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TRAINING KEY PEOPLE
IN
SOIL SURVEY INTERPRETATIONS
IN
SOUTHEAST ASIA
(FOR SOIL RESOURCE INVENTORY TRAINING COURSE)

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The purpose of this writing is to summarize and record some of the teachings in soil survey interpretations conducted during May and June of 1977 at the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) and the University of The Philippines at Los Banos in cooperation with the University of Hawaii and the Bureau of Soils, sponsored by the Agency for International Development. These teachings build upon the commonality of experiences of transfer of technical concepts in improving uses of soils that the author has gained in New York State (Olson, 1974), Latin America (Olson, 1975), Australia (Olson, 1976), and in other places. Few areas of endeavor offer so many opportunities to improve the lives of people as do soil survey interpretations; hopefully these few words and references will inspire the participants in this training course to pursue the application of soil information and maps in innovative and imaginative programs in land use planning for the future.

Soil survey interpretations consist of using soil maps and soil information for practical benefits to the people living in those areas. Publication of many copies of soil survey reports and active programs in helping people use soil maps are absolutely essential (Olson, 1977b). The benefits to be realized from investments in soil surveys and soil survey interpretations are truly enormous; it is a statement of fact that the soil survey "is one of the soundest investments of public funds that can be made" (Simonson, 1974). Surveys of benefits in use of soil information for ten communities in Massachusetts showed more than $110 benefit for each dollar expended for soil surveys. More than $25,000 was saved by using soil information in an airstrip extension; $105,600 was saved where the soil map showed a municipal sewer system was not needed; $250,000 was saved where septic tanks were not built on poor soils; $500,000 was saved in selection of a school site with the soil map; and so on (Simonson, 1974). In New York State recently, use of soil maps probably saved the state taxpayers $5,000,000 in a single court case claim against the state; soil maps from Chenango and Delaware counties were used to show the ubiquitous character of sand and gravel throughout the region and to prove that a 10-acre kame is not a unique feature. On South Hill near Ithaca, a $235,000 mistake in cost estimation for a sewer line excavated in bedrock was made because the soil survey was not used; the engineer making the cost estimation could have easily obtained the soil information he needed from the published soil survey. In general, benefits from uses of soil surveys increase as land use intensity increases. In the United States, with detailed soil surveys, costs of the surveys are about $1/acre and the soil surveys are useful for at least 25 years. Benefits from uses of soil surveys are about $0.20/acre/year for forest, range, and recreational land; about $1/acre/year for cropland; about $5/acre/year for irrigated land; and probably more than $250/acre for land being converted from farm to urban uses (Klingebiel, 1966). Relative costs and benefits from uses of soil surveys are applicable to any area in Southeast Asia or elsewhere; commonly adequate recognition is not given to soil surveys and they are not assigned the high priorities they deserve. On the other hand, national priorities could be assigned on the basis of soil surveys (along with other information) and project feasibility can be determined on the basis of soil properties as in work of the Bureau of Reclamation in the Mekong Basin (USBR, 1970).

Excellent information is becoming available about uses of soil surveys--as more surveys are published and used more widely. The book edited by Bartelli _et al_. (1966) reviews work in soil survey interpretations in the USA for planning

and other uses--including uses of soils in urban design, for tax assessments, in zoning, for recreational applications, for agricultural productivity evaluations, and in research and educational programs for improvement of the interpretations. The book by McHarg (1971) excellently outlines how a planner perceives soil information in the total perspective of considering all of the factors of the environment. Case studies of environmental planning projects are presented for Staten Island (New York), Washington, D. C., and other places. Simonson (1974) collected fifteen papers of works in progress in soil survey interpretations in places in the United States, Canada, The Netherlands, Australia, and New Zealand. Techniques described range from interpreting soil mapping at three inches to one mile in mountainous areas (Waterton Lakes National Park in Canada) to using grid borings to depths of seven feet at 250-foot intervals (Edmonton, Canada). Cases are very well presented (Simonson, 1974) about how soil surveys provide "opportunities for use of existing knowledge to promote the public welfare." Young (1976) has summarized some of his experiences in tropical soils and soil surveys; the references listed in this book will be particularly helpful to the participants in this course.

The usefulness of soil maps and soil information, of course, depends upon the nature and detail of the soil survey examinations. Recommendations usually are given to proceed from general mapping to more detailed soil examinations; thus general soil maps (1:1,000,000 or smaller scale) can be used to locate regions with potential for agricultural improvement; detailed soil maps (about 1:50,000 or larger scale) can be made to locate specific areas for farming; and highly detailed soil maps (about 1:10,000 scale or larger) can be used to design land leveling procedures and fertilizer practices for small irrigated rice plots. The minimal kind of soil information required (in addition to the soil map borings) include those data and observations given in Appendix A and B. Of particular importance in soil descriptions is the range in characteristics (Appendix A) which defines the limits for the soil map units delineated in soil surveys. Appendix B illustrates description and data for one of the soils of the Mekong Basin (USBR, 1970). The characterization and descriptions of the soils are vital for the mapping, classification, correlation, and use (Soil Survey Staff, 1975) of the areas delineated in soil surveys. When good basic soil surveys are made, then those soil maps can be interpreted for many different kinds of uses for agricultural and community development.

Soil survey interpretations generally involve groupings of soil areas for specific purposes. Thus the uses of soil maps are concerned with the designs of the map legends and the soil map complexities. Orvedal and Edwards (1941) have outlined the general principles of technical grouping of soils for agricultural uses. Classes of soils must be consistent and mutually exclusive; maps and soil groupings can conceivably be of four types--(1) categorically detailed and cartographically detailed, (2) categorically detailed and cartographically generalized, (3) categorically generalized and cartographically detailed, and (4) categorically generalized and cartographically generalized. Ideally, soils should be interpreted and rated for all uses in any area; Appendix C illustrates the computer output form for comprehensive soil survey interpretations used for all of the soils in the United States. Comprehensive evaluations of soils are of particular value for planners, because inclusive ratings enable decisions to be made based on quantitative soil factors for alternative land uses. Such ratings identify those areas where uses are competitive for the best soils, and those areas where certain soils are best suited to a limited number of land uses.

Land classifications (FAO, 1974) are commonly made on the basis of soil survey interpretations and other informations. Often local farmers have their own nomenclature to describe lands of different types. In Bangladesh, for example, farmers have their own traditional system of land classification (H. Brammer, personal communication) based on land levels in relation to flooding which govern the kinds of crops that can be grown. In this traditional system, "highland" (uchu jumi) is land lying above normal flood level which can be used for annual or perennial dryland crops (sugarcane, bananas, fruit trees). "Medium land" (madhyum jumi) is land flooded up to about six feet deep during the monsoon season. "Medium highland" (majhari uchu jumi) is land normally flooded only one to three feet deep during the monsoon season on which transplanted aman paddy rice can be grown (aus paddy rice and jute can also be grown on this land before the transplanting of the aman crop). "Medium lowland" (majhari nichu jumi) is land normally flooded up to three to six feet deep during the monsoon season, too deep for rice to be transplanted, but still suitable for broadcast rices and jute--broadcast (deep water or floating) aman paddy is the major crop, but aus paddy and jute can also be grown. "Lowland" (nichu jumi) is land normally flooded up to six to twelve or fifteen feet deep in the monsoon season. Broadcast aman paddy is the only crop that can be grown. Some farmers also recognize "bottom land" (khoj jumi), land too deeply flooded (more than 12-15 feet) for even deep water aman varieties to be grown, but suitable (in some cases) for boro paddy to be grown during the dry season. Depth and duration of flooding, of course, is not the only land characteristic important to cropping, but it is certainly one of the most important considerations for use of some areas in Bangladesh. When water control can be improved, then soil factors will become relatively more important in managing these areas for agricultural production.

At the present time, soils are grouped into classes with similar performance for specific uses--based on the soil properties significant to each use. Appendix D illustrates the fifteen groups of soil materials for engineering uses in the Unified soil classification system (FAO, 1973). Appendix E illustrates how these soil groups or classes are combined with other soil characteristics mapped in the survey to make ratings for road construction. Appendix F gives the characteristics of soil materials for compacted embankments. These soil characteristics, as mapped in the soil survey, are crucial for construction of dikes and levees and other structures to control the monsoon floods in certain areas in Bangladesh, the Mekong Basin, The Philippines, and other places in Southeast Asia. Soil mapping and soil characterization should always be an important part of any engineering project for area development and improvement.

For agricultural interpretations of soil surveys, plant performance can generally be estimated at least into three classes based on soil surveyors' observations--even if no yield data are available for the soils (Appendix G). When some yield data for soils are available, then estimates can be made about performance of each soil map unit under different levels of management (Appendix H). All the soil properties important for each crop should be carefully considered. Many crops yield best on the best (deep, nearly level, well drained, loamy, permeable, fertile) soils, but some crops will produce reasonable yields from soil conditions poor for most other crops. Thus some varieties of millet will yield satisfactorily on some shallow, stony, infertile soils; paddy rice does well on poorly drained soils; potatoes will tolerate soils of high altitudes; cassava will produce fairly well on sandy soils; peanuts prefer sands; coconuts will grow on almost pure sands that would support few other crops; sugarcane

grows on a wide range of soils, but requires different management practices on each; and so on (Young, 1976). In Malaysia, soil requirements and soil tolerances were determined for each crop and then priorities for developmental planning for different areas were formulated from the soil characteristics (Appendix I)--considering also other sociological, political, and economic necessities (R. Protz, personal communication). Ideally, yield data should be collected from crops on specific soil map units; then yield predictions for soils can be very precise (Appendix C; Soil Survey Staff Committee, 1977). Soil ratings for agriculture can be refined by segregation of soil characteristics into more than three classes (Appendix J); these refinements are particularly valuable for crop rotation or intercroppings when different crops with different rooting patterns are to be grown on the same soils. Ultimately, the goals are to provide information on soil potentials considering costs of modification of soils not ideal and amounts of economic inputs required (Appendix K) as well as information on the soil characteristics and the soil map areas themselves.

Soil maps are most useful when data can be related directly to soil map units. Appendix L, for example, illustrates some relationships between soil pH and plant zinc content for rice. Presently an awareness program is being conducted in The Philippines to inform farmers about the yield constraint of zinc deficiency to irrigated rice (R. Feuer, personal communication). Soils testing pH 6.8 and above are likely to be zinc deficient. Vertisols and other soils widely used for rice in The Philippines are pH 6.8-7.0 initially, and increase in pH after a few seasons of fertilization and irrigation with waters bringing Ca, Mg, and K from other upper parts of the landscapes. Experiments indicate that ZnO applied to dipped rice seedling roots (costing $2) can yield five to fifteen sacks more rough rice per acre or hectare (worth $35-$100) on soils with pH 6.8 or above. Thus measurement and mapping of soil pH (along with the other soil characteristics) are of extreme importance. Data on soil variability in the Bicol Ragay Irrigation Project area in The Philippines indicate that soil pH is likely to be one of the most reliable soil characteristics mapped in soil surveys (Appendix M; Concepcion, 1977).

When soils are described, characterized, classified, correlated, and interpreted for use--then planners have a powerful tool to assist them in development and improvement of specific areas. Soils described (Appendix A, B) and interpreted for comprehensive uses (Appendix C) can be discussed in relation to highly detailed studies on experiment stations (Olson, 1977c) or broad planning aspects on small-scale maps (Appendix N). Soils and soil map units can be a basis for further research on soil quality (Fritton and Olson, 1972), a basis for watershed management (Kling and Olson, 1975), a basis for farm planning (SCS, 1972), and a basis for community planning (SCS, 1973). Many additional aspects of the principles of presentation of soil survey data for immediate use and application will be further elaborated upon by the author during the teaching sessions at SEARCA (Olson et al., 1969; Olson, 1971, 1977a,b,c).

Crucena (1975) prepared a report excellently illustrating soil interpretations for agricultural and community development for an area north of Manila Bay; some of his maps are reproduced in Appendix O as illustrations. Seasonal interpretations for rice were required because soils behave differently at different times under different management systems. For example, Tagulod clay (0.0-1.0% slope, severely flooded) is not suited for irrigated rice in the wet

season, but well suited in the dry season. Quingua silty clay loam (0.0-1.0% slopes) is good for non-irrigated paddy rice in the wet season, but poor in the dry season due to droughtiness. Quingua soils are fair for highways, roads, structures, and airports; other soils are poor or not suitable due to flooding and poor support capabilities; ratings for houses, low buildings, and light industries are somewhat similar (Appendix O). Pawing loamy fine sand is a good source of roadfill material, and a good source of sand. Good topsoil is found at only one area on the sample map (Appendix O). Such maps as these are excellent for planners and others to use, because they locate specific areas and outline alternatives for area development and improvement (Edwards et al., 1970). Certain areas with unsuitable soils can be avoided, good soils can be developed and improved, and fair or poor areas can be modified to make them suitable if land pressures demand that. With the expanded and imaginative use of soil maps and other information, it should be possible to develop areas in a more rational, logical, and efficient manner in the future--for the benefit of both the people of Southeast Asia and their environment.

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Appendix A. Official soil description for the Volusia series.

Established Series
Rev. MGC-RLM-JEW
8/9/74

VOLUSIA SERIES

The Volusia series is a member of the fine-loamy, mixed, mesic family of Aeric Fragiaquepts. Volusia soils typically have very dark grayish brown channery silt loam Ap horizons, grayish brown distinctly mottled channery silt loam A2 horizons and dense dark grayish brown to olive brown mottled channery silt loam and loam fragipans.

Typifying Pedon: Volusia channery silt loam - cultivated
(Colors are for moist soil.)

Ap -- 0-8" --Very dark grayish brown (10YR 3/2) channery silt loam, dark grayish brown (10YR 4/2) rubbed; weak fine granular structure; friable; many fine roots; 20 percent coarse fragments; strongly acid; abrupt smooth boundary. (6 to 10 inches thick)

A2 -- 8-13" --Grayish brown (2.5Y 5/2) channery silt loam; many medium distinct yellowish brown (10YR 5/6) mottles; very weak fine subangular blocky structure; friable; common fine roots; many fine pores; 20 percent coarse fragments; strongly acid; clear wavy boundary. (3 to 12 inches thick)

Bx1 -- 13-26" --Olive brown (2.5Y 4/4) channery silt loam; common medium faint dark grayish brown (2.5Y 4/2) mottles in ped interiors; strong very coarse prismatic structure, separated by thin grayish brown (10YR 5/2) wedges with yellowish brown (10YR 5/6) outer rims; very firm, brittle; few roots between prisms; common fine pores within prisms have clay linings; silty coats on faces of prisms; 30 percent coarse fragments; strongly acid; diffuse smooth boundary. (10 to 15 inches thick)

Bx2 -- 26-38" --Dark grayish brown (2.5Y 4/2) channery loam; many faint coarse olive brown (2.5Y 4/4) and few large distinct yellowish brown (10YR 5/6) mottles; strong very coarse prisms 12 to 30 inches across, discontinuous cleavage planes within prisms; very firm, brittle; no roots; common fine pores with dark grayish brown (2.5Y 4/2) clay linings; silty coats on faces of prisms; 30 percent coarse fragments; medium acid; diffuse smooth boundary. (12 to 30 inches thick)

Bx3 -- 38-60" --Dark grayish brown (2.5Y 4/2) very channery loam; few medium distinct yellowish brown (10YR 5/6) mottles; massive; very firm, brittle; common fine pores with clay linings; 40 percent coarse fragments; slightly acid; diffuse smooth boundary. (8 to 25 inches thick)

C -- 60-70" --Dark grayish brown (2.5Y 4/2) very channery loam; weak thick lenticular platy structure; very firm; common fine pores, some with clay linings; 40 percent coarse fragments; slightly acid.

Type Location: Cortland County, New York. 1 mile west and 1/4 mile north of Truxton.

Range in Characteristics: Solum thickness ranges from 40 to 72 inches. Depth to fragipan ranges from 10 to 20 inches. Volusia soils, unless unlimed, are slightly acid to very strongly acid in the upper part and strongly acid to neutral in the lower part of the solum and medium acid to moderately alkaline in the C horizon. Coarse fragments range from 10 to 30 percent in the solum and from 0 to 60 percent in the C horizon. The estimated mean annual soil temperature ranges from 47° to 51° F.

The Ap horizons have hues of 10YR or 2.5Y, values of 3 to 5 and chroma of 2 or 3. They are loam or silt loam in the fine earth fraction. They have weak or moderate granular structure.

The A2 horizons have hues of 10YR to 5Y, values of 4 to 6 and chroma of 2 or 3. They have common or many, distinct or prominent mottles in chromas higher than the matrix. They are loam to silt loam with clay content between 18 and 25 percent. They have weak platy or blocky structure or are massive and are friable or firm. The A2 horizon is replaced by a B2 horizon in some pedons which have chroma of 2 to 4. An A'2 horizon up to 6 inches thick is in some pedons. The Bx horizons have hues of 10YR to 5Y, values of 3 to 5 and chroma 2 to 4. They have few or

common and faint to distinct mottles. They are dominantly loam or silt loam but range to light clay loam or silty clay loam. They have weak to strong very coarse prismatic structure. Clay films coat most pores and are in some depressions on vertical cleavage faces. Consistence is firm through extremely firm.

The C horizons have hues of 10YR to 5Y, values of 3 to 5 and chroma of 2 to 4. They are massive or have lenticular platy structure and are firm or very firm. The C horizons are loam or silt loam in the fine earth fraction.

Competing Series and Their Differentiae: There are no other known series in the same family. Related series in other families are the Erie, Dalton, Fremont, Morris, Platea, Scriba, Stissing and Venango soils. Erie, Platea and Venango soils have argillic horizons in the fragipan. Dalton soils have coarse-silty particle-size control sections. Fremont soils lack a fragipan. Morris, Scriba, and Stissing soils have coarse-loamy particle-size control sections.

Setting: Volusia soils occupy long uniform slopes ranging from 1 to 25 percent in gradient on valley sides and on broad divides of maturely dissected glaciated plateaus. The Volusia soils developed in firm basal till dominated by materials from siltstone, sandstone and brittle shale or slate and may be underlain by lacustrine materials in some areas. Mean annual precipitation ranges from 32 to 48 inches, mean annual temperature from 46° to 50° F and mean growing season from 110 to 150 days.

Principal Associated Soils: Alden and Chippewa soils are wetter catenary associates. Chenango and Howard soils are on associated glacial outwash deposits. Dalton soils are intimately associated where coarse silty deposists overlie the till. Lordstown soils are prominent on associated areas having soil moderately deep to bedrock. Mardin soils occupy associated drier sites.

Drainage and Permeability: Somewhat poorly drained. Internal drainage is slow or very slow. Runoff is medium to rapid. Permeability of the part above the fragipan is moderate, that of the fragipan is slow or very slow.

Use and Vegetation: A major part of the total area has been cleared. Much of the cleared area is idle or is used for growing unimproved permanent pasture. Cropped areas are used for growing hay, oats and corn for silage. Woodlots contain sugar maple, American beech, hemlock and associated species.

Distribution and Extent: Glaciated Allegheny Plateau of New York and northern Pennsylvania. The soil is extensive.

Series Established: Chautauqua County, New York, Westfield area, 1901.

Remarks: Placement as an Aeric Fragiaquept accommodates what is believed to be the major part of the series as it has been used but leaves an important segment of Aquic Fragiochrepts unclassified. The two segments cannot be mapped consistently as separate units.

National Cooperative Soil Survey
U.S.A.

Appendix B. Soil description and data for Nakhon Phanom silt loam (adapted from USBR, 1970).

MASTER SITE Pr-1-36 FIELD AND LABORATORY SOIL CHARACTERIZATION

Location Coordinates 254-517, Sheet 5462 IV, AMS L-706
Land Form Low Alluvial Terrace
Relief Level to nearly level
Microrelief Paddy dikes; termite mounds
Climate Tropical wet and dry (Aw)
Land Use, Native Vegetation Paddy rice

Elevation 176 Meters
Slope 0.5 percent
Aspect South
Rainfall Approximately 135 cm.

Soil Temperature Class Isohyperthermic
Surface Drainage Slow
Internal Drainage Slow
Soil Drainage Class Very poorly drained
Erosion None
Soil Moisture Moist

Soil Parent Material Old alluvium
Soil Series Nakhon Phanom silt loam
Soil Classification Aquic Hapludalf (Low Humic Gley)
Land Deficiences Moderately low CEC
Land Class (USBR)
Profile Description by John E. Honeycutt Date Feb. 3, 1969

Lab No	Depth, cm	Profile Description
43235	0-12 Ap1	Pale brown (10YR 6/3) silt loam, brown to dark brown (10YR 4/3) moist; moderate fine and medium subangular blocky structure; slightly hard; friable, slightly sticky and slightly plastic; plentiful very fine and fine roots spreading out horizontally; many very fine and fine random open tubular pores; common fine prominent strong brown (7.5YR 5/8) mottles in the root channels only; very strongly acid, pH 4.7 (1:1 H_2O) pH 4.3 (0.01M $CaCl_2$); abrupt smooth boundary.
43236	12-23 Ap2	Very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; strong medium subangular blocky and blocky structure; slightly hard; friable slightly sticky but slightly plastic; plentiful very fine and fine roots spreading horizontally; many very fine and fine random open tubular pores; common fine prominent strong brown (7.5YR 5/8) mottles in the root channels only; strongly acid, pH 5.2 (1:1 H_2O); pH 4.4 (0.01M $CaCl_2$); abrupt smooth boundary.
43237	23-33 B11g	Very pale brown (10YR 7/3) loam, brown (10YR 5/3) moist; gleyed; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; plentiful very fine and fine roots spreading out horizontally; many very fine and fine random open tubular pores; common medium prominent strong brown (7.5YR 5/8) mottles; strong acid, pH 5.1 (1:1 H_2O); pH 4.2 (0.01M $CaCl_2$); abrupt smooth boundary.
43238	33-58 B12g	Pinkish gray (7.5YR 7/2) loam, brown (7.5YR 5/2) moist; gleyed; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine and fine roots spreading out horizontally; many very fine and fine random open tubular pores; common medium prominent strong brown (7.5YR 5/8) mottles; few coarse fragments (Soft Fe_1MnO_2 concretions); strongly acid, pH 5.2 (1:1 H_2O); pH 4.1 (0.01M $CaCl_2$); abrupt wavy boundary.
43239	58-98 B21tg	Pinkish white (7.5YR 8/2) silty clay, pinkish gray (7.5YR 6/2) moist; gleyed, moderate medium subangular blocky and blocky structure; hard, firm, sticky and plastic; few very fine and fine roots spreading out horizontally; common very fine and fine random open tubular pores; many large prominent strong brown (7.5YR 5/8) mottles; strongly acid, pH 5.1 (1:1 H_2O); pH 4.0 (0.01M $CaCl_2$); clear wavy boundary.
43240	98-150 B22tg	Pinkish white (7.5YR 8/2) silty clay, pinkish gray (7.5YR 6/2) moist; gleyed; strong medium subangular blocky and blocky structure; hard, firm, sticky and plastic; few very fine and fine roots spreading out horizontally; common very fine and fine random open tubular pores; few fine prominent red (2.5YR 4/8) and strong brown (7.5YR 5/8) mottles; very strongly acid, pH 5.0 (1:1 H_2O); pH 3.9 (0.01M $CaCl_2$).
43241	150-210 IIC1g	Very pale brown (10YR 8/3) clay loam, pale brown (10YR 6/3) moist; gleyed; strong medium subangular blocky and blocky structure; hard, firm, sticky and plastic; common very fine and fine random open tubular pores; common and few prominent red (2.5YR 5/8) and strong brown (7.5YR 5/8) mottles; strongly acid, pH 5.1 (1:1 H_2O); pH 4.0 (0.01M $CaCl_2$).
43242	210-270 IIIC2g	White (10YR 8/1) loam, light gray (10YR 7/1) moist; gleyed; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few medium prominent brownish yellow (10YR 6/8) mottles; strongly acid, pH 5.3 (1:1 H_2O); pH 4.2 (0.01M $CaCl_2$).
43243	270-300 III C3g	White (10YR 8/1) loam, light gray (10YR 7/1) moist; gleyed; moderate subangular blocky structure; hard; firm, sticky and plastic; common large prominent and many large distinct red (2.5YR 4/2) and brownish yellow (10YR 6/6) mottles; strongly acid, pH 5.5 (1:1 H_2O); pH 4.5 (0.01M $CaCl_2$).

Determination	Laboratory Number / Laboratory Data								
	43235	43236	43237	43238	43239	43240	43241	43242	43243
Depth (cm)	0-12	12-23	23-33	33-58	58-98	98-126	126-210	210-270	270-300
Particle Size (percent)									
Total sand (2-0.05 mm.)	18.9	21.6	25.4	46.7	12.1	8.9	25.2	42.8	41.0
Silt (0.05-0.002 mm.)	60.0	58.1	48.9	36.1	40.8	42.8	36.8	34.3	36.8
Clay (<0.002 mm.)	21.1	19.8	24.9	16.7	47.1	48.7	36.9	22.7	22.2
Textural Class (Lab.)	SiL	SiL	L	L	SiC	SiC	CL	L	L
Hydraulic Conductivity (cm/hr.)									
6th hr.	0.64	0.20	0.37	0.53	0.16	0.05	0.15	0.40	0.35
24th hr.	0.49	0.20	0.32	0.47	0.12	0.05	0.15	0.40	0.30
Settling Volume (ml)	14	19	20	16	25	25	19	20	19
Moisture Retention (percent)									
1/10 bar	34.1	28.6	30.2	27.1	34.0	37.7	36.0	30.5	30.4
1/3 bar	26.5	21.5	21.1	16.5	28.4	28.8	25.2	20.8	21.2
15 bar	13.3	11.6	13.2	9.3	22.7	22.5	18.8	11.8	12.6
Soil Reaction-pH									
1:1 H_2O	4.7	5.2	5.1	5.2	5.1	5.0	5.1	5.3	5.5
1:1 1 N KCl	3.8	3.9	3.7	3.8	3.5	3.4	3.5	3.6	4.0
1:2 0.01 M $CaCl_2$	4.3	4.4	4.2	4.1	4.0	3.9	4.0	4.2	4.5
Organic Carbon (percent)	0.88	0.19	0.15	0.04	0.11	0.12	0.08	0.04	0.15
Available Phosphorus (ppm)	1.60	1.10	0.80	0.70	1.00	0.20	0.80	0.60	0.40
Active Iron (percent)	0.34	0.55	0.81	0.51	1.00	0.92	0.95	0.08	2.21
Active Manganese (percent)	0.02	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Saturation Extract									
Saturation Percentage	35.4	30.6	31.1	42.4	45.9	46.9	48.4	43.2	37.0
EC_e @ 25°C (mmhos/cm)	1.45	0.33	0.28	0.18	0.18	0.18	0.18	0.19	0.18
Ca^{++} (me/l)	2.92	0.65	0.49	0.16	0.16	0.16	0.16	0.32	0.16
Mg^{++} (me/l)	1.94	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.00
Na^{+} (me/l)	9.05	2.73	1.72	1.81	1.81	1.81	1.81	1.63	1.72
K^{+} (me/l)	0.21	0.05	0.05	0.02	0.02	0.01	0.03	0.02	0.04
SAR	5.78	4.79	2.37	6.40	6.40	6.40	5.40	4.07	6.08
Acidity (me/100g)									
1 N KCL exchange acidity	2.02	1.46	5.60	4.37	10.6	11.1	7.62	3.64	2.18
$-H^{+}$	0.72	0.60	1.23	1.24	0.76	1.42	1.14	0.83	0.78
$-Al^{+++}$	1.30	0.86	4.37	3.13	9.88	9.72	6.48	2.81	1.40
Total acidity extracted by $BaCl_2$-TEA at pH 8.2 (me/100g)	8.53	6.02	12.1	7.53	16.6	16.6	13.1	7.03	6.53
Bases extractable by 1 N KCl									
$-Ca^{++} + Mg^{++}$ (me/100g)	3.20	2.80	2.60	1.30	3.20	3.50	1.30	3.00	3.60
$-Na^{+}$ (me/100g)	0.44	0.14	0.15	0.13	0.68	0.81	0.57	0.34	0.30
Cation-exchange-capacity by $NaOAc_{c}$ @ pH 8.2 (me/100g)	9.0	7.6	10.6	8.8	22.1	21.2	15.2	10.8	9.6
Charge Characterization									
Acid Status (me/100g)									
$-H^{+} + Al^{+++}$	0.6	0.8	2.7	1.9	3.7	4.3	5.3	2.1	1.5
$-H_v + H_{an}$	4.6	3.3	4.6	3.0	8.8	10.6	6.3	2.3	2.6
Exchange capacity (me/100g)									
$-CEC_t$	8.6	7.4	10.5	9.0	15.8	14.2	11.7	8.2	7.3
$-CEC_p$	5.6	3.2	7.2	5.1	10.5	9.2	6.0	4.7	4.4
$-CEC_v$	3.0	4.2	3.3	3.9	5.3	5.0	5.7	3.5	2.9
$-CEC_m$	10.4	8.3	12.4	7.4	18.1	18.5	14.4	9.9	9.8
-AEC	2.0	2.0	3.0	3.8	3.7	3.6	4.6	1.8	3.5
Ratio $-CEC_p:CEC_v:AEC$	7:3:2	4:6:3	7:3:3	6:4:4	7:3:2	6:4:3	5:5:4	6:4:2	6:4:5

Appendix C. Computer output form for comprehensive soil survey interpretations for the Honeoye series.

NY0117

S O I L S U R V E Y I N T E R P R E T A T I O N S

HONEOYE SERIES

MLRA(S): 101
JWW, 4-73
GLOSSOBORIC HAPLUDALFS, FINE-LOAMY, MIXED, MESIC

THE HONEOYE SERIES CONSISTS OF DEEP, WELL DRAINED SOILS ON UPLANDS. THEY FORMED IN GLACIAL TILL. TYPICALLY THESE SOILS HAVE A DARK GRAYISH BROWN LOAM SURFACE LAYER 8 INCHES THICK. THE BROWN SUBSOIL FROM 8 TO 12 INCHES IS LOAM, FROM 12 TO 18 INCHES IS GRAVELLY LOAM, AND FROM 18 TO 26 INCHES IS GRAVELLY CLAY LOAM. THE SUBSTRATUM FROM 26 TO 40 INCHES IS DARK GRAYISH BROWN VERY GRAVELLY LOAM. SLOPES RANGE FROM 0 TO 30 PERCENT.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-8	L, SIL, FSL	ML, SM	A-2, A-4	0	80-95	75-90	50-85	30-80	25-35	5-10
0-8	GR-L, GR-SIL, GR-FSL	ML, SM	A-2, A-4	0-10	60-75	55-70	40-65	20-60	25-35	5-10
8-26	GR-L, SIL	ML, CL, GC, SC	A-4	0-10	65-95	60-90	55-85	40-80	25-35	5-10
26-40	GR-L, GR-SIL, GRV-FSL	SM, GC, CL	A-2, A-1, A-4	5-10	45-75	40-70	30-65	15-60	15-25	5-10

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUP
0-8	0.6-2.0	0.12-0.20	5.6-6.5	-	LOW	LOW	LOW	.32	3	-
0-8	0.6-2.0	0.09-0.16	5.6-6.5	-	LOW	LOW	LOW	.24	3	-
8-26	0.6-2.0	0.08-0.18	5.6-7.3	-	LOW	LOW	LOW	.28		
26-40	0.06-0.2	0.06-0.13	7.4-8.4	-	LOW	LOW	LOW	.17		

FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (FT)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	CEMENTED PAN DEPTH (IN)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (IN)	BEDROCK HARDNESS	SUBSIDENCE INIT. (IN)	SUBSIDENCE TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			3-6	APPARENT	NOV-APR	-		>60		-		B	MODERATE

SANITARY FACILITIES (B)

SEPTIC TANK ABSORPTION FIELDS	0-15%: SEVERE-PERCS SLOWLY 15+%: SEVERE-SLOPE
SEWAGE LAGOONS	0-2%: SLIGHT 2-7%: MODERATE-SLOPE 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH)	0-25%: SEVERE-WET 25+%: SEVERE-SLOPE
SANITARY LANDFILL (AREA)	0-15%: MODERATE-WET 15+%: SEVERE-SLOPE
DAILY COVER FOR LANDFILL	0-15%: FAIR-SMALL STONES 15+%: POOR-SLOPE

COMMUNITY DEVELOPMENT (B)

SHALLOW EXCAVATIONS	0-15% L,SIL: MODERATE-WET 0-15% GR: MODERATE-SMALL STONES,WET 15+%: SEVERE-SLOPE
DWELLINGS WITHOUT BASEMENTS	0-15%: MODERATE-FROST ACTION 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-15%: MODERATE-WET 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-8%: MODERATE-FROST ACTION 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-15%: MODERATE-FROST ACTION 15+%: SEVERE-SLOPE

REGIONAL INTERPRETATIONS

LAWNS, LANDSCAPING, GOLF FAIRWAY	0-8% L, SIL: SLIGHT 8-15% L, SIL: MODERATE-SLOPE 0-15% GR: MODERATE-SMALL STONES 15+%: SEVERE-SLOPE

SOURCE MATERIAL (B)

ROADFILL	0-25%: FAIR-FROST ACTION 25+%: POOR-SLOPE
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	0-8% L,SIL: GOOD 8-15% L,SIL: FAIR-SLOPE 0-15% GR: POOR-SMALL STONES 15+%: POOR-SLOPE

WATER MANAGEMENT (B)

POND RESERVOIR AREA	SLOPE
EMBANKMENTS DIKES AND LEVEES	HARD TO PACK
EXCAVATED PONDS AQUIFIER FED	NO WATER
DRAINAGE	NOT NEEDED
IRRIGATION	SLOPE,ERODES EASILY
TERRACES AND DIVERSIONS	ERODES EASILY,SLOPE
GRASSED WATERWAYS	SLOPE,ERODES EASILY

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RECREATION (C)

CAMP AREAS	0-15%: MODERATE-PERCS SLOWLY 15+%: SEVERE-SLOPE	PLAYGROUNDS	0-6% L,SIL: MODERATE-PERCS SLOWLY 0-6% GR: SEVERE-SMALL STONES 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8% L,SIL: SLIGHT 8-15% L,SIL: MODERATE-SLOPE 0-15% GR: MODERATE-SMALL STONES 15+%: SEVERE-SLOPE	PATHS AND TRAILS	0-15% L,SIL: SLIGHT 15-25% L,SIL: MODERATE-SLOPE 0-25% GR: MODERATE-SMALL STONES 25+%: SEVERE-SLOPE

CAPABILITY AND PREDICTED YIELDS -- CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPA-BILITY	CORN (BU)		CORN SILAGE (TONS)		OATS (BU)		ALFALFA HAY (TONS)		GRASS-LEGUME HAY (TONS)		PASTURE (AUM)	
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
0-3%	1		130		26		100		6.0		5.0		9.5			
3-8%	2E		130		26		100		6.0		5.0		9.5			
8-15%	3E		120		24		100		6.0		5.0		9.5			
15-25%	4E		105		21		90		5.0		4.0		8.0			
25-35%	6E		-		-		-		-		-		-			

WOODLAND SUITABILITY (D)

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: IMPORTANT TREES	SITE INDX	TREES TO PLANT
0-15%	2O	SLIGHT	SLIGHT	SLIGHT	SLIGHT		SUGAR MAPLE	80	EASTERN WHITE PINE
15-35%	2R	MODERATE	MODERATE	SLIGHT	SLIGHT		NORTHERN RED OAK	80	BLACK WALNUT
							YELLOW-POPLAR	85	YELLOW-POPLAR
									BLACK CHERRY

WINDBREAKS

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY (E)

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
									POTENTIAL AS HABITAT FOR:			
0-3%	GOOD	GOOD	GOOD	GOOD	GOOD	-	POOR	V. POOR	GOOD	GOOD	V. POOR	-
3-8%	FAIR	GOOD	GOOD	GOOD	GOOD	-	POOR	V. POOR	GOOD	GOOD	V. POOR	-
8-15%	FAIR	GOOD	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	FAIR	GOOD	V. POOR	-
15-25%	POOR	FAIR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	FAIR	GOOD	V. POOR	-
25-35%	V. POOR	FAIR	GOOD	GOOD	GOOD	-	V. POOR	V. POOR	FAIR	GOOD	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS						
NORMAL YEARS						
UNFAVORABLE YEARS						

FOOTNOTES

A ESTIMATES OF ENGINEERING PROPERTIES BASED ON TEST DATA OF 2 PEDONS FROM NEW YORK
B RATINGS BASED ON GUIDE FOR INTERPRETING ENGINEERING USES OF SOILS, NOV. 1971
1 SOLUTION CAVERNS AND SINKHOLES IN BEDROCK MAY ALLOW POLLUTION OF GROUND WATER
2 RATINGS BASED ON NORTHEAST REGIONAL CRITERIA, MAR. 1966
C RECREATION RATINGS BASED ON SOILS MEMORANDUM 69, OCT. 1968
D RATINGS BY SOILS MEMO. 26, SEPT. 1967 AND REGIONAL CRITERIA. SITE INDEX VALUES MAY RANGE + OR - 5 OR MORE
E WILDLIFE RATINGS BASED ON SOILS MEMORANDUM 74, JAN. 1972

Appendix D. Typical names and group symbols of the Unified soil classification system (adapted from FAO, 1973).

Group symbol	*Typical names*
GW	Well-graded gravel, gravel and sand mixtures, little or no fines
GP	Poorly graded gravel, gravel and sand mixtures, little or no fines
GM	Silty gravel, gravel and sand and silt mixtures
GC	Clayey gravel, gravel and sand and clay mixtures
SW	Well-graded sands, gravelly sands, little or no fines
SP	Poorly graded sands, gravelly sands, little or no fines
SM	Silty sands, sand and silt mixtures
SC	Clayey sands, sand and clay mixtures
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
OL	Organic silts and organic silty clays of low plasticity
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
CH	Inorganic clays of high plasticity, fat clays
OH	Organic clays of medium to high plasticity, organic silts
Pt	Peat, muck, and other highly organic soils

Appendix E. Ratings of soils for secondary roads (adapted from FAO, 1973).

Item affecting use	*Soil limitation rating*		
	Slight	*Moderate*	*Severe*
Slope	0–8%	8–15%	> 15%
Depth to hard bedrock	> 40 in.	20–40 in.	< 20 in.
Unified soil group for subgrade	GW, GP, SW, SP, GM, GC, SM, SC	CL with PI < 15	CL with PI > 15, CH, MH, OH, OL, Pt
Shrink-swell potential	Low	Moderate	High
Susceptibility to frost action	Low	Moderate	High
Stoniness*	0, 1, 2	3	4, 5
Soil drainage class	Well drained, moderately well drained	Somewhat poorly drained	Poorly drained, very poorly drained
Flooding frequency	None	Soils flooded less than once in 5 years	Soils flooded more than once in 5 years

Appendix F. Characteristics of soil materials for compacted embankments according to the Unified classification (adapted from FAO, 1973).

Unified classification	*Compressibility*	*Compaction characteristics*	*Permeability of compacted soil*
GW	Low	Good	High
GP	Low	Good	High
GM	Low	Fair to good	Medium to low
GC	Low to medium	Good to fair	Low
SW	Low	Good	High
SP	Low	Good	High
SM	Low to medium	Fair to good	Medium to low
SC	Low to medium	Good to fair	Low
ML	Medium	Fair to poor	Medium to low
CL	Medium	Fair to good	Low
MH	High	Poor	Low to medium
CH	High	Fair to poor	Low
OL	High	Fair to poor	Low to medium
OH	High	Poor	Low
Pt	Not suitable	Not suitable	Not suitable

Appendix G. Suitability of soil map units for growing specific plants on St. Croix (adapted from Rivera et al., 1970; figure 1 indicates that the plant is suited to the soil; figure 2 indicates that it is suited under special management; figure 3 indicates that the plant is not suited).

Plants	Soils																					
	Aguilita gravelly clay loam	Aguirre clay	Coamo clay loam	Cornhill gravelly clay loam	Cramer gravelly clay loam	Cramer stony clay loam	Descalabrado clay loam	Diamond clay loam	Fraternidad clay	Fredensborg clay	Glynn clay loam	Hesselberg clay	Isaac gravelly clay loam	Jacana clay loam	Jaucas sand	Lavallee gravelly clay loam	Limestone rock land	Parasol clay loam	San Anton clay loam	Sion clay loam	Southgate clay loam	Victory clay loam
African tulip	3	2	2	2	2	2	2	3	2	2	2	3	2	1	3	2	3	2	1	2	2	2
Alamanda	3	2	1	1	1	1	1	3	2	2	2	3	2	1	2	1	3	1	1	2	2	1
Almond	2	2	2	2	1	1	1	3	2	2	2	3	1	1	1	1	3	1	1	2	1	1
Australian pine	2	2	1	1	1	1	1	2	2	1	1	2	1	1	2	1	2	1	1	1	1	1
Avocado	2	3	2	2	2	2	2	3	3	1	3	3	2	1	3	1	3	1	2	1	2	2
Bamboo	2	2	2	2	2	2	1	3	2	2	2	3	2	2	2	2	3	1	1	1	2	2
Banana, plantain	2	2	1	2	1	2	2	3	2	1	2	3	1	1	3	1	3	1	1	1	2	1
Bougainvillea	1	2	1	1	1	1	1	2	1	1	2	2	1	1	2	1	3	1	1	1	1	1
Breadfruit	3	3	3	3	2	2	2	3	2	3	3	3	3	2	3	2	3	2	2	2	3	2
Cashew	3	2	1	2	1	2	1	3	2	2	2	3	1	1	1	1	3	1	1	2	2	1
Cedar (tabebuia)	1	2	2	2	1	1	1	2	2	1	2	2	1	1	2	1	2	1	1	1	1	1
Coconut palm	2	2	2	2	1	1	1	3	2	1	2	2	1	1	1	1	3	1	1	1	1	1
Cocoplum	3	3	1	3	2	3	2	3	2	2	2	3	2	1	1	1	3	1	1	2	2	2
Croton	2	2	1	1	1	1	1	3	2	2	2	3	2	1	2	1	3	1	1	1	2	1
Custardapple	3	3	3	3	2	2	2	3	2	3	3	3	2	1	3	2	3	2	1	2	2	2
Date	2	2	2	2	2	3	2	3	2	2	2	3	2	1	2	1	3	1	1	2	2	2
Flamboyanttree	1	2	1	1	1	1	1	2	1	2	1	2	1	1	1	1	3	1	1	1	1	1
Frangipani	1	2	1	1	1	1	1	2	2	1	1	2	1	1	2	1	3	1	1	1	1	1
Genip	2	2	1	2	1	1	1	2	2	1	1	2	1	1	2	1	3	1	1	1	1	1
Ginger Thomas	1	2	1	1	1	1	1	2	2	1	2	2	1	1	2	1	2	1	1	1	1	1
Gooseberry	2	2	1	2	1	1	1	3	1	1	1	2	2	1	2	1	3	1	1	1	1	1
Governorsplum	2	2	2	2	1	1	1	3	2	1	2	3	2	1	3	1	3	1	1	1	2	1
Guava	2	2	1	2	1	1	1	2	1	2	1	2	1	1	2	1	2	1	1	2	1	1
Guavaberrytree	3	2	2	2	1	1	1	3	3	3	2	3	2	1	3	1	3	1	2	2	3	1
Hibiscus	2	2	2	2	1	1	1	3	2	1	2	2	1	1	2	1	3	1	1	2	2	1
Hogplum	3	2	1	2	1	1	1	3	1	1	1	2	1	1	3	1	3	1	1	1	1	1
Jerusalemthorn	3	3	1	1	2	2	2	3	2	2	1	2	2	2	3	2	3	2	2	2	2	2
Jujube	2	2	1	1	1	1	1	2	1	1	1	2	1	1	1	1	3	1	1	1	1	1
Lime	1	2	1	1	1	1	1	2	2	1	2	2	2	1	3	1	2	1	1	1	1	1
Mahogany	1	2	1	1	1	1	1	2	1	1	1	2	1	1	2	1	2	1	1	1	1	1
Mamey	2	2	1	1	1	1	1	3	1	1	1	3	1	1	2	1	3	1	1	1	1	1
Mango	3	2	1	2	1	1	1	3	2	2	2	3	1	1	3	2	3	1	1	3	2	1
Mesple	1	2	1	2	1	1	1	2	1	1	2	2	1	1	2	1	1	1	1	1	1	1
Oleander	2	2	1	2	1	1	1	2	1	1	1	3	1	1	2	1	3	1	1	1	1	1
Orange, grapefruit	3	3	2	2	2	2	2	3	3	2	2	3	2	2	3	2	3	2	3	2	3	2
Ota Haiti	3	1	1	3	2	2	2	3	2	2	2	3	1	1	1	1	3	1	1	2	1	2
Papaya	2	2	1	2	1	2	1	3	2	1	2	2	1	1	2	1	3	1	1	1	1	1
Pineapple	3	3	1	3	1	1	1	3	3	2	2	3	2	2	3	2	3	1	2	2	3	2
Pomegranate	3	2	2	2	1	1	1	3	3	2	2	3	2	1	3	2	3	1	1	2	2	2
Plums de Terre	3	3	2	3	1	1	1	3	2	2	2	3	2	1	3	1	3	1	1	2	2	1

Appendix H. Average yields per acre of principal crops under two levels of management (adapted from Rivera et al., 1970; figures in columns A indicate yields under average management; figures in columns B indicate yields under improved management).

Soil	Tomatoes		Sweetpotatoes		Grain sorghum		Sorghum for silage		Guineagrass	
	A	B	A	B	A	B	A	B	A	B
	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Tons	Tons	Tons	Tons
Aguilita gravelly clay loam, 2 to 5 percent slopes--------	6,000	7,500	-----	------	3,500	4,500	15	18	7	9
Aguirre clay, 0 to 2 percent slopes----------	6,000	7,500	-----	------	4,000	5,000	17	20	8	10
Coamo clay loam, 2 to 5 percent slopes----------	7,000	8,500	7,000	9,000	4,000	5,000	19	22	9	11
Cornhill gravelly clay loam, 0 to 2 percent slopes--------	5,500	7,000	6,500	8,500	3,500	4,500	18	21	8	10
Fraternidad clay, 0 to 3 percent slopes----------	6,500	8,000	-----	------	4,000	5,000	17	20	8	10
Fraternidad clay, 3 to 12 percent slopes, eroded----------	5,500	7,000	-----	------	3,500	4,500	14	17	6	8
Fredensborg clay, 0 to 2 percent slopes----------	7,500	9,000	8,000	10,000	5,000	6,000	22	25	12	14
Fredensborg clay, 2 to 5 percent slopes----------	7,000	8,500	7,000	9,000	4,500	5,500	20	23	11	12
Fredensborg clay, 5 to 12 percent slopes, eroded--------	6,500	8,000	6,000	8,000	4,000	5,000	15	18	7	9
Glynn clay loam, 2 to 5 percent slopes----------	8,000	9,500	8,000	10,000	5,000	6,000	22	25	12	14
Glynn clay loam, 5 to 12 percent slopes, eroded----------	6,500	8,000	7,000	9,000	4,500	5,500	20	23	9	11
Hesselberg clay, 0 to 2 percent slopes----------	6,500	8,000	6,500	8,500	4,000	5,000	17	20	9	11
Jacana clay loam, 2 to 5 percent slopes----------	5,000	6,500	-----	------	3,500	4,500	14	17	6	8
Jacana clay loam, 5 to 12 percent slopes----------	5,000	6,500	-----	------	3,500	4,500	14	17	6	8
Lavallee gravelly clay loam, 2 to 5 percent slopes--------	8,000	9,500	8,000	10,000	5,000	6,000	22	25	12	14
Parasol clay loam, 2 to 5 percent slopes----------	8,000	9,500	8,000	10,000	5,000	6,000	22	25	12	14
Parasol clay loam, 5 to 12 percent slopes----------	6,500	8,000	7,000	9,000	4,500	5,500	20	23	9	11
Pozo Blanco clay loam, 5 to 12 percent slopes----------	6,000	7,500	-----	------	3,500	4,500	15	18	7	9
San Anton clay loam, 0 to 3 percent slopes----------	8,000	9,500	8,000	10,000	5,000	6,000	22	25	12	14
San Anton clay loam, 5 to 12 percent slopes----------	6,500	8,000	7,000	9,000	4,500	5,500	20	23	9	11
Sion clay loam, 0 to 5 percent slopes----------	6,500	8,000	6,500	8,500	4,000	5,000	17	20	9	11
Sion clay loam, 5 to 12 percent slopes----------	6,000	7,500	-----	------	3,500	4,500	15	18	7	9

Appendix I. Soil criteria used for assessing crop suitability for areas in Malaysia (adapted from materials provided by R. Protz for Pahang Tenggara region and peninsular Malaysia).

Crop Group	Crop	Soil Criteria									
		Slope	Effective Soil Depth	Soil Texture Structure	Drainage	Water Release	Salinity mmhos/cm at 25°C	pH	Depth to Acid Sulphate	Thickness of Peat (drained)	Workability
A. Rubber ..	Rubber ..	0-20°	>125cm	Exclude LS or coarser	Exclude poorly drained	All year	<2 mmhos in top 150cm	4.0-6.0	>150cm	<50cm	N.I.[1]
B. Oil Palm ..	Oil Palm ..	0-16°	>125cm	Exclude SL or coarser	Some temporily poorly drained	All year	<2 mmhos in top 150cm	4.0-6.5	>100cm	<100cm	N.I.
C. Sago Palm	Sago Palm ..	0-2°	>100cm	Exclude SL or coarser	Very poorly to poorly only	—	<2 mmhos in top 150cm	4.0-6.0	>125cm	<50cm	N.I.
D. Tapioca ..	Tapioca ..	0-6°	>50cm	Exclude clays and poor structures	Exclude poorly drained	All year	<2 mmhos in top 100cm	4.3-7.3	>50cm	No restriction	No restrictions allowed
	Sweet Potatoes	0-6°	>50cm	Exclude clays and poor structures	Exclude poorly drained	All year	<2 mmhos in top 100cm	4.3-6.0	>50cm	No restriction	No restrictions allowed
	Soyabeans ..	0-6°	>25cm	Exclude clays and poor structures	Well to imperfectly only	Throughout growing season	<4 mmhos in top 50cm	5.5-6.5	>50cm	<25cm	No restrictions allowed
	Chillies ..	0-6°	>25cm	Exclude clays and poor structures	Well to imperfectly ..	Throughout growing season	<4 mmhos in top 50cm	5.0-6.5	>50cm	<25cm	No restrictions allowed
	Vegetables ..	0-6°	>25cm	Exclude clays and poor structures	Well to imperfectly ..	Throughout growing season	<4 mmhos in top 50cm	4.5-6.5	>50cm	No restriction	No restrictions allowed
E. Tea ..	Lowland Tea	0-20°	>100cm	Exclude sands, clays ..	Well to imperfectly ..	All year	<2 mmhos in top 150cm	4.0-6.0	25cm	No peat ..	N.I.
F. Grass ..	Grasses (Cut)	0-12°	>25cm	Exclude LS and coarser	Well to poorly ..	All year	<4 mmhos in top 50cm	4.3-7.0	>50cm	No restriction	No restrictions allowed
	Stylo	0-12°	>25cm	Exclude sands ..	Well to poorly ..	All year	<4 mmhos in top 50cm	4.3-7.0	>50cm	Not known	No restrictions allowed
G. Citrus ..	Citrus ..	0-20°	>125cm	Exclude sands and heavy clays	Well, some imperfectly	All year	<2 mmhos in top 150cm	5.0-7.0	>150cm	<50cm	No stones
	Chiku ..	0-20°	>125cm	Exclude sands and heavy clays	Well to imperfectly ..	All year	<2 mmhos in top 150cm	Not known	>150cm	[illegible]	No stones
	Mangosteen ..	0-20°	>125cm	Exclude sands and heavy clays	Well to imperfectly ..	All year	<2 mmhos in top 150cm	Not known	>150cm	<50cm	No stones
H. Papaya ..	Papaya ..	0-12°	>50cm	Exclude LS or coarser	Well to imperfectly ..	All year	<2 mmhos in top 100cm	5.0-6.5	<100cm	No peat ..	No stones
	Pineapple ..	0-6°	>25cm	All textures	Well to imperfectly ..	All year	<2 mmhos in top 50cm	4.5-5.5	>50cm	No restrictions	No stones
	Passion fruit..	0-12°	>50cm	Exclude sands and heavy clays	Well to imperfectly ..	All year	<2 mmhos in top 100cm	4.5-6.5	>100cm	<50cm	No stones
	Guava ..	0-12°	>50cm	Exclude LS or coarser	Well to imperfectly ..	All year	<2 mmhos in top 100cm	4.5-6.5	>100cm	<100cm	No stones

N.I.[1]—Not important.

Crop Group	Crop	Soil Criteria									
		Slope	Effective Soil Depth	Soil Texture Structure	Drainage	Water Release	Salinity mmhos/cm at 25	pH	Depth to Acid Sulphate	Thickness of Peat (drained)	Workability
	Salak ..	0-12°	>50cm	Exclude LS or coarser	Well drained	All year	<2 mmhos in top 100cm	Not known	>100cm	No peat ..	No stones
I. Bananas ..	Bananas ..	0-12°	>125cm	Exclude LS or coarser	Well to imperfectly ..	All year	<2 mmhos in top 100cm	5.0-7.0	>125cm	<25cm	No stones
	Durian ..	0-12°	>100cm	Exclude LS or coarser; firm soils; organic soils	Well to imperfectly ..	All year	<2 mmhos in top 100cm	4.5-6.5	>100cm	No peat ..	N.I.
	Rambutan ..	0-12°	>100cm	Exclude LS or coarser	Well to imperfectly ..	All year	<2 mmhos in top 100cm	4.5-6.5	>100cm	<100cm	No stones
	Langsat ..	0-12°	>100cm	Exclude clays and sands	Well drained	All year	<2 mmhos in top 100cm	Not known	>100cm	No peat ..	N.I.
	Duku.. ..	0-12°	>100cm	Exclude clays and sands	Well drained	All year	<2 mmhos in top 100cm	Not known	>100cm	No peat ..	N.I.
	Soursop ..	0-6°	>100cm	Exclude clays and sands	Well drained	All year	<2 mmhos in top 100cm	Not known	>100cm	No peat ..	N.I.
	Jackfruit ..	0-12°	>100cm	Exclude LS or coarser	Well to imperfectly ..	All year	<2 mmhos in top 100cm	4.5-6.5	>100cm	<100cm	No stones
	Chempedak ..	0-12°	>100cm	Exclude LS or coarser	Well to imperfectly ..	All year	<2 mmhos in top 100cm	Not known	>100cm	No peat ..	N.I.
	Avacado ..	0-12°	>100cm	Exclude LS or coarser	Well to imperfectly ..	All year	<2 mmhos in top 150cm	5.5-6.5	>125cm	No peat ..	N.I.
	Kundangan ..	0-12°	>100cm	Exclude clays ..	Well drained	All year	<2 mmhos in top 150cm	Not known	>125cm	No peat ..	N.I.
J. Cashew ..	Cashew ..	0-20°	>100cm	Exclude clays ..	Well to imperfectly ..	9 month	<2 mmhos in top 150cm	4.0-7.3	>125cm	<100cm	N.I.
K. Cocoa ..	Cocoa ..	0-12°	>150cm	Exclude SL or coarser	Well to imperfectly ..	High all year ..	<2 mmhos	5.0-7.5	>125cm	< 50cm	N.I.
	Coffee ..	0-12°	>125cm	Exclude sands ..	Well to imperfectly ..	All year	<2 mmhos in top 150cm	4.5-6.5	>100cm	>125cm	N.I.
L. Coconut ..	Coconut ..	0-6°	>100cm	Exclude LS or coarser	Well to imperfectly ..	All year	<2 mmhos in top 150cm	4.5-7.5	>100cm	>100cm	N.I.
M. Maize ..	Maize ..	0-6°	>50cm	Exclude sands and clays	Well to imperfectly ..	Good in growing season	<2 mmhos in top 50cm	>5.0	>125cm	No restriction	No restrictions allowed
	Sorghum ..	0-6°	>50cm	Exclude sands ..	Well to imperfectly ..	Good in growing season	<4 mmhos in top 50cm	>5.0	>125cm	No restriction	No restrictions allowed
	Groundnut ..	0-6°	>25cm	Exclude sands and clays	Well to moderately well	Good in growing season	<4 mmhos in top 50cm	5.5-7.0	>50cm	No peat ..	No restrictions allowed
N. Rice ..	Lowland Rice	0-2°	>25cm	SCL or finer	Drainage control necessary	Dry during harvest	<4 mmhos in top 25cm	>4.0	>25cm	No peat ..	No restrictions allowed

Appendix J. Ratings of soils for general farming in central New York State (adapted from Rogoff, 1976).

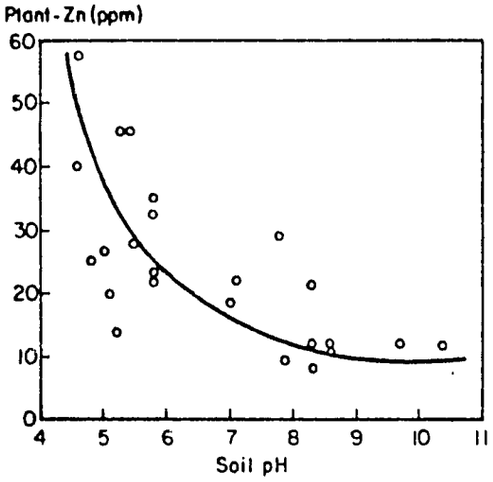
Item Affecting Use	*Soil Potential*				
	Very Good	*Good*	*Moderate*	*Poor*	*Very Poor*
Drainage class and approximate depth in inches to permanent or fluctuting water table	Well drained >36	Moderately well drained 18-36	Somewhat poorly drained 12-18	Poorly drained 6-12	Very poorly drained <6
Total water-holding capacity [in H_2O/ rooting depth;	>6	4-6	3-4	2-3	<2
Slope (%)	<3	3-8	8-15	15-25	>25
Rooting depth (in. to root restricting horizon)	>40	30-40	20-30	10-20	<10
Trafficability [Unified soil group;	GW, GP, SW, SP, GM, GC, SM, SC, Pt (drained)	CL with PI <15	ML, CL with PI >15	OH, OL, MH	CH, Pt (un-drained)
Permeability class (in./hr in least permeable horizon)	0.6-2.0	2.0-6.0	>6.0	0.6-0.06	<0.06
Erosion	None to slightly eroded	Slightly eroded	Moderately eroded	Severely eroded	Very severely eroded
Stoniness and rockiness	0	1	2	3	4 and 5
pH in B horizon	>7.0	6.5-7.0	6.0-6.5	5.5-6.0	<5.5
Texture	sil	1, sicl	sl, cl	scl, c	s, ls (not irrigated)
Elevation (ft)	<400	400-1,000	1,000-1,600	1,600-2,000	>2,000

Appendix K. Some of the investments necessary to reach full soil potential in wet and sloping areas in New York State (adapted from Rogoff, 1976).

Conservation Practice	*Soil Potential*				
	Very Good	*Good*	*Moderate*	*Poor*	*Very Poor*
Tile drains	0	100($100)	250($250)	450($450)	>600(>$600)
Diversion ditches	0	60($60)	120($120)	>120(>$120)	>120(>$120)
Terraces	0	500($500)	1,000($1,000)	Not recommended	Not recommended

The average cost was calculated at $1.00 per linear foot for tile drains, diversion ditches, and terraces (terraces are not recommended for slopes greater than 12%). These estimates assume that the major limitations of poorer classes are permeability and wetness for tile drains, erosion and slope for diversion ditches, and runoff hazards for terraces.

Appendix L. Relationship between soil pH and plant zinc content (adapted from Castro, 1976).



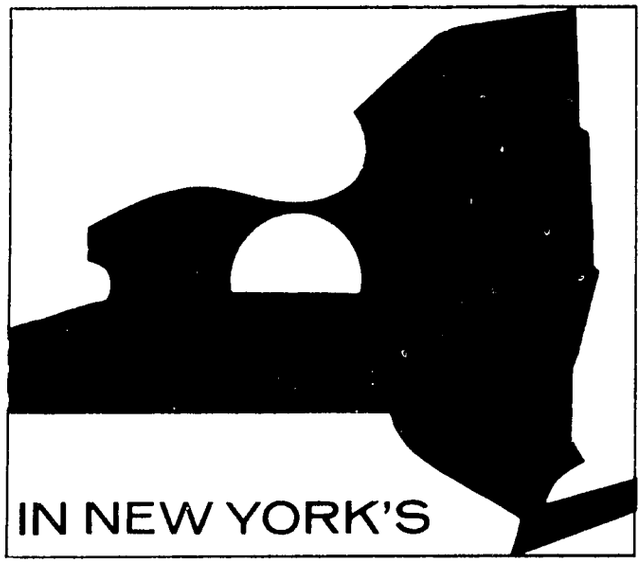
Appendix M

Number of Samples Necessary to Estimate the Mean of Population Within Plus or Minus 10 and 20 percent Accuracy Levels using 95 Percent Confidence Interval from Analyses of Soil Samples from Selected Soil Bodies in the Bicol Ragay Irrigation Project in Luzon, Philippines.

Property	Bantog		Bigaa		Libmanan		Pamplona	
	±10%	±20%	±10%	±20%	±10%	±20%	±10%	±20%
pH(1:1)	4	1	6	1	6	1	4	1
pH(1:2)	6	1	3	1	5	1	9	2
Organic Carbon	82	20	29	7	79	20	61	19
Phosphorous	327	81	217	54	184	45	249	63
Potassium	44	11	72	18	54	13	50	13
Free Fe_2O_3	234	58	85	21	485	97	87	23
Exchangeable Cations:								
Ca + Mg	67	17	16	4	20	5	28	7
Na	148	42	87	21	116	29	208	49
K	357	86	2062	515	175	58	290	34
H	54	15	69	17	542	131	35	7
Cation Exchange Capacity	32	8	12	3	7	2	14	3
Percent Base Saturation	17	4	2	1	7	2	6	1
Electrical Conductivity	128	32	40	10	182	45	77	19
Percent Sand	196	49	81	20	230	57	120	30
Percent Silt	66	16	95	11	27	7	24	6
Percent Clay	14	3	3	1	7	2	10	2
Field Capacity	12	3	5	1	7	2	8	5
Wilting Coefficient	30	7	5	1	30	7	22	6
Available Moisture	17	4	37	9	47	12	27	7
Settling Volume	12	3	3	1	18	4	6	2

Appendix N. Discussion of soil problems and potentials in broad planning areas mapped at small scale.

Soil Problems, Potentials



IN NEW YORK'S APPALACHIA REGION

by G. W. Olson, *Department of Agronomy, Ithaca*

The Appalachia Region of New York occupies 14 counties, about 14,802 square miles, or about one-fourth of the total land area of the state. As basic resources, soils are an integral part of this environment. They were inventoried[1,2] in 1968 and 1969 in a special soils study made under contract to the New York State Office of Planning Coordination (OPC). The inventory information, provided by the Cooperative Soil Survey[3], will be used to guide and plan future development in harmony with natural soil resources.

In mapping the soil resources, 54 soil associations were designated, but only areas larger than 300 acres were delineated on the map of the entire region at a scale of 1:250,000 (about 1 inch to 4 miles). These areas have two or more different soils side by side in the landscape. Soil associations with different important characteristics were then grouped into six general categories according to their limitations for uses like sanitary landfill, streets and parking lots, septic-tank filter fields, campsite (or play and picnic) areas, field crops, and woodlands. These areas, having different problems and potentials, appear in six colors on the soil map in an atlas of Appalachia resources published by OPC.

In figure 1, a shaded reproduction of the six-color soil map, each soil association symbol is accompanied by a number in parentheses that denotes the general suitability of that area for most intensive uses, based mainly on soil materials, drainage, and geomorphology. Table 1 lists the soil associations, their areas, and proportions.

Most of the soil association areas marked (1) (yellow on the OPC Appalachia soil map) in figure 1 are good, or have slight limitations, for most uses. These soils—dominantly deep, well drained, medium to moderately coarse textured, nearly level to hilly—in gravel and sand occupy 14.72 percent of the region or 1,731.90 square miles. In general they provide good support for highways, foundations, and other engineering structures. The soils are nearly level in many places, are easily traversed by modern farming equipment, and respond well to fertilizer application. Groundwater yields to wells in these areas are generally excellent. Septic-tank filter fields function well in the permeable subsoils, with only slight contamination hazards. Most of these areas are considered too valuable for such extensive uses as forestry, but could be very productive of trees and tree products. At the edges of the (1) areas, and at small spots with inclusions of other soils, local changes in elevation and soil factors such as wetness would be important in planning certain recreational developments.

Soils in the areas marked (2) (green on OPC map) are good to moderate, or have slight to moderate limitations, for most uses. These soils are dominantly deep, well to moderately well drained, medium textured, undulating to sloping, and have formed in glacial till. The (2) areas occupy 12.41 percent of the region or 1,464.86 square miles.

These soils have slow permeability for septic tanks, and wells within their boundaries generally have low yields. With proper drainage installations, most of the soils can provide good support for highways, foundations, and other engineering structures. The gentler slopes are fairly well suited to mechanized farming, and the soils are fairly responsive to fertilization. Some of these areas could be productive forests, and considerable recreational potential exists in localities having undulating slopes, esthetic landscapes, and good views.

The glacial-till soils in areas marked (3) (blue on OPC map) in figure 1 are dominantly deep, somewhat poorly to moderately well drained, medium textured, and gently to moderately sloping. They occupy 37.73 percent of the region or 4,453.26 square miles. These areas have soil wetness problems; a dense fragipan drastically reduces permeability of water into the substrata. In general, the soils are mediocre, or have moderate limitations, for most uses. With drainage they provide good support for highways, foundations, and other structures. Without drainage, frost heaving may be severe. Steeper slopes are not well suited to modern farming. For cropping, many fields in these areas would need drainage. Septic-tank filter fields function poorly if not designed for the seasonally wet and nearly impermeable subsoils. Groundwater yields are low. Large areas of these soils not now intensively used may have considerable potential for

forestry. Such areas also have many good sites for water impoundments.

Soils marked (4) (purple) are mostly moderately deep to shallow above bedrock, are well to somewhat poorly drained, are medium to fine textured, and occupy nearly level to steep slopes. These soils occupy 3,555.93 square miles or 30.13 percent of the region. They are difficult to excavate because of bedrock. Steep slopes in places also limit development possibilities. These mediocre soils have moderate to severe limitations for most uses. Ranging from shallow to moderately deep above bedrock, they can supply only limited nutrients and water to plants. Groundwater yields are low. Effluent from septic tanks can contaminate wells where it percolates rapidly through cracks in the bedrock.

Although not optimal, relatively large areas of these soils would be suitable for extensive forest practices. On steep slopes and in some other places, these soils hold promise for recreational developments, including ski slopes, hiking trails, vacation lodges, campsites, and picnic areas.

Wetness and instability impose severe limitations for most uses of soils numbered (5) in figure 1 (orange on OPC atlas map). Fortunately, they occupy only 514.30 square miles, 4.11 percent of the region. These soils are dominantly deep, moderately well to somewhat poorly drained, medium to fine textured, nearly level to sloping, and free from stones and gravel in glacial lake deposits.

Subject to frost heaving, soils in the (5) areas provide poor support for highways, foundations, and other engineering structures. With their seasonally wet soil conditions in many places, they are only fair for farming; septic tanks function poorly in the wet subsoils; well yields are low; and soil wetness retards tree growth. Despite their shortcomings, some places on these soils have recreational value in their esthetic views or as possible sites for ponds and small lakes. But embankments for water impoundments are subject to piping in the unstable soil materials.

Because of their location along waterways, rather than size, (6) areas are important. Occupying only 82.06 square miles (0.69 percent of the region), these areas are subject to flooding which greatly limits their use. These (6) areas are shown in red on the map published by OPC.

Where flooding can be prevented by engineering structures or conservation practices, however, the soils are good for some uses. Several organic soil areas could be developed for intensive, high-value cropping. And soils in alluvium (BBM, MC, and MH areas) also could be farmed intensively to produce high yields. The organic

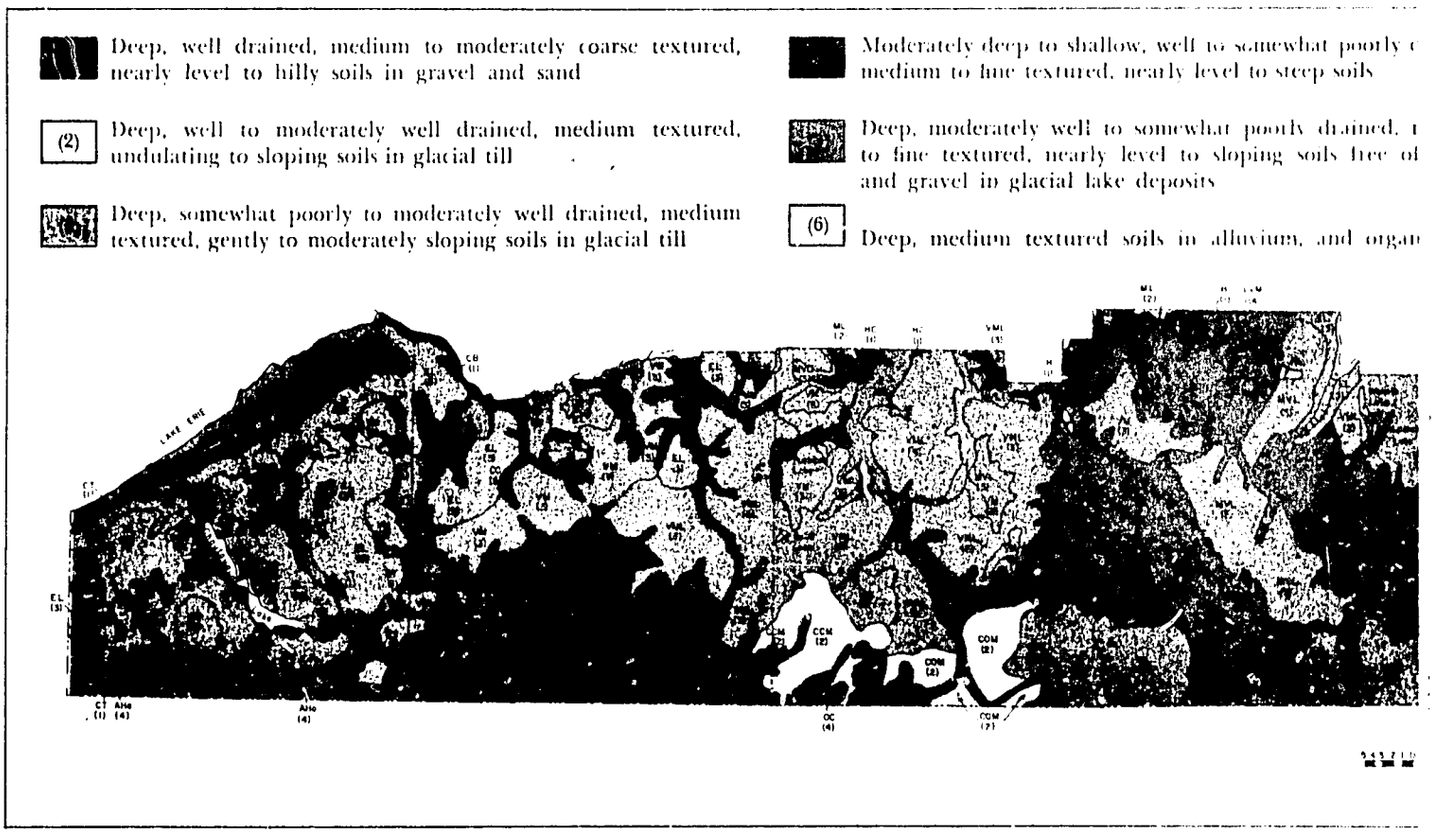


Figure 1. *Map showing general suitability of soil areas and soils associations in Appalachia, reduced from 1:250,000 scale. See*

soils cannot support heavy structures and urban development uses should generally be avoided. If flood hazard and soil wetness are eliminated, soils in alluvium can support structures and septic-tank filter fields. Groundwater yields are generally good, but some contamination potential exists.

These soils are good for forestry, but the lack of extensive acreages makes this use impractical. Because they are located along streams and rivers, they have high recreation potential as campsites and picnic areas and for water-related activities. Proposed water impoundments, if implemented, would flood some of these areas.

Agricultural uses of the soils in Appalachia reached their peak about 1875. Initially, grain crops predominated, particularly from 1800 to 1850, when the world wheat market created a strong demand and growers were moving west to avoid infestations of Hessian fly, smut, rust, and mildew in eastern New York. But the sloping and moderately productive upland soils were better suited to expansion of the dairy industry that followed.

Between 1875 and 1960, more than 60 percent of the farms in New York went out of business, and much of this attrition took place in the Appalachia Region. Many acres of abandoned land here are now planted to conifers; vegetation on the more recently deserted lands first reverts to grass, then to brush, and eventually becomes deciduous forest.

Predicting the future uses of Appalachia soils is conjecture, of course, but if the state's economy, population, and demand for recreational lands continues to expand at present rates, Appalachia can be expected to contribute to this growth. The region's established assets of construction sands and gravels, ability to produce forest products, and localized intensive farming operations also suggest a future of usefulness.

In any case, decisions for future commitments can be made with greater confidence by using the comprehensive soils inventory and use interpretations accumulated during these studies.

[1]Jansen, I. J., R. L. Guthrie, G. M. Coen, J. G. Bockus, C. Wang, and G. W. Olson. 1969. Soils of the fourteen-county Appalachia Region in New York State. Cornell Agronomy Mimeo 68-1. 132 pages with maps. Also published by Office of Planning Coordination, Albany.

[2]Rose, R. D., G. F. Kling, J. G. Bockus, and G. W. Olson. 1969. Use of soils in the fourteen-county Appalachia Region of New York State. Cornell Agronomy Mimeo 69-5. 341 pages. Also published by Office of Planning Coordination, Albany.

[3]The Cooperative Soil Survey is a joint effort of the United States Department of Agriculture, the Cornell University Agricultural Experiment Station, and other state agencies in New York.

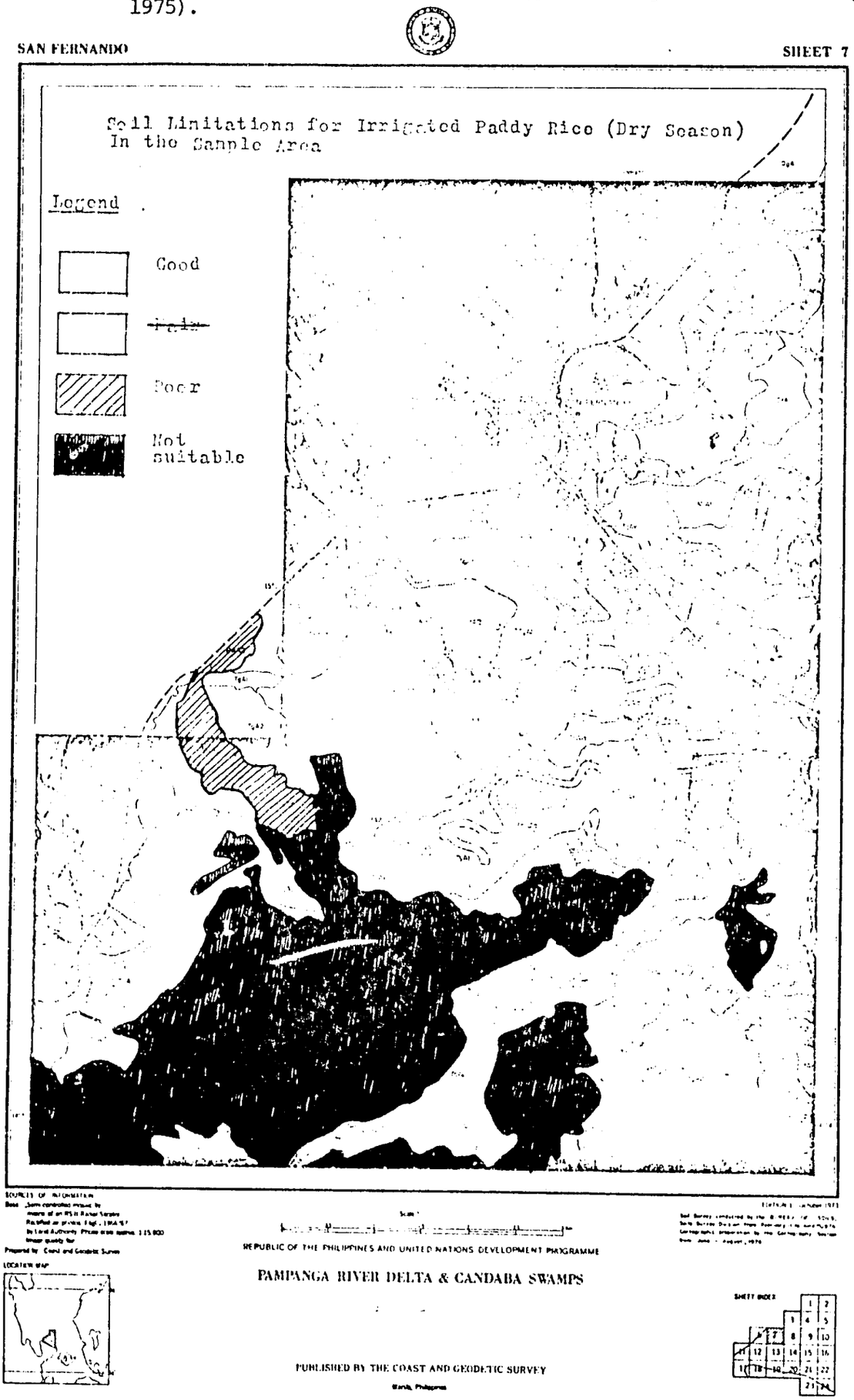
1 for legend of this map and areas of the map units.

Table 1. *Soil associations*[1] *and their extent on map of Appalachia Region of New York State at 1:250,000 scale.*

Symbol	*Soil Association Name*	*Area (mi²)*	*Percent of Area*
ACo	Angola-Collamer	72.59	0.61
AHo	Allis-Hornell	23.60	0.20
BBM	Barbour-Basher-Middlebury	28.05	0.24
BEN	Burdett-Erie-Nunda	33.16	0.28
C	Canaadea	152.29	1.29
CB	Chenango-Bath	193.53	1.69
CC	Chenango-Canaadea	33.36	0.28
CCA	Canaadea-Collamer-Alden	140.88	1.19
CCM	Cattaraugus-Culvers-Morris	91.16	0.77
CDa	Canaseraga-Dalton	4.10	0.03
CM	Culvers-Morris	226.59	1.92
CMO	Cattaraugus-Morris-Oquaga	134.69	1.14
COM	Cattaraugus-Oquaga-Morris	659.59	5.59
CT	Chenango-Tioga	583.36	4.94
Dk	Dekalb	166.79	1.41
DN	Darien-Nunda	47.41	0.40
EL	Erie-Langford	853.87	7.23
FL	Farmington-Lyons	13.64	0.11
H	Howard	82.25	0.70
HC	Howard-Chenango	462.32	3.92
HCa	Hudson-Cayuga	28.67	0.24
HF	Honeoye-Farmington	33.61	0.28
HL	Honeoye-Lima	15.24	0.13
HLa	Howard-Langford	211.40	1.79
HMV	Hornell-Mardin-Volusia	252.57	2.14
HR	Hudson-Rhinebeck	68.09	0.54
L	Lordstown	417.33	3.54
LA	Lansing-Appleton	18.86	0.16
LC	Lansing-Conesus	70.28	0.60
LE	Langford-Erie	181.27	1.54
LEL	Langford-Erie-Lordstown	75.02	0.64
LL	Lordstown-Langford	51.84	0.44
LMa	Lordstown-Mardin	496.45	4.21
LMV	Lordstown-Mardin-Volusia	254.77	2.16
LV	Lordstown-Volusia	233.78	1.98
LVM	Lordstown-Volusia-Mardin	794.65	6.73
MC	Middlebury-Chenango	33.25	0.28
MH	Middlebury-Howard	14.71	0.12
ML	Mardin-Lordstown	298.20	2.53
MoH	Mohawk-Honeoye	143.23	1.21
MP	Muck-Peat	6.05	0.05
MVL	Mardin-Volusia-Lordstown	296.87	2.52
N	Nassau	5.49	0.05
OA	Oquaga-Arnot	481.72	4.08
OC	Oquaga-Cattaraugus	222.15	1.88
OM	Oquaga-Morris	141.15	1.20
P	Palmyra	78.81	0.67
S	Schoharie	32.93	0.08
TB	Tunkhannock-Barbour	62.85	0.53
VC	Valois-Chenango	24.02	0.20
VL	Volusia-Lordstown	476.61	4.04
VM	Volusia-Mardin	765.45	6.48
VML	Volusia-Mardin-Lordstown	1,492.91	12.65
WW	Williamson-Wallington	18.85	0.16
Total		11,802.31	99.79[2]

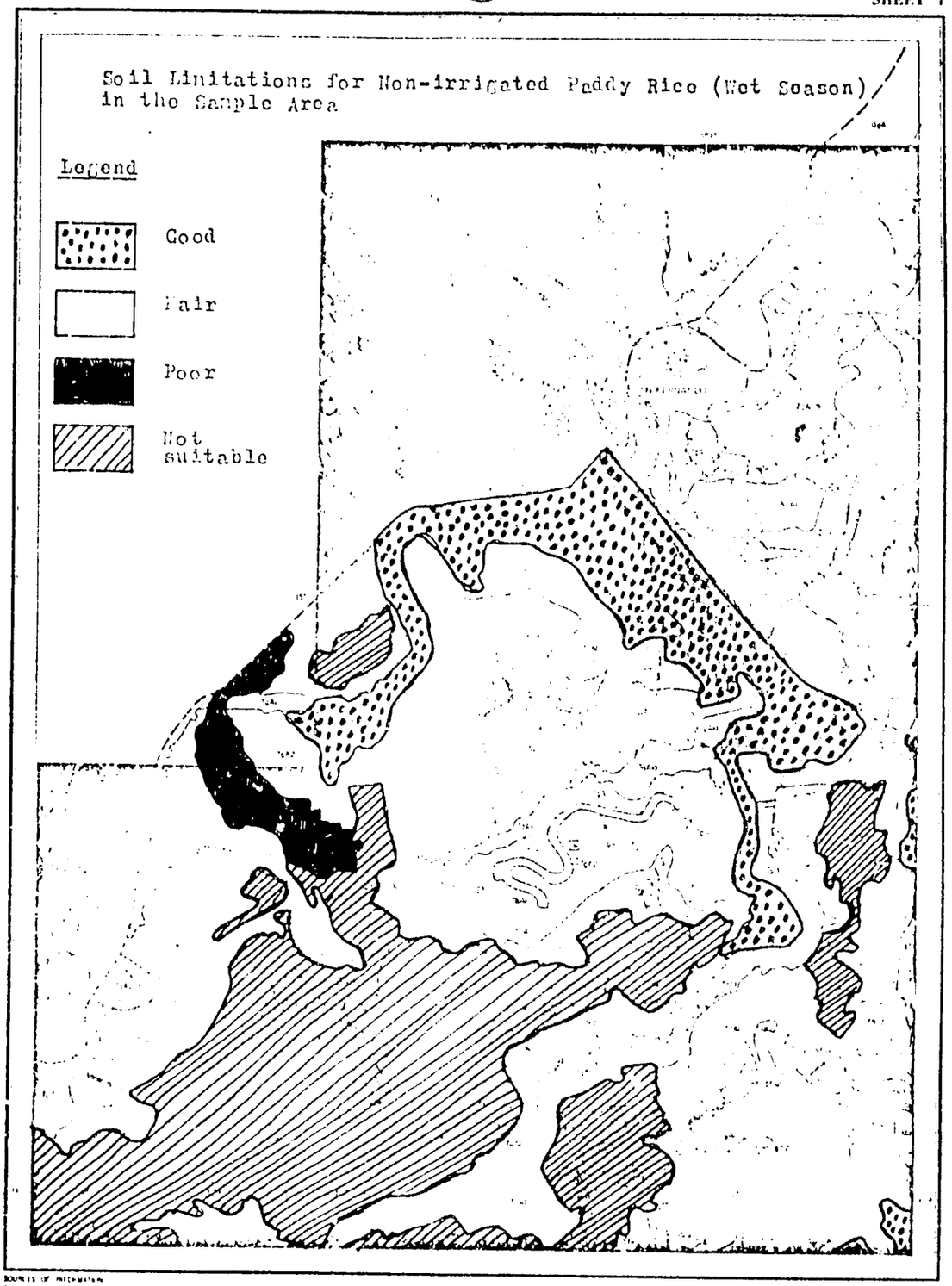
[1] *A few soil names are subject to change pending final correlations.*
[2] *Percentages rounded to nearest hundredth total 99.79 percent.*

Appendix O. Soil survey interpretations for an area north of Manila Bay south of San Fernando in the Philippines (adapted from Crucena, 1975).



SAN FERNANDO

SHEET 7



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PAMPANGA RIVER DELTA & CANDABA SWAMPS

LOCATION MAP

SHEET INDEX

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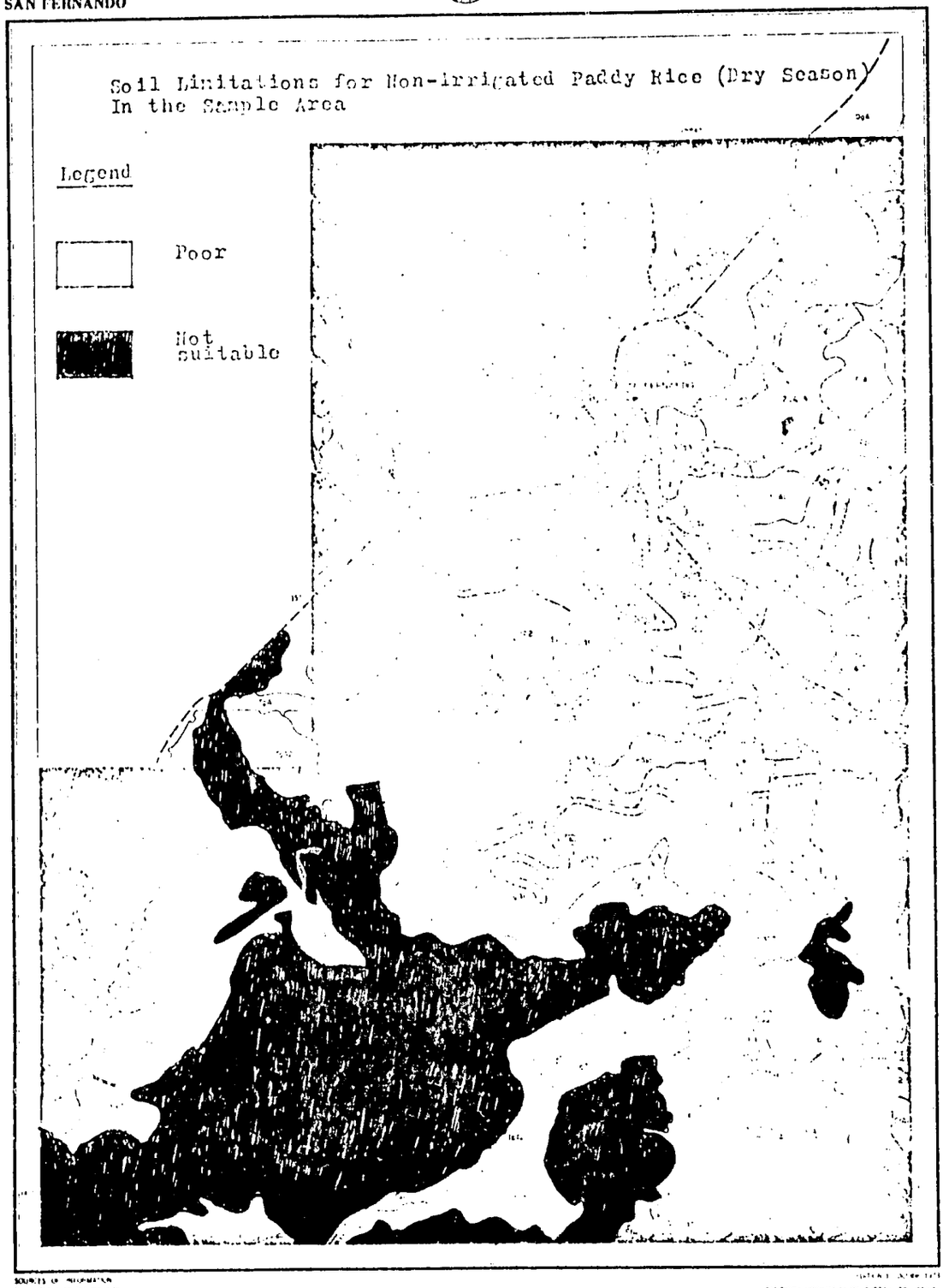
SAN FERNANDO

SHEET 7



SOURCES OF INFORMATION

Base: Stereo controlled mosaic by means of an RS III Wide Sector Rectified air photos (Flight Line 67) by Land Authority. Photo scale approx. 1:15,000 Image quality fair

Prepared by Coast and Geodetic Survey

LOCATION MAP

Scale

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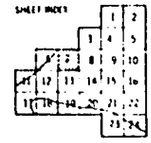

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Manila, Philippines

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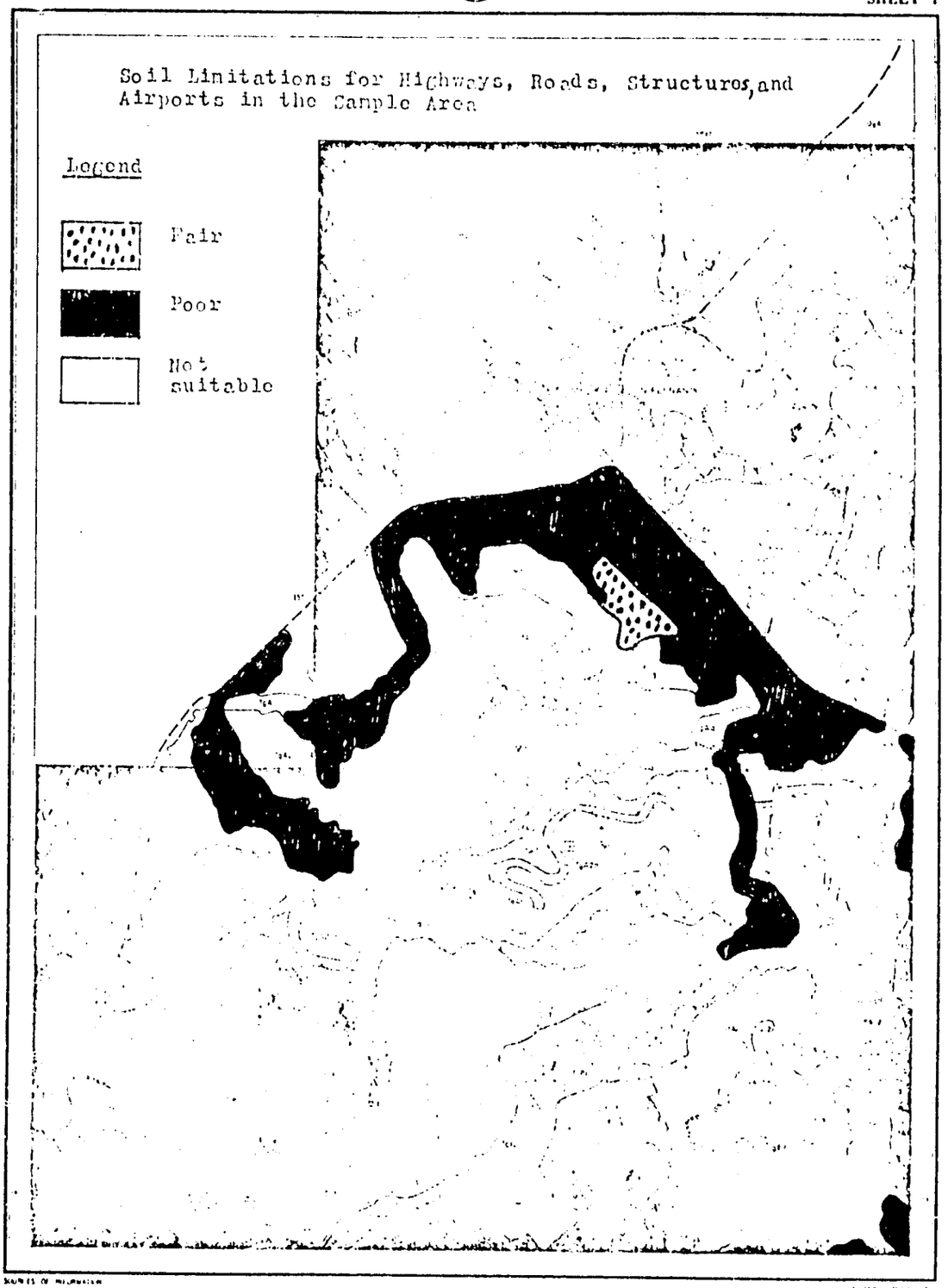
SHEET 7



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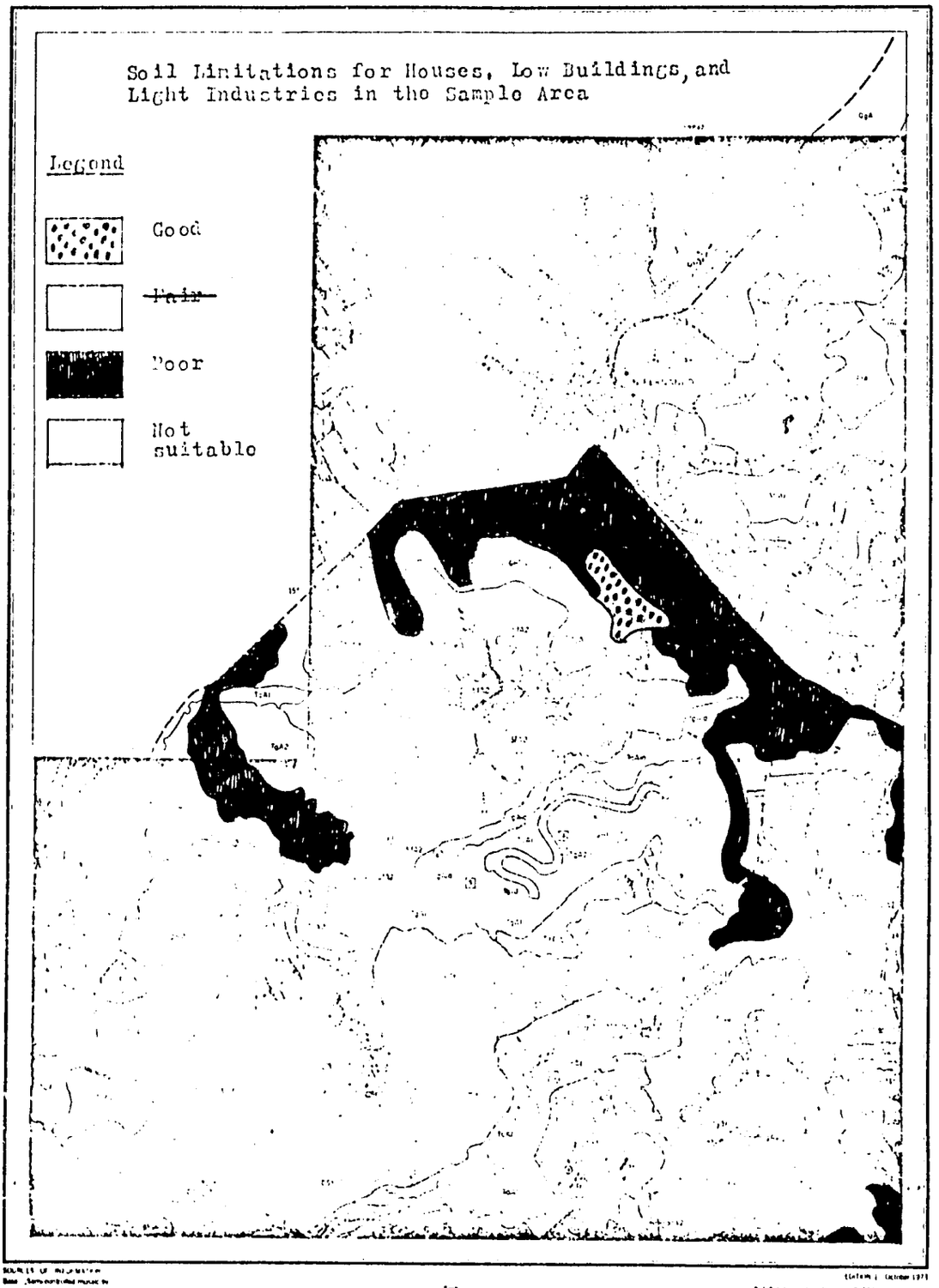

SOURCES OF INFORMATION

Base: Semi-controlled mosaic by
means of an RC-8 Aerial Camera
Rectified orthophoto flight 1966-67
by Land Authority. Photo scale approx. 1:15,000
mosaic scale by

Prepared by: Coast and Geodetic Survey

LOCATION MAP

Scale

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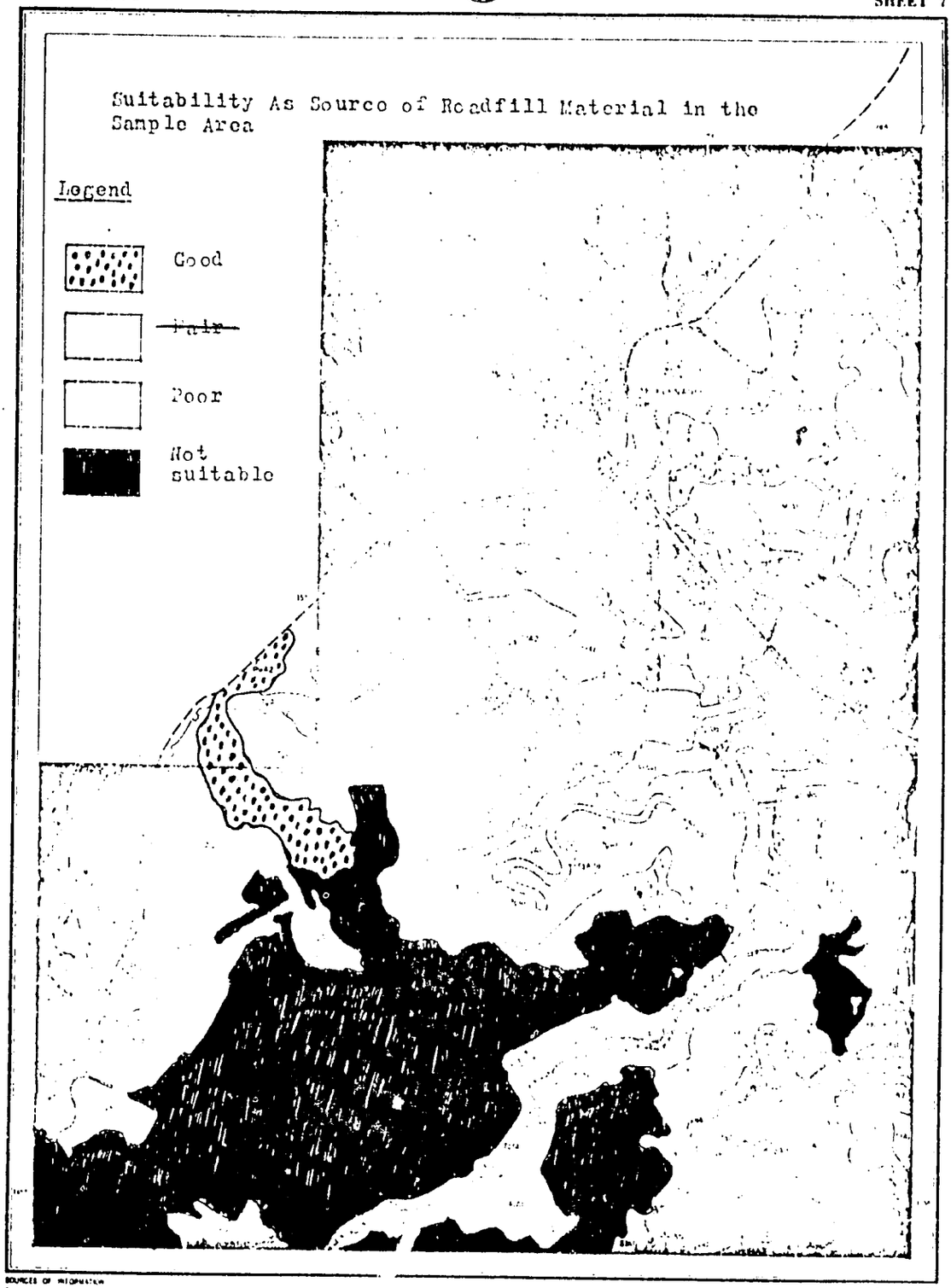

SOURCES OF INFORMATION

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Prepared by: Coast and Geodetic Survey

Scale

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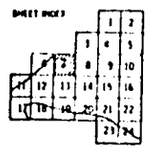

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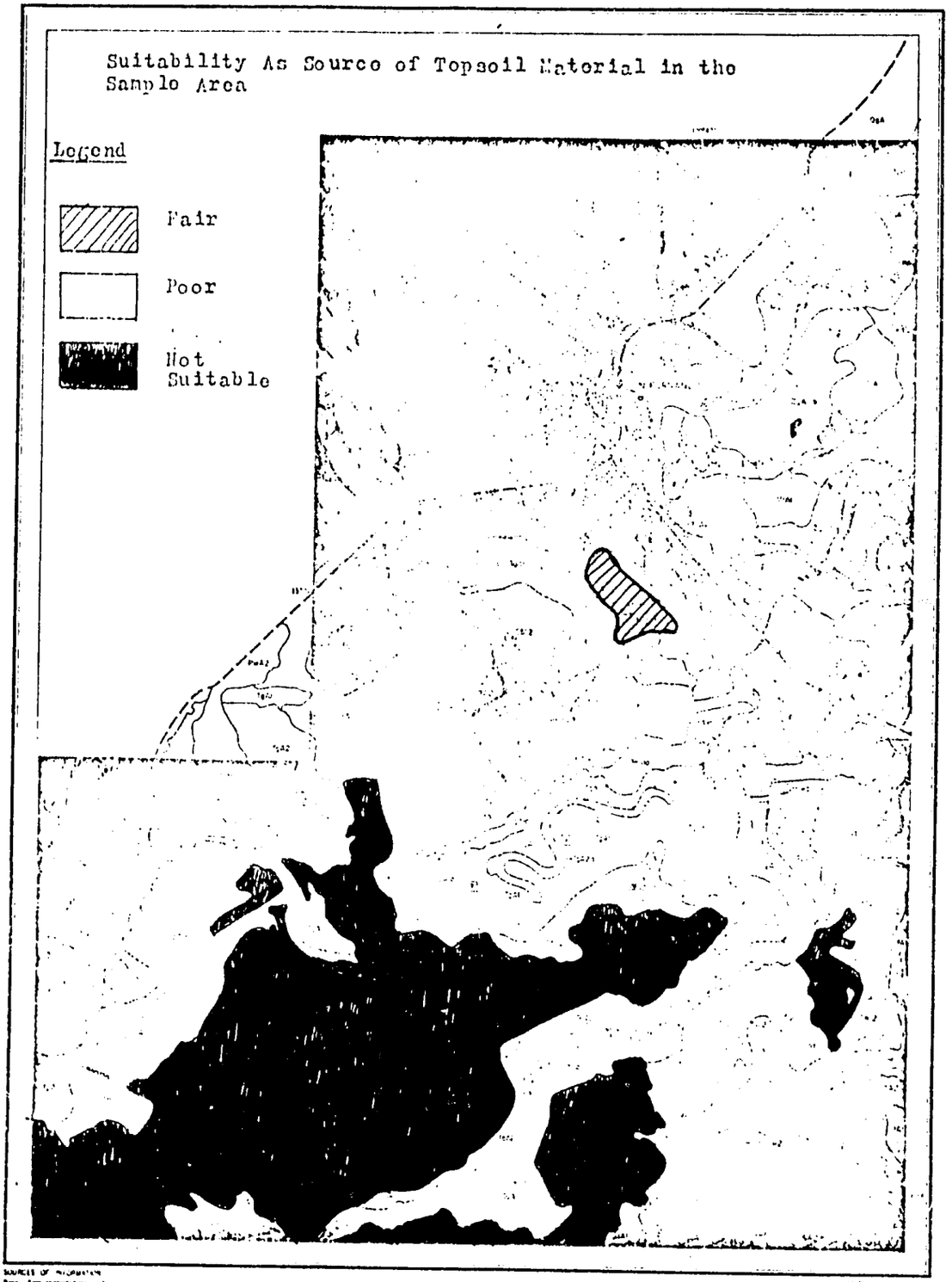

Scale

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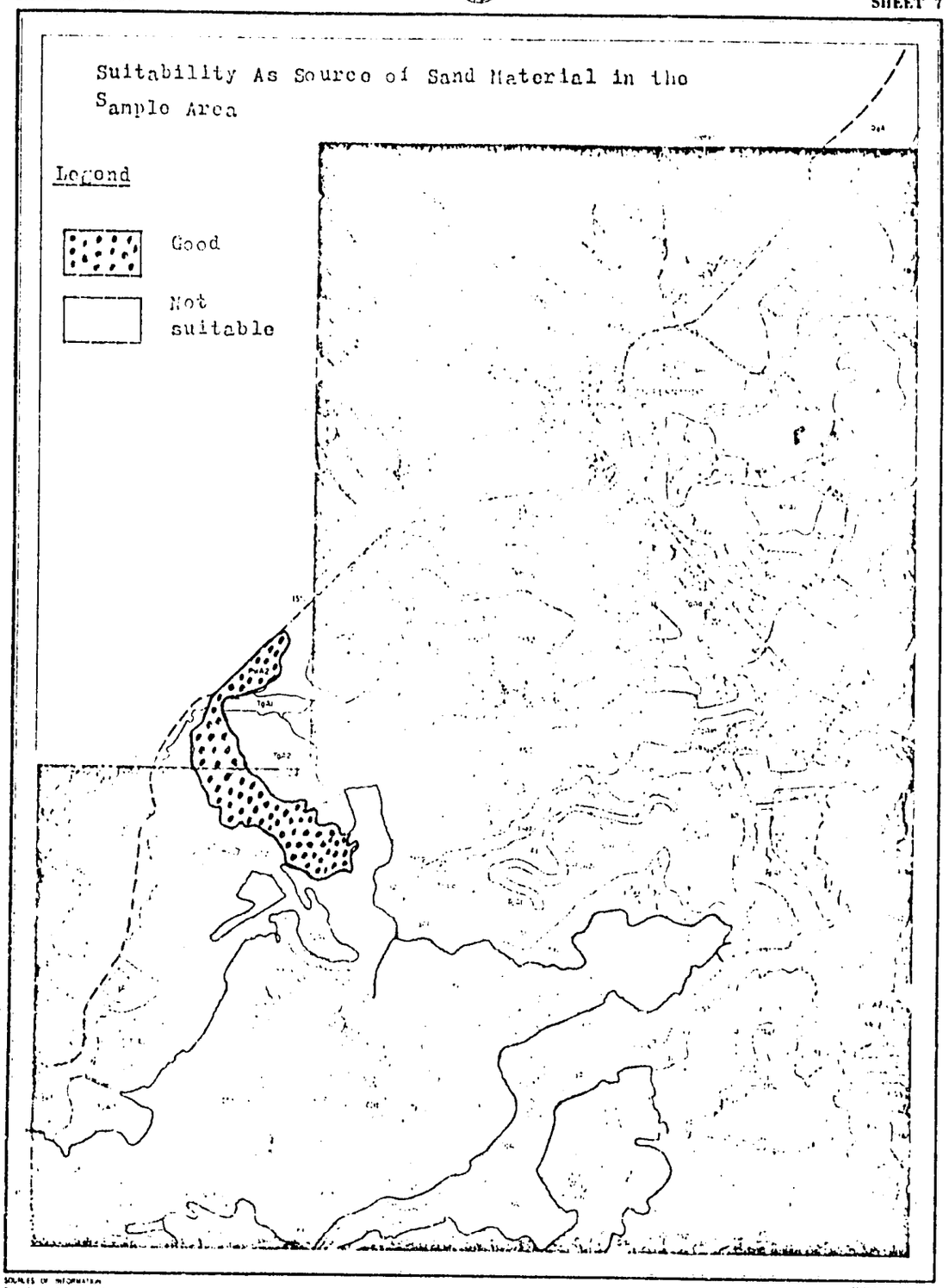
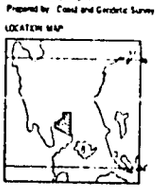


SOURCES OF INFORMATION

Base: Semi-controlled mosaic by means of an RS-II Radar Sensor. Rectified on photo. Flight 1966-67 by Land Author ity. Photo scale approx. 1:15,000 whose quality for

Prepared by: Coast and Geodetic Survey

LOCATION MAP



Scale

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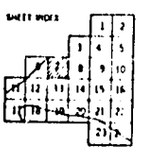

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