good crops of bananas and plantains are being grown, and the acreage in these crops could well be extended.

SUBGROUP C

Subgroup C of group 2 includes only one soil type, San Anton loam.

SAN ANTON LOAM

This soil occurs along stream bottoms and on alluvial fans, in and adjacent to the volcanic oldlands of the island. In very gravelly areas, which are indicated on the map by gravel symbols, the soil is

likely to dry out quickly after rains. Otherwise, this is an ideal soil. It is somewhat deficient in nitrogen but is rich in other necessary plant foods. One small area, lying about three-fourths mile west of Krause Lagoon, is so very sandy and gravelly that it is of no value except for pasture.

This soil has a brown or gray-brown friable surface soil and a somewhat lighter-colored subsoil. In typical areas the subsoil is not heavy but consists of recently deposited alluvial silts, sands, and gravel. In most places the profile is slightly calcareous throughout. In the reconnaissance survey it is not practical to separate all areas of this soil from the Cornhill and other soils with which it is associated. Therefore some areas shown as this soil on the map doubtless include a large total area of other soils. Where rainfall is sufficient, this soil is well adapted to any of the crops common to this region. It would make excellent citrus-fruit land provided enough moisture were available. Most of the soil is probably too high in lime for successful pineapple culture. Beans should do very well.

SOILS OF GROUP 3

The soils of group 3 comprise more than half the total area of the island, but much of the land involved is so steep or stony that it is of little agricultural importance. The smoother areas of these soils are very productive, however. The surface soils are almost universally dark colored and fairly high in organic matter. The subsoils are lighter colored and in many places have accumulated more or less lime. In a few places, which are not shown on the map, both surface soils and subsoils have a decided tinge of red. These areas are of little interest to the farmer, however, because most of them occur in places too steep or too stony for cultivation.

DESCALABRADO CLAY

The surface soil of Descalabrado clay is coarsely granular rather stiff brown or dark gray-brown clay about 1 foot thick. It is underlain by yellowish-brown slightly heavier clay which contains many rotten tuff fragments. At a depth ranging from 15 to 30 or more inches is rotten volcanic rock, most of which is tufaceous or shaly in character. Seams of accumulated lime occur in many places in the upper part of the parent material. Rock outcrops are shown on the map by rock-outcrop symbols.

This soil is widespread in the mountainous regions. In the western half of the island the land is extensively used for the production of cane, vegetables, and fruits, and in the drier eastern part it is either devoted to pasture grasses or has retained its heavy cover of bush and cacti. The comparatively prosperous farming district near Annaly owes much of its prosperity to this soil. Selected areas of the deeper soils of this type, in the western half of the island, should prove to be excellent citrus-fruit land. Pineapples grow better on this than on any other soil observed on the island, but, judging from observations on the reaction of soils producing pineapples elsewhere, the indications are that this soil is too nearly neutral or too alkaline to offer much hope for the extensive cultivation of this fruit. Pineapples evidently prefer highly leached medium acid or strongly acid soils.

DESCALABRADO CLAY, STEEP PHASE

The steep phase of Descalabrado clay resembles the typical soil in every respect except that it lies on slopes too steep for convenient cultivation. As mapped it includes very large areas of very shallow soils and large areas of very stony land. The rock outcrops observed are roughly indicated on the map by appropriate symbols. Doubtless there are other stony areas, not observed or shown on the map. This steep soil occurs in close association with the typical soil. In the western part of the mountainous region large areas of the steep phase are under cultivation and are giving satisfactory yields. Some of this steep land in the eastern part of the island is used for pasture.

DESCALABRADO CLAY, SHALLOW PHASE

This shallow soil consists of dark-brown granular loam or clay loam about 12 inches thick, which lies directly on rotten tufaceous shales. It is used mainly for growing guinea grass for pasture and produces good yields of this crop. It is too droughty for most cultivated crops. Steep areas of this soil were included on the map with Descalabrado clay, steep phase.

PARASOL CLAY LOAM

Parasol clay loam occurs only in one large area in the vicinity of River and Fountain. The surface soil is very dark colored and deep, and the subsoil is yellowish brown and overlies rotten volcanic rocks. In places there is an accumulation of lime in the subsoil. Toward the valley bottom colluvial wash makes the soil thicker than it is near the hills. The soil has good granulation and works up well under the plow. Its heavy texture and large organic matter content should give it a high moisture-holding capacity. At present most of the land is devoted to cane but it should produce very good yields of corn, vegetables, dry beans, and fruits. It is regarded as naturally one of the richest soils on St. Croix Island.

SOILS OF GROUP 4

The soils of Group 4 include soils typical of the environs of the seacoast.

SERRANO CLAY LOAM

Serrano clay loam consists of a lagoon deposit of clays, sands, and loams which are gray, wet, and poorly drained. Most of the areas are more or less salty, and all of them are too near sea level for drainage without pumping. They have no agricultural value at present.

JAUCAS SAND

Jaucas sand is a pale-yellow sand made up almost entirely of coral fragments. It occurs in intermittent strips along the seacoast. In some places it is barren of vegetation, and in others it supports a growth of brush. It contains a moderate amount of organic matter. Some of the soil near Westend Saltpond has hardened into limestone.

Several small coconut groves are scattered over the Jaucas sand areas, and the trees seem to thrive. It would probably be well to extend such plantings.

IRRIGATION AND ALKALI

With the rather low precipitation over most of the island it would be very advantageous if a supply of water sufficient for irrigation could be obtained. Irrigation would be especially desirable in the so-called "mari belt" and on the alluvial fans of the eastern half of the island. There seems to be no hope of getting water for this section of the island, but some scientists believe that water might be obtained from certain parts of the lower Tertiary beds. Up to the present time no wells have tapped this horizon. Shallow wells have struck sufficient water for cattle but no supply large enough for irrigation purposes has been discovered. There are no reservoir sites that would furnish very large storage space and at the same time drain sufficient territory to assure a good volume of flood waters. The only hope for irrigation, therefore, and a slender one at that, is to tap the lower Tertiary beds in the hope of striking a good flow of water.

In case a water supply of considerable volume is found, it will be necessary to take precautions to use the water carefully and to dispose of the waste water in such a manner as to prevent the excessive accumulation of alkali and soluble salts. Alkali salts in small quantities were noticed in many places. Most of these areas, except those close to the sea or to lagoons, contain only enough alkali at present to slightly affect the soil. Irrigation would tend to concentrate the salts in low places where subdrainage is poor and along areas where there is a change in slope from comparatively steep to more gentle.

The accompanying soil map shows in a general way the location of the areas of soil that are affected by salts of various kinds. Sodium carbonate, commonly referred to as black alkali, was found affecting a few fairly large areas near Great Pond, the leper asylum, Southgate, Bethlehem, Castle Burke, and Jerusalem. It does not occur uniformly over the areas but in spots and streaks, especially in those places where sodium chloride has come in contact with limy soil or with the zone of lime accumulation in the soils that are noncalcareous in their surface horizons. It is especially common along the courses of intermittent streams, where there is a sudden change in the slope of the land surface.

The more soluble salts of sodium (chloride and sulphate), with minor quantities of other soluble salts, constitute what is commonly known as white alkali. These salts, especially sodium chloride, are widely distributed along marginal lands of the low coastal plains and alluvial fans. They are most concentrated near the numerous lagoons, and the salt concentration rapidly decreases toward the inland. There are a few narrow strips in which the concentration of white alkali is low in the inland between Enfield Green and Morningstar.

Soils affected by black alkali become puddled and impervious to water. Their naturally good granular structure breaks down, the

soil runs together, and it is impossible to make them productive without expensive chemical treatment combined with copious irrigation and carefully planned drainage.

The map shows three degrees of concentration of alkali salts. The affected areas were mapped on the basis of field observations, and a few representative samples were taken and tested on the electrolytic bridge for percentage of salts present. The locations of samples are indicated on the map by a red dot to one side of which is placed a number in fractional form. The upper number of the "fraction" indicates the percentage of salts in the surface foot of dry soil, and the lower number indicates the average percentage of salts to dry soil for the entire profile. Another number, in parentheses, indicates the depth to which the soil was sampled. Soils shown as weakly affected contain from 0.2 to 0.4 per cent salts, those shown as moderately affected from 0.4 to 1 per cent, and those as strongly affected from 1 to more than 3 per cent. In the weakly affected areas most crops will show a somewhat decreased yield, and some trouble may be experienced with getting seeds to germinate and with the dying of young and tender plants. In moderately affected areas there are likely to be large barren spots and much plant loss. Only highly salt-tolerant crops will produce on these lands. Some grasses will do fairly well, but most cultivated crops will give trouble. Coconuts will usually grow fairly well. The strongly affected areas will ordinarily be devoid of all economic crops.

Doubtless some areas of soil affected by alkali are not shown on the map, and doubtless, also, there are areas of unaffected land included in those parts shown as being affected. Only a carefully conducted detailed survey would bring out all the facts regarding the soils and alkali conditions.

SOILS AND THEIR INTERPRETATION

The island of St. Croix is well within the Tropical Zone. It is far enough north, however, to be almost constantly fanned by the trade winds. Low islands in the trade-wind belt have low rainfall, and many of them are desertlike. Where mountains occur on the islands, however, the warm winds rise sufficiently to become cool enough to drop part of their moisture. St. Croix Island has two low chains of mountains running east and west, which are sufficiently high to cause enough precipitation to support agriculture over much of the island. The highest recorded mean annual rainfall is, however, only about 52 inches. The lowest recorded mean is nearly 39 inches, but it is almost certain that some places in the eastern end of the island receive an average of less than 20 inches annually. This is an estimate based on observations by residents and on the character of the vegetation in that part of the island. In the Temperate Zone an average rainfall equal to the recorded minimum of St. Croix Island would constitute a humid climate. In the Tropics, however, and especially in the trade-wind belt, the climate under a 39-inch rainfall is semiarid.

With the foregoing facts in mind one would expect the mature soils of St. Croix Island to be marked by accumulations of the carbonates of calcium and magnesium somewhere between the surface

and parent material. Such is the case, with the exception of a few small and restricted areas in the moist region near Annaly, which were too small to be shown on a reconnaissance map.

Mature soils occupy only a small part of the total area of the island. They occur on old alluvial fans and colluvial slopes and as residuum from the volcanic rocks of the highlands. Probably 60 per cent of the agricultural lands are rendzinas[5] which are fairly shallow dark-colored soils lying on soft, chalky, or marly lime deposits or on hard or moderately soft limestones. The highly calcareous parent materials have retarded normal soil development. Between one-third and one-half of the total area of the island is covered with soils which are immature in stage of development, owing mainly to the steepness of the hills and mountains on which they occur. Most of these incipient soils consist of dark-colored surface soils, ranging from a few inches to a foot or more in thickness, lying directly on the rotten parent rock. The soils on gentler slopes have developed a thin heavy subsoil layer which in spots is underlain by slight accumulations of lime. These soils do not, however, show the depth of weathering and thickness of subsoil horizons characteristic of the normal mature soils of the region.

Since the entire Island falls within a climatic zone that has caused the formation of soils which are closely related to each other it seems most logical to discuss the individual soil series in the natural groups in which they fall. The factors, other than climate, which have contributed to soil formation and have produced the soil characteristics, are vegetation, parent material, and, in places, certain soluble salts. After climatic influences have been considered, the character of the parent material plays the most important rôle in the determination of the natural soil groupings of St. Croix Island. The other factors seem to be of secondary importance. Owing to the effects of the parent materials in parts of the island, the effects of salts in other parts, and the youthfulness of the deposits of soil materials in still other parts, there are few, if any, areas of normal mature soils. The soils will be discussed under the same four groups as those under which they were discussed in the section on Soils and Crops.

The soils covering much of the strip of territory from Little Princess and Vagthus Point to Westend Saltpond and Frederiksted owe most of their characteristics to the soft marls and limestones from which they are derived. These soils have been placed in group 1 and in soil terminology are classed as rendzinas. They are rich in humus, except where hereafter noted, are fairly thin, and have little or no subsoil, or B horizon, development. The group includes the Fredensborg, Diamond, Sion, Coakley, Aguilita, and Hesselberg soils.

Following are descriptions of the more important soils, with briefer mention of those which are less important.

A sample of Fredensborg clay, taken about three-eighths mile southeast of Slob, showed the following layers: From 0 to 10 inches, very dark gray calcareous plastic clay. The clay is very granular and falls apart into medium-sized angular grains when dry or moist.

[5] Soils developing under the influence of highly calcareous parent material and not yet advanced beyond a very early stage of development.

The dark color is caused by a large content of organic matter. From 10 to 14 inches, gray-white, rust-colored, and yellow mottled granular calcareous clay which is very plastic when wet. Many dark and light worm casts occur in this horizon. From 14 to 36 inches, very friable porous yellowish-white marly or soft limestone.

This soil occurs in low broad flats between limestone hills. Natural surface drainage ranges from fair to poor but, owing to the porous parent material, farmers experience very little trouble from poor drainage. A few areas near the seacoast contain sufficient salt accumulations to interfere with crop production.

Diamond clay differs from Fredensborg clay in being somewhat deeper and in having a surface soil which is grayish brown instead of nearly black. It is somewhat less plastic in the upper two horizons and seems to contain much less organic matter. Granulation in the two soils is about the same. This soil occurs in slightly better drained positions than Fredensborg clay. The deep phase of this soil has a considerably thicker solum than the typical soil.

The soil structure and parent materials of the Sion soils are very much like those of the Fredensborg and Diamond soils, but their color is medium brownish gray or dark brownish gray, with gray predominating. Unlike the Fredensborg and Diamond soils, the Sion soils are friable from the surface downward, even very soon after heavy rains.

The Coakley soils are much like the Sion soils except that they are dark colored and, at a depth of about 10 inches, lie on a semiindurated chalk deposit. This chalk is simply another form of the different Tertiary limestones of the region.

The Aguilita soils are derived from the harder layers of the Tertiary limestones. They usually occur on hills where natural drainage is excessive, but they are able to hold sufficient moisture to support fairly good crops. The surface soils are dark gray or dark grayish brown, are granular, like the other rendzinas, and differ greatly in thickness, according to whether the slopes on which they lie are concave or convex. In most places a soft marly transitional layer occurs between the dark-colored A horizon and the hard limestone which lies at a depth ranging from 1 or 2 inches to 3 or 4 feet. The shallow phase of Aguilita clay has almost no soil covering the limestone, whereas the steep phase is very stony.

Hesselberg clay is the one soil of this group with a red hue. It has a 5-inch reddish-brown medium granular stiff clay surface soil and a 7-inch brownish-red granular clay subsoil overlying fairly hard limestone which contains cracks filled with red clay. The soil is very stony and calcareous throughout.

As there is little, if any, strictly virgin land on St. Croix Island, it is difficult to say what kind of natural vegetation covered it originally. At the present time abandoned lands of group 1 grow up to a scrubby growth of thorn bushes, small trees, and some cacti. Lands not too densely covered by these bushes have, in addition, a growth of native and introduced grasses.

Bordering the strip of soils of group 1, just described, overlapping it in many places, and extending out from the mountains in alluvial fans elsewhere, are strips and patches of soil which comprise group 2. Soils of the Hope, Santa Isabel, Granard, Glynn, Cornhill,

Lavallee, Barrancas, Orangegrove, and San Anton series are included in this group. The first six are solonetzlike in character and contain more or less lime in the subsoil. Much of the lime has accumulated from the carbonation of the calcium compounds of the basic igneous minerals of the parent materials and their subsequent translocation from the surface by percolating waters. Undoubtedly some of the lime may also have come directly from the alluvial materials derived from the Tertiary limestones. This latter will hold true at least in the western and southwestern parts of the island. Sufficient quantities of sodium chloride have either been carried up from the sea by heavy storms or washed from the parent rocks to unite with the carbonates in forming small quantities of sodium carbonate in the soil. This compound is formed at the places where the sodium chloride may meet the accumulated lime, in other words, in the upper part of the subsoil. It has the effect of deflocculating the subsoil, causing the clay to puddle and form an almost impenetrable layer. Subsequent leaching may remove the carbonates, but the very heavy impenetrable layer remains for a long time. When this layer dries out it breaks into rough hard columns which will withstand much weathering in exposed cuts. In numerous places, which are shown on the map, there are still traces of sodium carbonate in the soil. The hard layer, or claypan, is very troublesome to farmers because of the difficulties it offers to cultivation and to root penetration. A special variety of cane, with sharp-pointed roots which pierce the claypan, was developed on St. Croix Island.

In the following descriptions it will be noted that the soils of some series have developed heavier and harder claypans than those of others.

A sample of Hope clay, taken one-sixteenth mile east of Hope, showed some accumulation of soluble salts in the lower layers. From 0 to 5½ inches the soil material is dark gray-brown finely cloddy slightly calcareous very stiff clay; from 5½ to 18 inches it is a very heavy black columnar slightly calcareous claypan which is exceedingly stiff and intractable; from 18 to 30 inches it is olive-drab, mottled with gray, somewhat granular calcareous stiff clay; and from 30 to 40+ inches it is yellow and olive-drab clay containing some iron and manganese concretions. This layer is very calcareous and plastic, and it contains some soluble salts. It is underlain by gravelly alluvium.

The Hope soils lie on broad, flat, gently sloping plains that, at present, are for the most part covered with pasture grasses or planted to sugarcane. In many places Hope soils contain large quantities of gravel of tufaceous or shaly origin. Comparatively large areas of this soil are subject to slight or moderate accumulations of salts.

A sample of Santa Isabel clay, taken one-eighth mile south of Enfield Green, showed the following profile: From 0 to 6 inches, brownish-gray medium-granular calcareous clay which is stiff when wet; from 6 to 10 inches, heavy finely cloddy very stiff olive-drab calcareous clay containing hard angular lime concretions; from 10 to 70 inches, brownish-yellow sticky plastic clay containing some limy spots, in which the interstitial soil is very calcareous; and from 70 to 80+ inches, yellowish-brown or reddish-yellow gravelly fine sandy clay loam containing lime concretions.

Santa Isabel clay occupies positions similar to those occupied by Hope clay. It shows evidence of salt accumulation in many places. The alluvium from which it is derived contains more or less limestone mixed with volcanic alluvium.

Granard clay is much like Santa Isabel clay except that it is somewhat darker and contains no hard lime concretions. The lime occurs in large silty spots. This soil is derived from mixed volcanic fragments and limestone of Tertiary age. These materials were laid down just before the great mass of the limestones of St. Croix Island and have since been exposed by erosion.

Glynn clay loam lies between areas of Hope clay and the mountains. The claypan has developed but slightly in this soil, and the soil is much lighter colored than the Hope soils. The parent material consists almost entirely of old alluvial gravel and silt washed out from the volcanic uplands. The soil is younger than Hope clay, but it has a slight accumulation of lime in the subsoil.

A sample of Cornhill clay loam, taken just east of Cornhill, indicates a profile as follows: From 0 to 4 inches, dark gray-brown friable fine-granular heavy loam or light clay loam; from 4 to 10 inches, dark-gray or nearly black gravelly clay which is cloddy and stiff, and which puddles when wet; from 10 to 16 inches, light yellowish-brown cloddy plastic calcareous clay; from 16 to 30 inches, yellowish-brown or reddish-yellow plastic clay, mottled with gray-white lime accumulations, which is cloddy when dry; and from 30 to 60+ inches, reddish-yellow or yellow-brown gravelly calcareous clay loam. At this place there was a slight accumulation of salts in the lower three layers, but in many places soluble salts are absent, or present only in minute quantities.

The vegetation on this type of soil consists of thorny bushes, cacti, and grasses. On land that has not been kept clear these bushy growths have become so dense that it is impossible to pass through without cutting one's way with a machete.

A sample of Lavallee clay loam, taken one-fourth mile southeast of Lavallee, shows the following profile: From 0 to 15 inches, brown coarsely granular somewhat stiff noncalcareous gravelly clay loam; from 15 to 39 inches, reddish-brown or brownish-red heavy gravelly clay which is stiff when moist and hard when dry; from 39 to 53 inches, light-brown stratified gravelly loam; from 53 to 83 inches, coarsely mottled red, brown, yellow, and gray limy gravelly clay loam; and from 83 to 113 inches, similar material to that in the above layer, with yellow mottles predominating. Gravelly layers occur in both the upper and lower parts of this layer. The soil material is puddled and slick when wet.

This soil occurs on deep alluvial deposits, chiefly along the northwestern coast of the island, from Sugar Bay to Ham Bay, and on the southeast coast, from Grass Point to East Point. Minor variations from the typical soil are noted in the section on Soils and Crops.

The natural vegetation on Lavellee clay loam was originally about the same as that on the Cornhill soils. Pasture grasses occupy much of the land at present.

Barrancas clay is a dark-gray or nearly black waxy clay with a gray and rust-colored mottled clay subsoil. It lacks the definite well-developed heavy horizon of the solonetzlike soils described, but

it is closely associated with those soils. This soil occurs in depressions and is poorly drained except areas that have been ditched. In most places it shows indications of slight accumulations of soluble salts in the upper part of the subsoil and in some places at the surface. The materials from which this soil is derived are a mixture of volcanic and limy water-laid materials.

Orangegrove loam and San Anton loam are both derived from fluvial sediments. Orangegrove loam shows evidence of having been strongly weathered, but typical San Anton loam is of recent deposition. A brief description of each soil follows:

A sample of Orangegrove loam, taken one-fourth mile east and slightly north of Orangegrove from a narrow high stream terrace, shows the following profile: From 0 to 15 inches, brown friable loam of loosely granular or single-grain structure; from 15 to 27 inches, dark gray-brown friable loam with whitish, moldlike spots; from 27 to 40 inches, reddish-yellow granular stiff gravelly clay; and from 40 to 90 inches, stratified old alluvium consisting of light reddish-yellow friable sandy clay loam.

Orangegrove loam contains no visible lime accumulation, but the second and third layers are distinctly alkaline.

A sample of San Anton loam, taken one-fourth mile northwest of Solitude, shows the following profile: From 0 to 7 inches, dark-brown slightly calcareous friable silt loam or loam; from 7 to 18 inches, light yellowish-brown slightly calcareous friable clay loam; and from 18 to 40 inches, dark-brown gravelly slightly calcareous friable loam underlain by alluvial materials which in places contain lime accumulation. The lime accumulation seems to belong to a soil which has been buried under more recent fluvial deposits.

This soil has little or no profile development, owing to its recent deposition, but it is so interlaced with mature soils derived from older alluvium that it is difficult, in mapping, to separate the old from the more recent deposits. One is sure, therefore, to find that San Anton loam, as mapped, includes many small areas of the other members of this group and vice versa.

Group 3 includes soils derived from the volcanic oldland materials which occur in two large areas corresponding to the mountainous areas of the island.

Descalabrado clay and its steep phase occupy much of this oldland area. This soil has a solum ranging in thickness from a few inches to about 2 feet and averaging about 16 inches. The surface soil consists of dark grayish-brown coarsely granular moderately stiff clay, from 8 to 12 inches thick. The 4 to 6 inch subsoil layer is brown or olive-drab finely cloddy clay. The parent material consists of rotten tuff or tufaceous shales which in many places contain streaks and seams of soft lime accumulation at their point of contact with the solum. The lime deposits are lacking in many places in the moist region around Annaly, but the soil retains a high pH value, nevertheless. Near Annaly, on some of the very small flat areas, are a few spots in which the subsoil is lightly mottled with red, yellow, and gray, giving evidence of very small spots having imperfect drainage. Aside from these small spots the soil has good or excessive natural drainage. The soils mapped in the Descalabrado series in the eastern part of the island seem to

have somewhat more lime accumulation than those in the western part.

Descalabrado clay, steep phase, occupies the steep mountainous slopes of the island. These soils are similar to the typical soil but are thinner, and in many places rocks outcrop. Included on the map with this steep soil are large areas of thin reddish-brown soil having neutral or slightly alkaline reaction. These areas are fairly common near the northern coast of the island, from Barron Bluff to Ham Bay, and in spots on that part of the island between Seven Hills and East Point. Incomplete field evidence seems to indicate that this local variation in color is probably caused by differences in the rocks. For example one very small unmapped area of serpentinelike rock near Lavallee was covered by a thin somewhat red soil. Trap rock in other places was covered by red soils in spots. The steep phase of Descalabrado clay also includes steep areas of the shallow phase of Descalabrado clay.

The natural vegetation on this soil is chiefly native forest trees and underbrush. Small trees, thorn bushes, and cacti cover this soil in the eastern part of the island.

Parasol clay loam is very similar in morphological features to the chernozem soils which occur in the Great Plains area of the United States and the Russian steppes.

A sample of this soil, taken five-eighths mile south of Parasol shows the following profile: From 0 to 10 inches, dark-brown coarsely granular, friable when dry but stiff when moist, clay loam having excellent tilth; from 10 to 20 inches, black, coarsely granular clay which is stiff when moist, has excellent tilth, and is high in organic matter; from 20 to 35 inches, mottled dark-gray and yellowish-brown clay loam, in which the mottling is caused by organic soil mixed with rotten tufaceous materials; and from 35 to 50 inches, brownish-yellow clay loam consisting of highly decayed volcanic rocks. In many places the upper part of this layer is highly impregnated with soft accumulated lime.

In this soil as in many others, the zone of lime accumulation is variable, being entirely lacking in some places and very thick in others, although the areas may be very closely associated. All of this soil observed was devoted to cultivated crops or to pasture grasses.

TABLE 4.—*pH determinations of soils on St. Croix Island, Virgin Islands*[1]

Sample No.	Soil type	Depth	pH	Sample No.	Soil type	Depth	pH
		Inches				*Inches*	
600107	Hesselberg clay	0–5	7.85	600145	Lavallee clay loam	0–15	7.29
600108	do	5–12	8.05	600146	do	15–39	7.63
600109	do	12–15+	8.27	600147	do	39–53	7.72
600110	San Anton loam	0–7	7.92	600148	do	53–83	8.24
600111	do	7–18	8.09	600149	do	83–113	8.69
600112	do	18–40+	8.27	600154	Cornhill clay loam	0–4	7.40
600130	Descalabrado clay	0–8	7.21	600155	do	4–10	6.76
600131	do	8–13	7.83	600156	do	10–16	8.72
600132	do	13–19	8.09	600157	do	16–30	8.63
600133	do	19–48+	8.29	600158	do	30–60+	8.27
600134	Orangegrove loam	0–15	6.57				
600135	do	15–27	8.31				
600136	do	27–40	8.30				
600137	do	40–90+	7.62				

[1] Determinations made by E. H. Bailey.

Group 4 includes two soil types, or, more strictly, soil materials of recent deposition. These soils are Serrano clay loam and Jaucas sand. Their characteristics are described in a preceding section on Soils and Crops.

Table 4 shows the reactions, in terms of pH values, of various soils of the island, which were sampled. Determinations were made by the electrometric method, using the hydrogen electrode.

SUMMARY

St. Croix, the largest of the American Virgin Islands, has a subhumid or semiarid tropical climate and is almost constantly fanned by the warm trade winds. Somewhat more than half of its 82 square miles of land surface is mountainous or hilly.

The agricultural lands are situated chiefly in the central part of the southern side of the island. In the past, the chief crop grown was sugarcane which was manufactured into sugar, molasses, and rum. During recent droughts and owing to current low prices of sugar, agriculture has languished almost to the vanishing point. Rum has not been commercially manufactured during recent years because of the passage of the eighteenth ammendment to the Constitution. Much land is being devoted to pasture for cattle which at present supply a moderately large export item.

The soils have been classified into 20 soil types and 5 phases of types, according to the usual Bureau of Chemistry and Soils methods. Members of one group of these soils comprising 7 soil types and 3 phases are derived from limestones, some of which are soft and some hard. These soils are moderately shallow but in general very fertile so far as chemical elements of fertility are concerned. A second group of 9 soil types includes soils derived from alluvial deposits. All but 2 of these have definite lime accumulations in the subsoils, and all but 3 have a heavy claypan in the upper part of the subsoil. Soils of a third group, including 2 soil types and 2 phases, are derived chiefly from volcanic rocks. They are dark colored and very fertile where not too shallow and too steep for cultivation. They occupy at least one-half of the island. The fourth group, including 2 soil types, represents lagoon and beach deposits of low agricultural value. Several areas of soil, especially near the lagoons and sea margins, are impregnated with soluble salts and black alkali.

The arable soils of the island are, in general, fairly fertile and are well adapted to a large variety of fruits, vegetables, cotton, and sugarcane in years when the precipitation is sufficient. The steeper and stonier areas are well adapted to tropical forest trees and to pasture grasses. Most of the unused lands are covered with a dense growth of thorny brush and cactus.

If sugarcane culture continues to decline, other agricultural pursuits will have to take its place. It is recommended that especial attention be paid to subsistence crops, cattle, dry beans for the Puerto Rican market, and tropical fruits. Vegetables for the winter markets of the United States may also prove profitable.

Lands are owned chiefly in large estates. Labor is performed mainly by negroes, and farm wages are low. The buildings on the estates, with a few exceptions, are badly run down or in ruins. The island is well supplied with churches and schools and has a good road system that reaches most parts.

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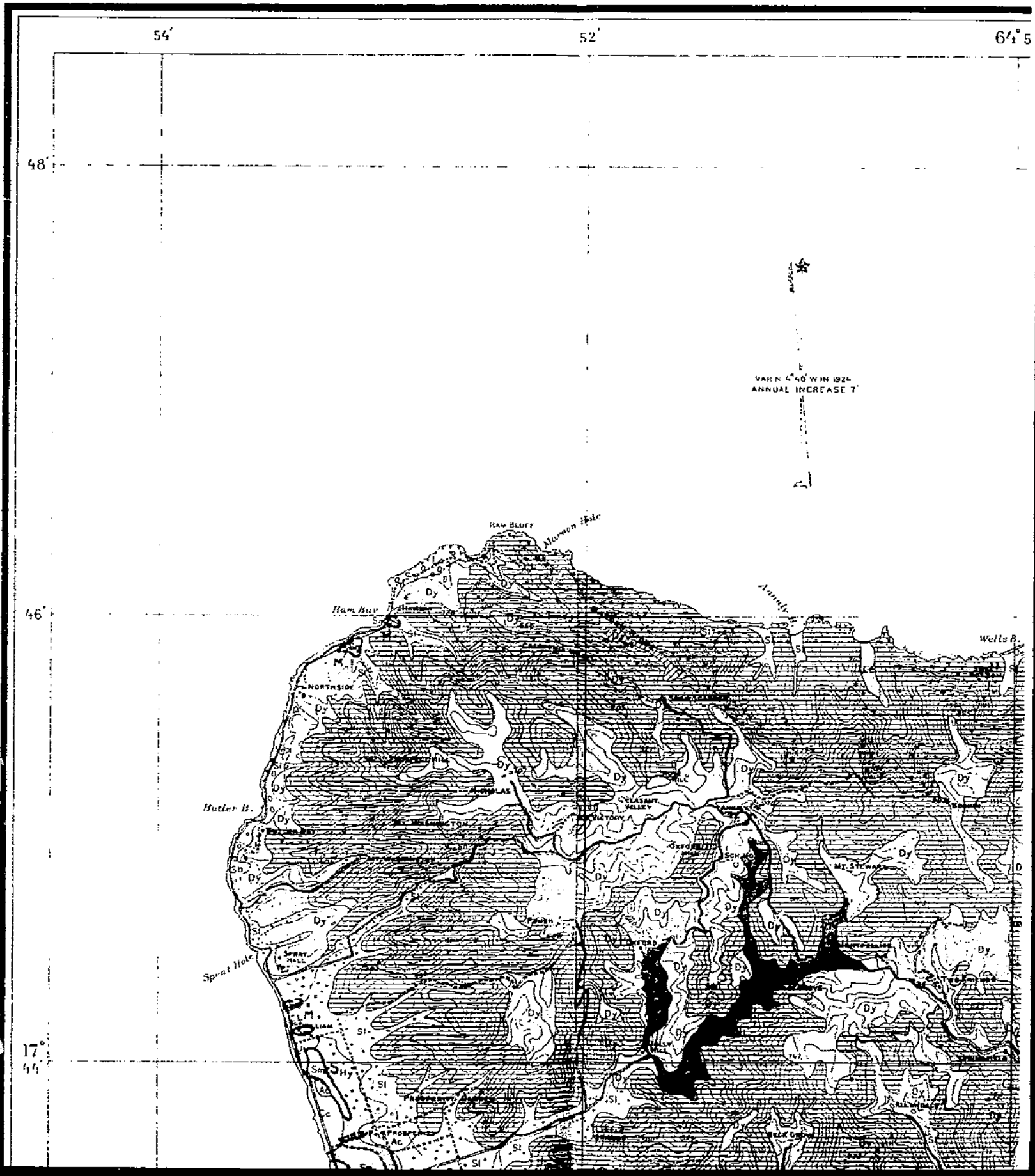
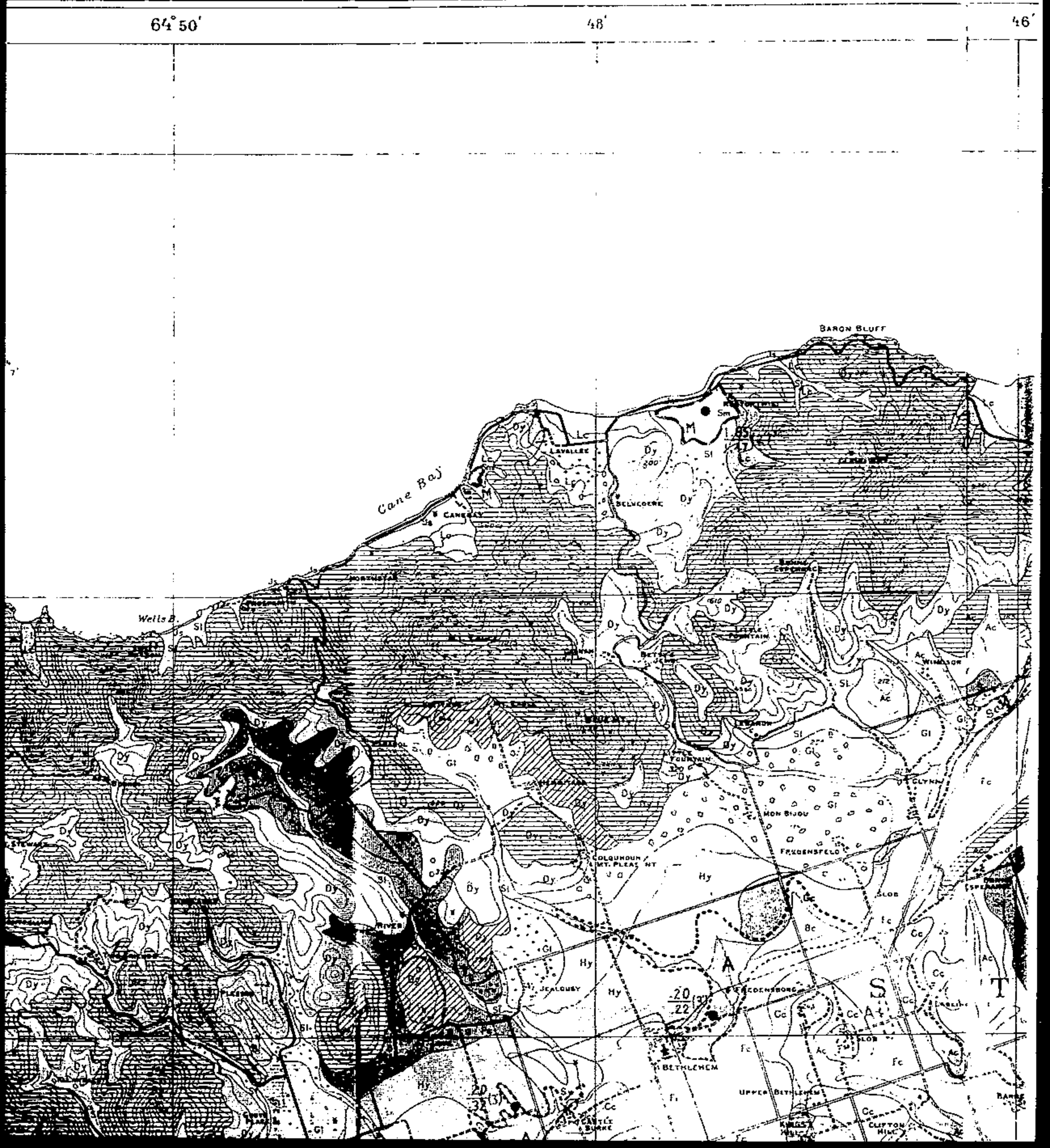


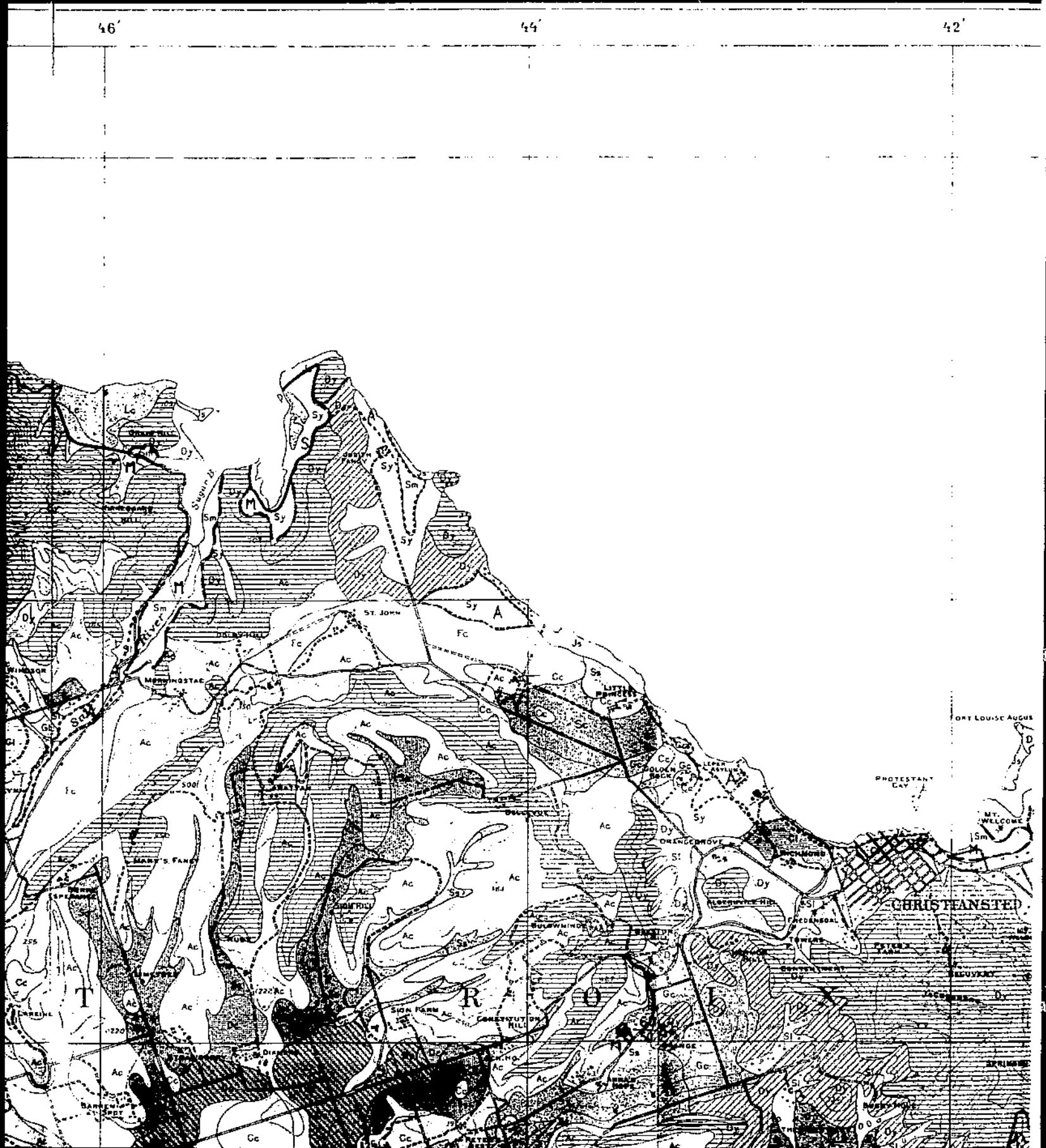

64°50'
48'
46'
BARON BLUFF
Cane Bay
Wells B.
LAVALLEE
BELVEDERE
CANEBAY
COLQUHOUN
MT. PLEASANT
MON BIJOU
FREDENSFELD
WINDSOR
GLYNN
SLOB
RIVER
JEALOUSY
FREDENSBORG
BETHLEHEM
UPPER BETHLEHEM
CASTLE BURKE
CLIFTON HILL
A
S
T

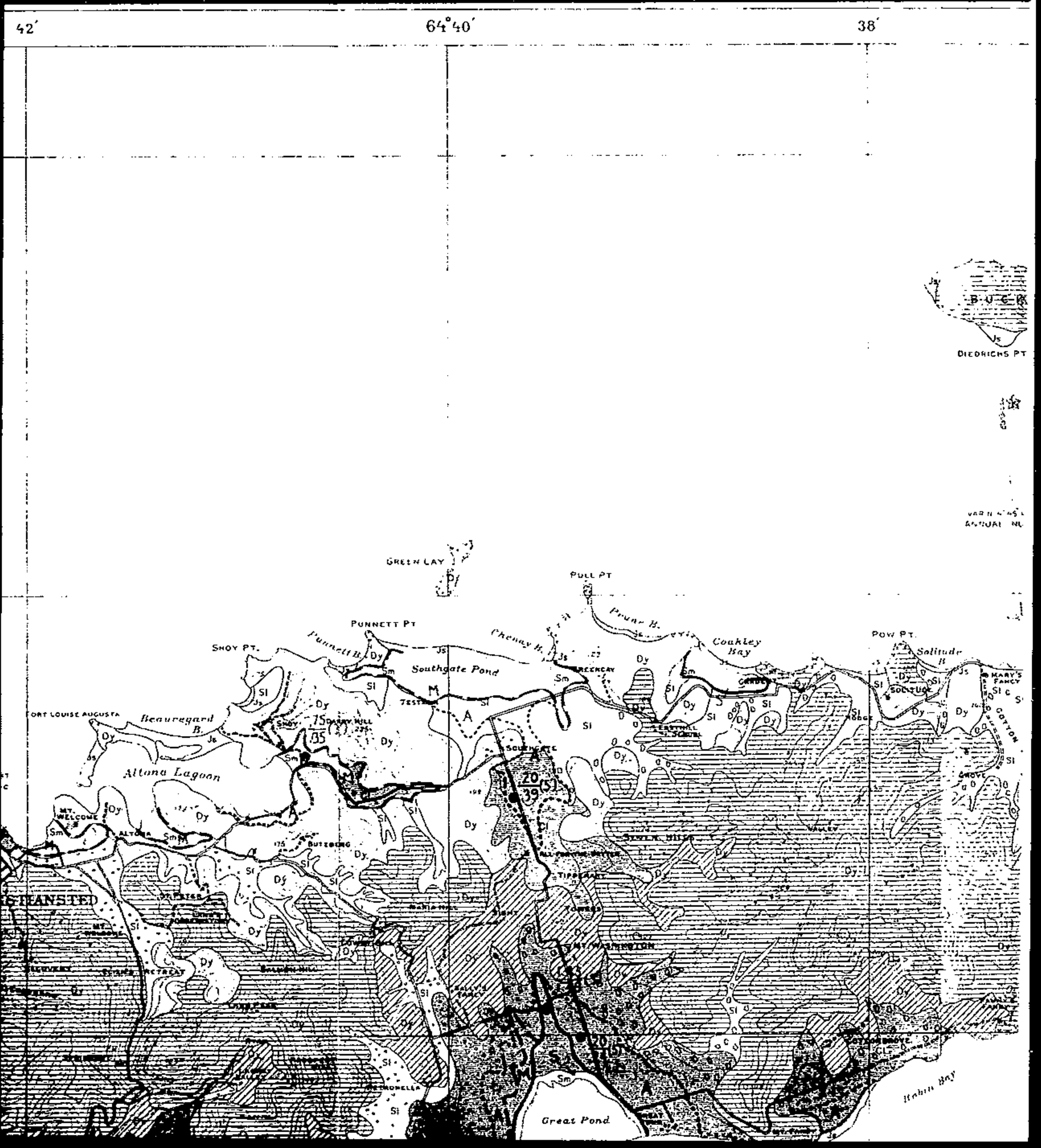
SOIL MAP

RECONNAISSANCE SURVEY

ST. CROIX ISLAND

VIRGIN ISLANDS




42′
64°40′
38′
DIEDRICHS PT
GREEN CAY
PULL PT
PUNNETT PT
Punnett B.
SHOY PT.
Southgate Pond
Cheney B.
Prune B.
Coakley Bay
POW PT.
Solitude B.
FORT LOUISE AUGUSTA
Beauregard B.
Altona Lagoon
ALTONA
SOUTHGATE
Great Pond
Robin Bay

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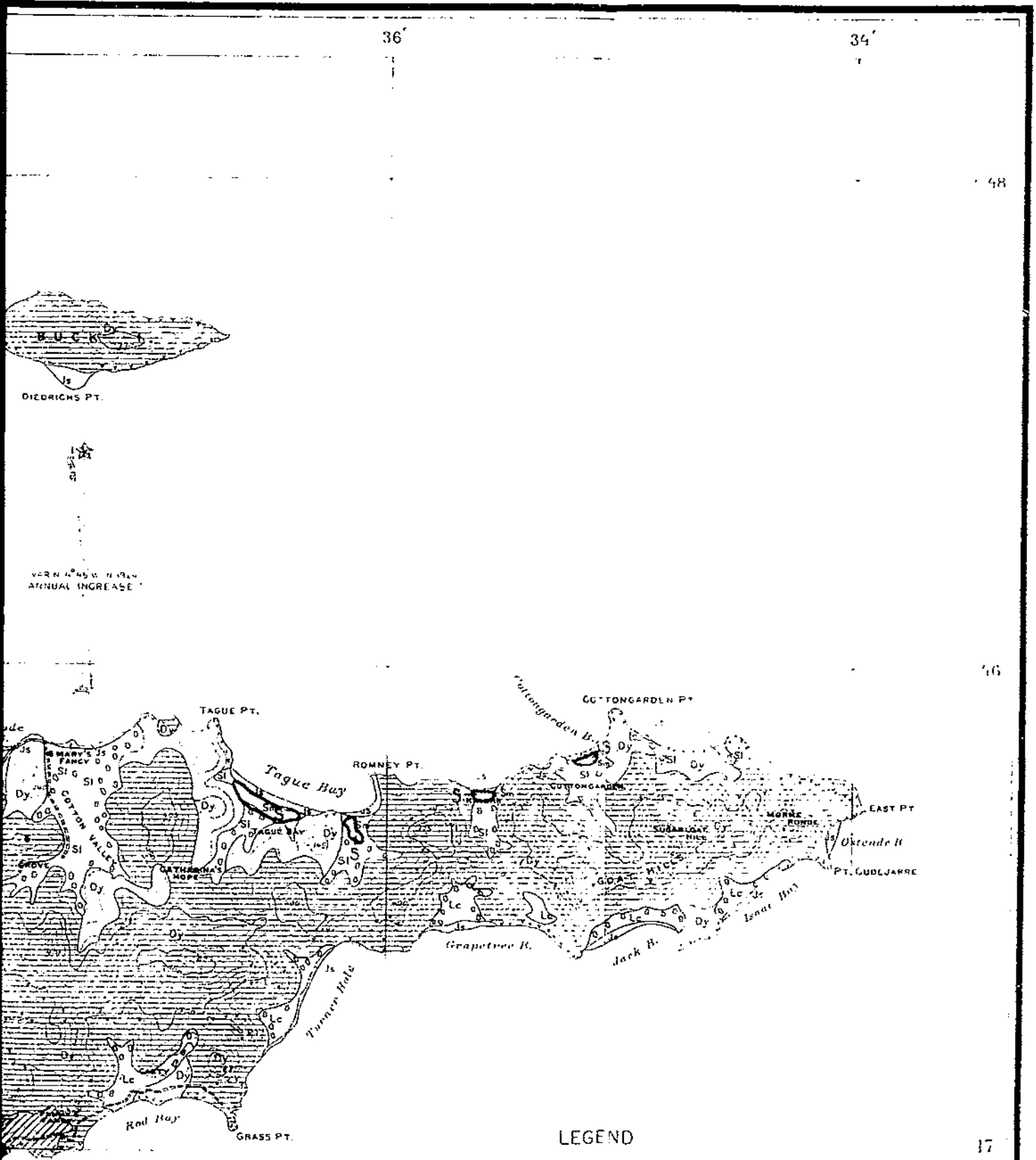
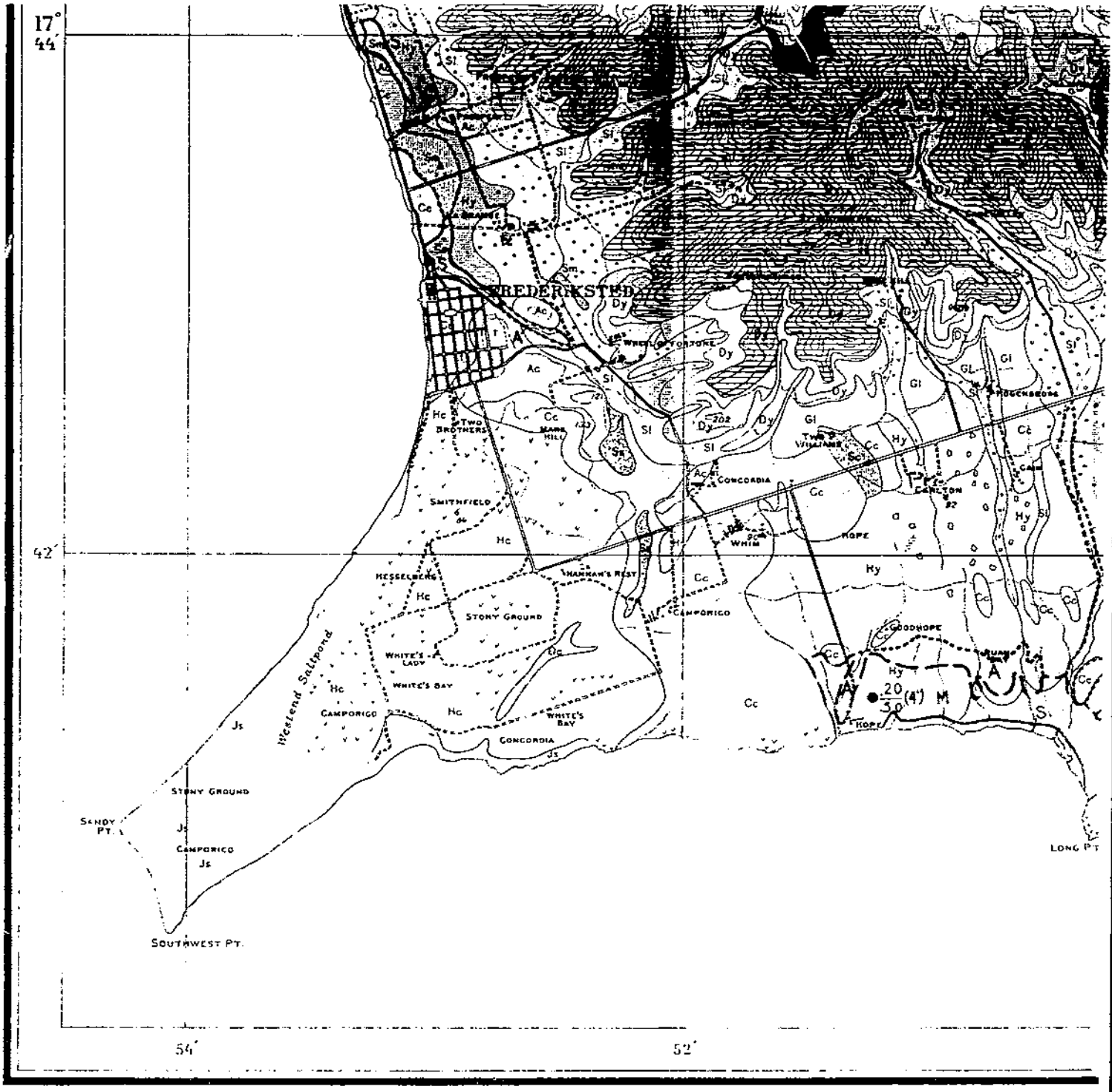
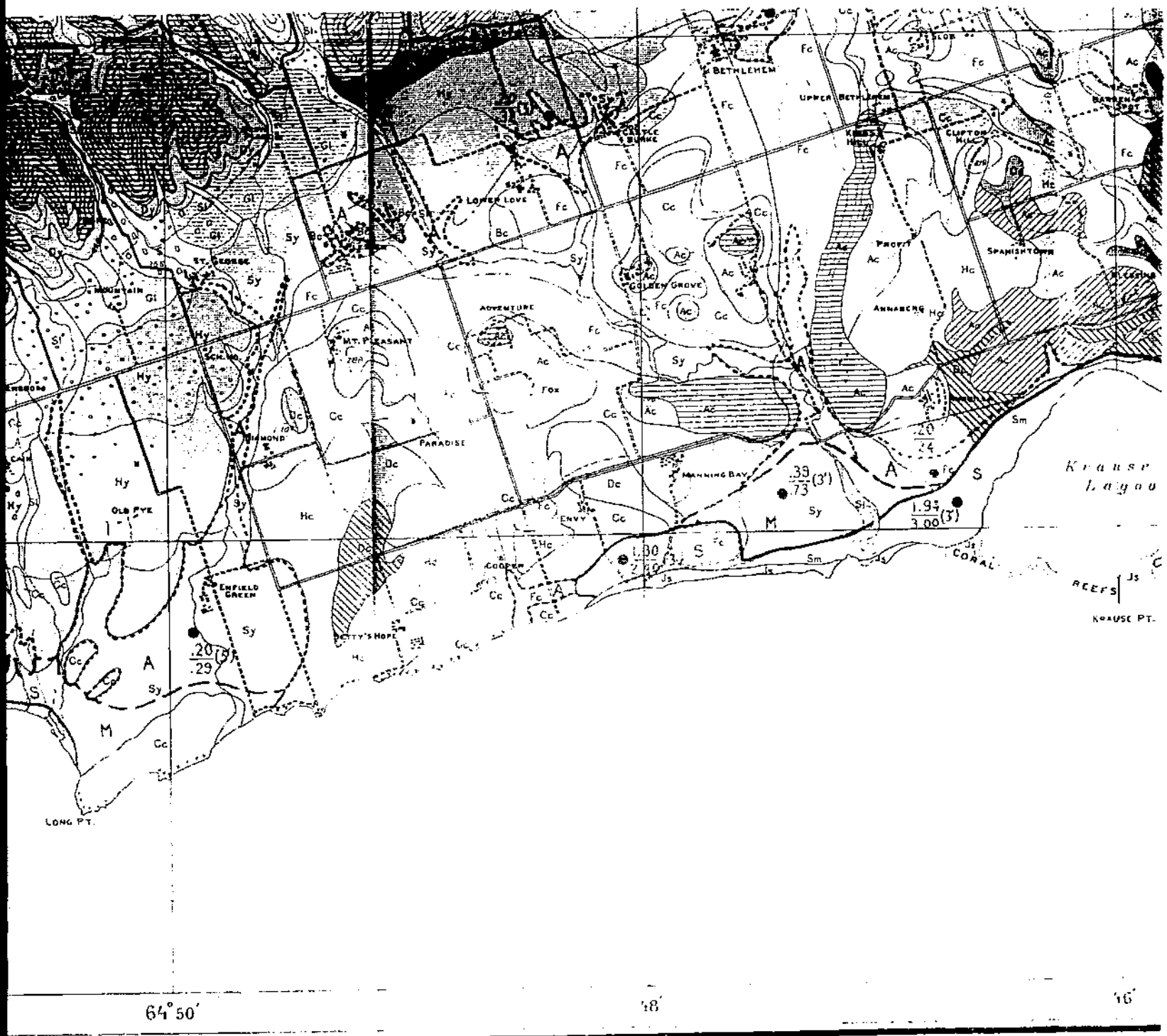
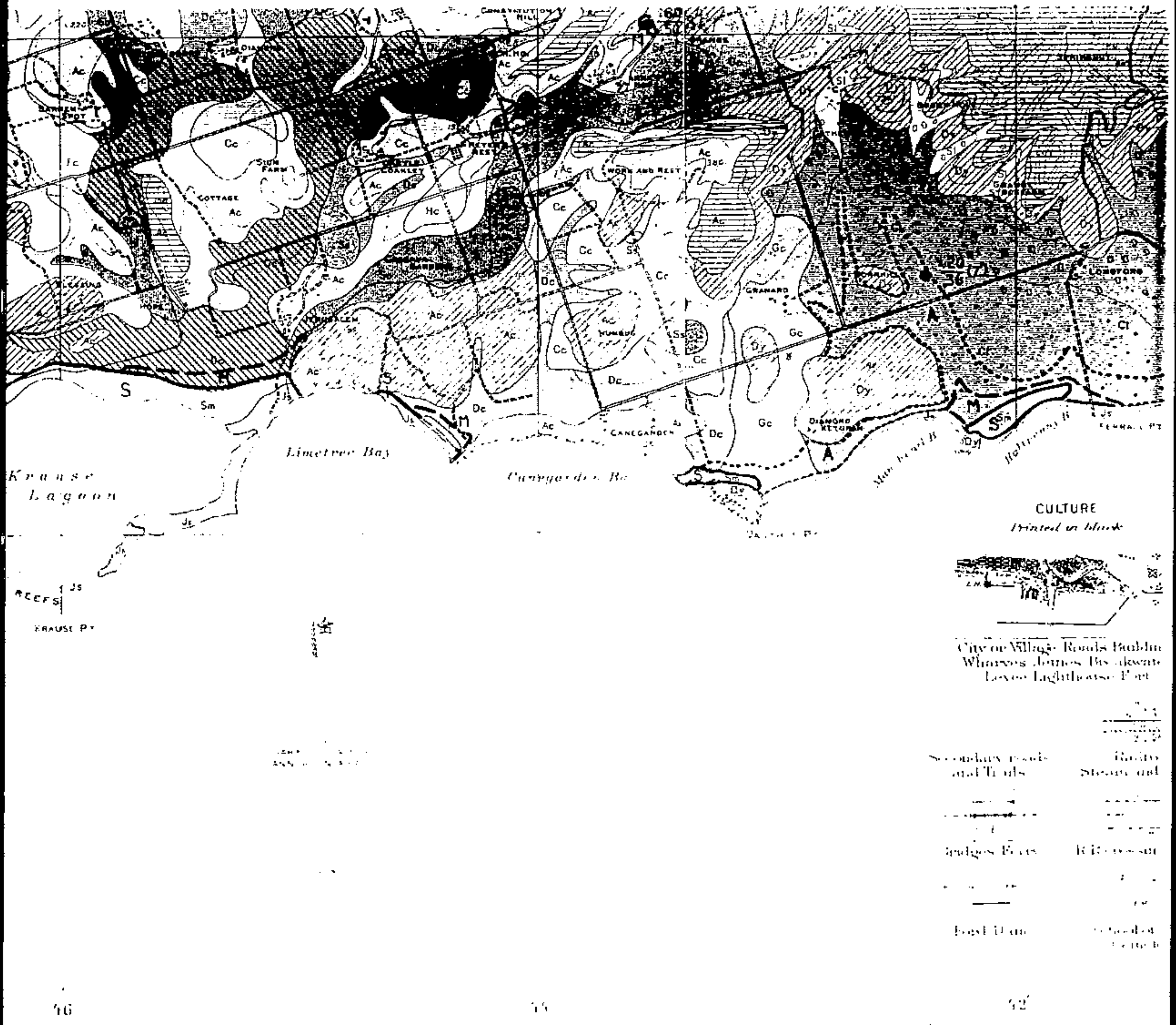


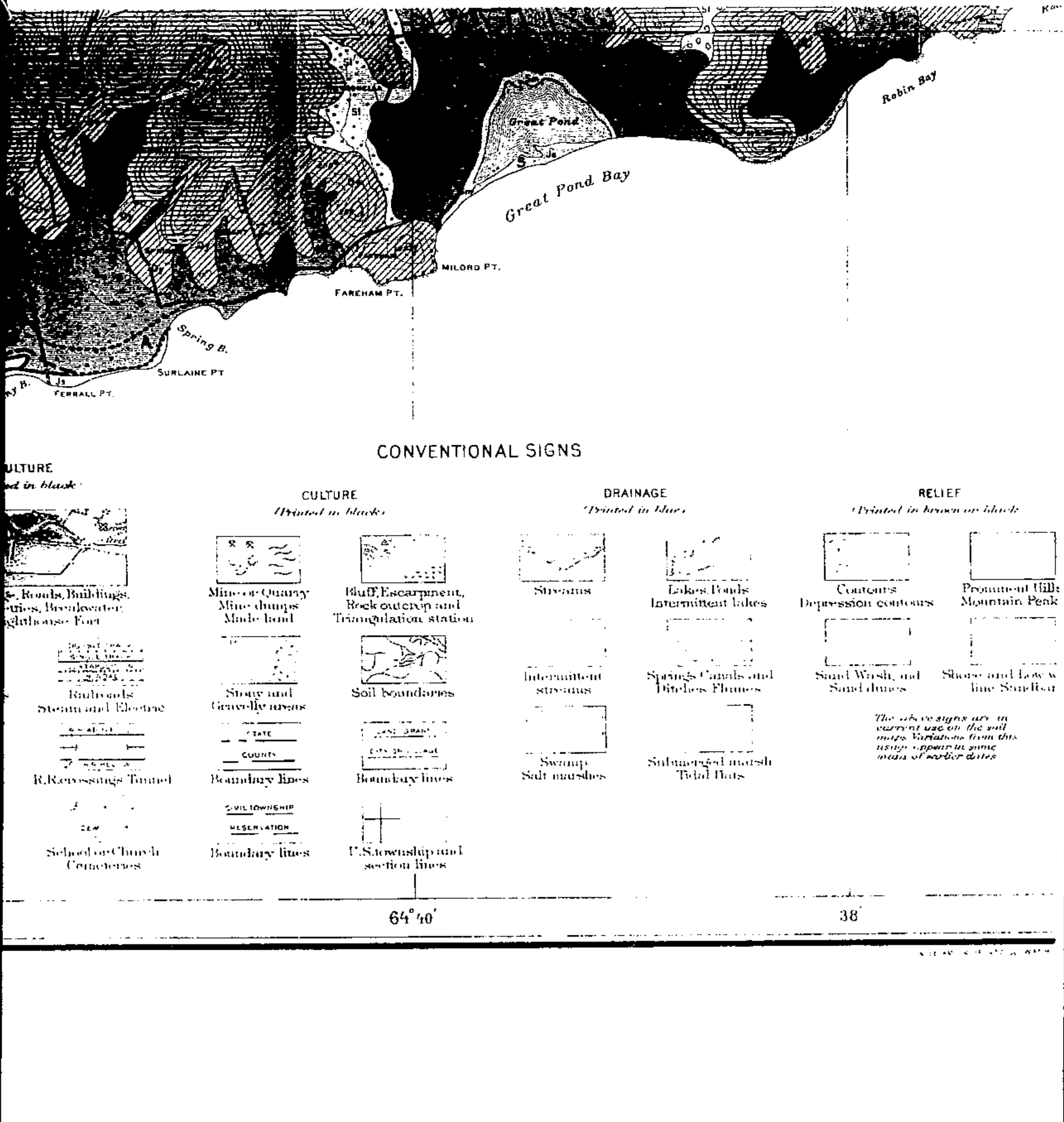


Soils surveyed by James Thorp.


BETHLEHEM
UPPER BETHLEHEM
CLIFTON HILL
LOWER LOVE
ST. GEORGE
MOUNTAIN
MT. PLEASANT
ADVENTURE
GOLDEN GROVE
PROFIT
SPANISHTOWN
ANNABERG
PARADISE
DIAMOND
OLD FYE
MANNING BAY
ENVY
COOPER
ENFIELD GREEN
BETTY'S HOPE
CORAL REEFS
KRAUSE PT.
LONG PT.
Krause Lagoon
64°50'
48'
46'



CONSTITUTION HILL
COTTAGE
WORK AND REST
GRANARD
HUMBUG
CANEGARDEN
DIAMOND RETURN
LONGFORD
FERRALL PT
Limetree Bay
Krause Lagoon
REEFS
KRAUSE PT
CULTURE
Printed in black


Robin Bay
Great Pond
Great Pond Bay
MILORD PT.
FAREHAM PT.
Spring B.
SURLAINE PT
FERRALL PT.
CONVENTIONAL SIGNS
CULTURE
(Printed in black)
Mine or Quarry
Mine dumps
Made land
Bluff, Escarpment,
Rock outcrop and
Triangulation station
Stony and
Gravelly areas
Soil boundaries
Boundary lines
Boundary lines
Boundary lines
U.S. township and
section lines
Railroads
Steam and Electric
R.R. crossings Tunnel
School or Church
Cemeteries
DRAINAGE
(Printed in blue)
Streams
Lakes, Ponds
Intermittent lakes
Intermittent
streams
Springs Canals and
Ditches Flumes
Swamp
Salt marshes
Submerged marsh
Tidal flats
RELIEF
(Printed in brown or black)
Contours
Depression contours
Sand Wash, and
Sand dunes
The above signs are in
current use on the soil
maps. Variations from this
usage appear in some
maps of earlier dates
64°40′
38′

GRASS PT.

LEGEND

Descalabrado clay — Dc

Granard clay

Lavallee clay loam

Santa Isabel clay — Sy

Aguilita clay — Ac

Shallow phase — Dc

Hesselberg clay — Hc

Orangegrove loam

Serrano clay loam — Sm

Ac — Shallow phase

Dy — Steep phase

Hope clay — Hy

Parasol clay loam

Sion clay — Sn

Ac — Steep phase

Diamond clay — Dc

Jaucas sand — Js

San Anton loam — Sl

Sion silty clay — Ss

Barrancas clay — Bc

Dc — Deep phase

Coakley clay loam — Cc

Fredensborg clay — Fc

Cornhill clay loam — Ch

Glynn clay loam — Gl

ALKALI AREAS

Slightly affected — A

Moderately affected — M

Strongly affected — S

Note. *Location of borings and results of field tests shown thus:* $\bullet \frac{5}{28}$

The upper figure shows the percentage concentration in the surface foot.

The lower figure shows the average concentration to the depth indicated by the figure in parenthesis.

RELIEF

Prominent Hills Mountain Peaks

Shore and Low water line Sandbar

The signs are in use on the soil. Variations from this appear in some earlier dates.

17' 44'

42'

36'

34'

WILLIAMS & HEINTZ CO WASH DC

Field Operations
Bureau of Chemistry and S...
1931

END