c) Profiles of the Croplands

In the soil survey, sites of the profile examination are selected on the lands where typical soil species have developed under natural conditions of weathering and climate, because soils of the croplands have been disturbed artificially by cultivation, being not appropriate to be adopted for soil genesis classification.

In fact, upland crop field soils with the exception of coconut fields gave more or less different surface profiles from those of undisturved soils in available depth, compactness, structure and so on. Particularly, those of the fields reclaimed along lower part of the sloping lands were plowed deeper and less compact. Pit No. 25 (Ubay Sandy Loam) and No. 45 (Ubay Loam Type 1) present good examples.

In case of paddy rice fields mostly distributing on the depressed areas or flat alluvial valleys, the surface soils of each soil type are originally deep and upon reclamation these are more deepened, finer textured and less gravelly by furnishing the adjacent land soil and cultivation practice such as puddling.

The profile deviations with land slope can be understood on FIGURE D5-5 which illustrates different characteristics of the paddy rice fields. Such deviations will be dealt with classification of soil phase in the next paragraph.

5.3 Distribution of Soil Types

Soil map in series and type of the project area was prepared in FIGURE D5-6. Higher categories of the types are also reflected in the legend.

Extent of each soil type is as follows:

Type	Hectare	Percent
Hydrosol	150	1.2
Ubay Sandy Loam	4,570	36.0
Ubay Loam Type 1	2,690	21.2
Ubay Loam Type 2	5,290	41.6
Total	12,700	100

Hydrosol occurs on the flat alluvial lands along lower streams of the river. While, Ubay soil series has a wide range of topographic features, from undulating areas to rolling and steep hills. The elevation ranges from 3 to 50 m.

Ubay Sandy Loam distributes largely on the gently sloping terrain areas in the eastern part of the project area. Ubay Loam, especially its type 2, prevails on the rolling and undulating terrain areas in the western part. This soil type has presumably been dissected more severally than Loam Type 1, resulting in lack of coarse-textured surface layer.

From soil genetic point of view, textural relationships among soil type formation can be illustrated as shown in FIGURE D5-7.

5.4 Soil Phase and Final Mapping

Soil phase is a variation within the soil type, differing in some minor features, generally external, that may be of special practical significance. For example, differences in relief, stoniness, and extent or degree of erosion are shown as phases.

In the project area, differences in relief expressed as slope gradient of the land appear to represent soil conditions related to available soil depth, gravel content and degree of erosion. Accordingly, the soil type was further divided into soil phases with four gradients of the land slope.

Using 1:4,000 topographical maps, sub-division was conducted to delineate the lands with the gradients of 0 - 3% (A), 3 - 5% (B), 5 - 8% (C) and more than 8% (D) from viewpoints of land suitability classification. Breakdown of the soil type to phase in hectarage is referred to TABLE D6-3.

Detailed soil maps scaled at 1:10,000 were depicted with soil phase level. FIGURES D5-8, -9, -10 and -11 are the smaller scaled copies of these maps which are separated largely with municipality.

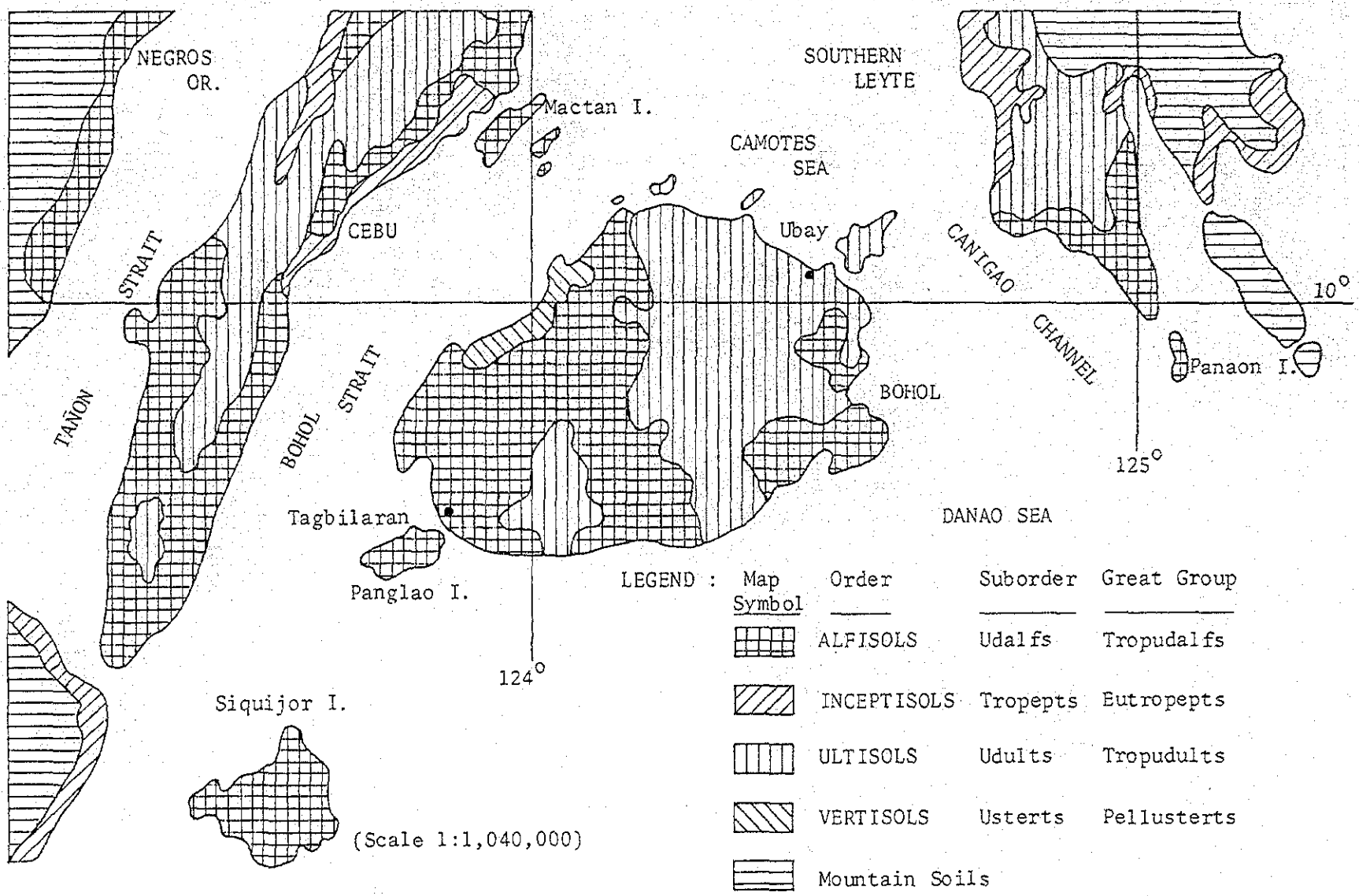
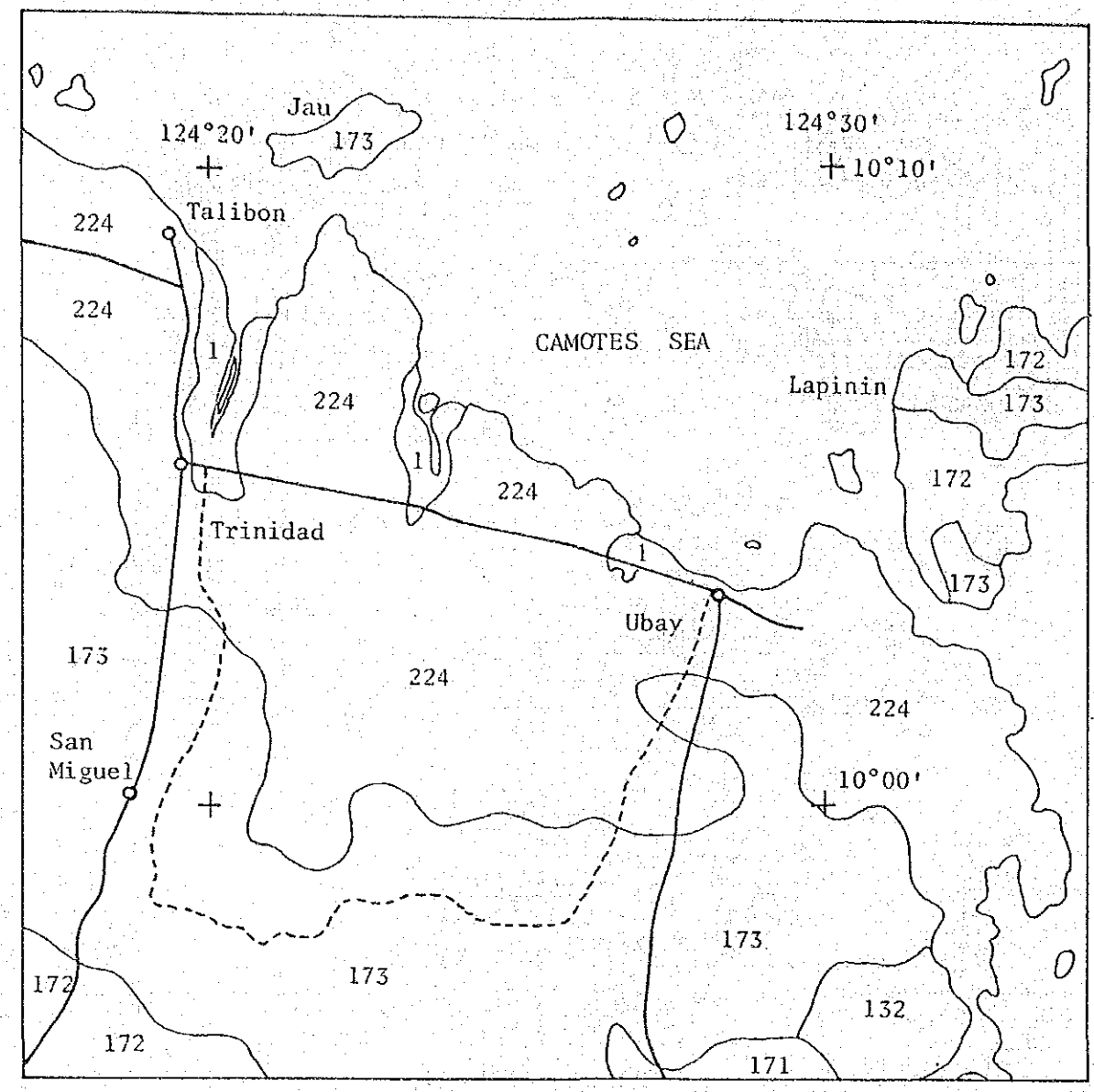


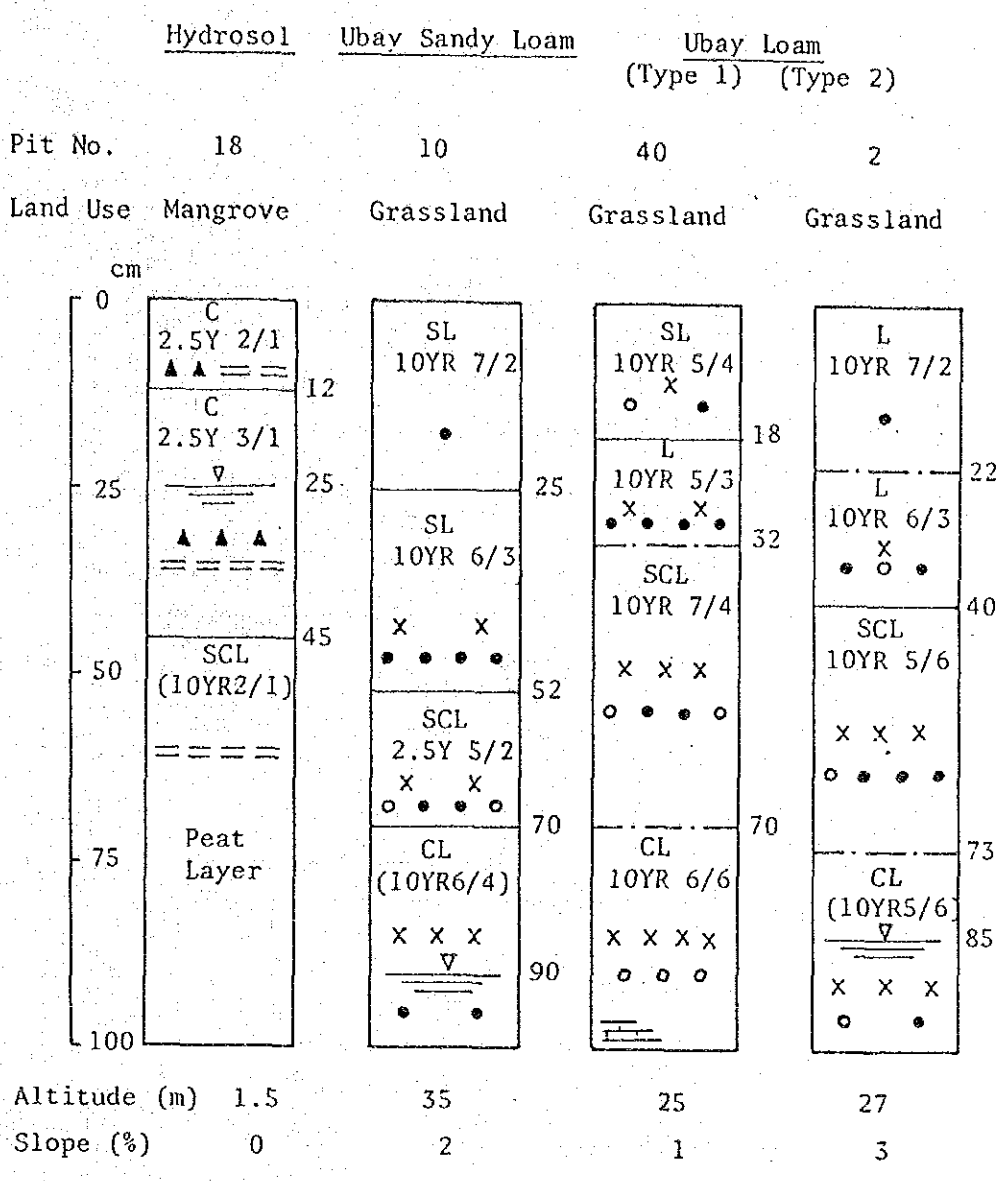
FIGURE D 5 - 1 SOIL MAP OF THE PHILIPPINES AROUND BOHOL PROVINCE (1972)



LEGEND:

Soil Type No.	Name of Soil Type	Suborder	Order
1	Hydrosol	Aquents	ENTISOLS
132	Faraon Clay		
171	Rough stony land		
172	Ubay clay loam	Udults	ULTISOLS
173	Ubay clay		
224	Ubay Sandy Loam		

FIGURE D 5 - 2 SOIL TYPES AROUND THE PROJECT AREA CITED FROM THE SOIL SURVEY REPORT OF BOHOL PROVINCE (1947)



Legend:

Color mottlings:

X	Few (<2%)
X X	Common (2-20%)
X X X	Many (20-40%)
X X X X	Abundant (>40%)
▲	Peat
= = = =	Gley Layer
	Weathered Shale Layer

Gravels:

o	Very few (<5%)
o o	Few (5-15%)
o o o	Frequent (15-40%)
o o o o	Very frequent (>40%)
o	Soft particles
●	Hard particles
▽	Groundwater Level

FIGURE D 5-3 COLUMNAR DIAGRAM OF TYPICAL SOIL PROFILES OBSERVED IN THE PROJECT AREA

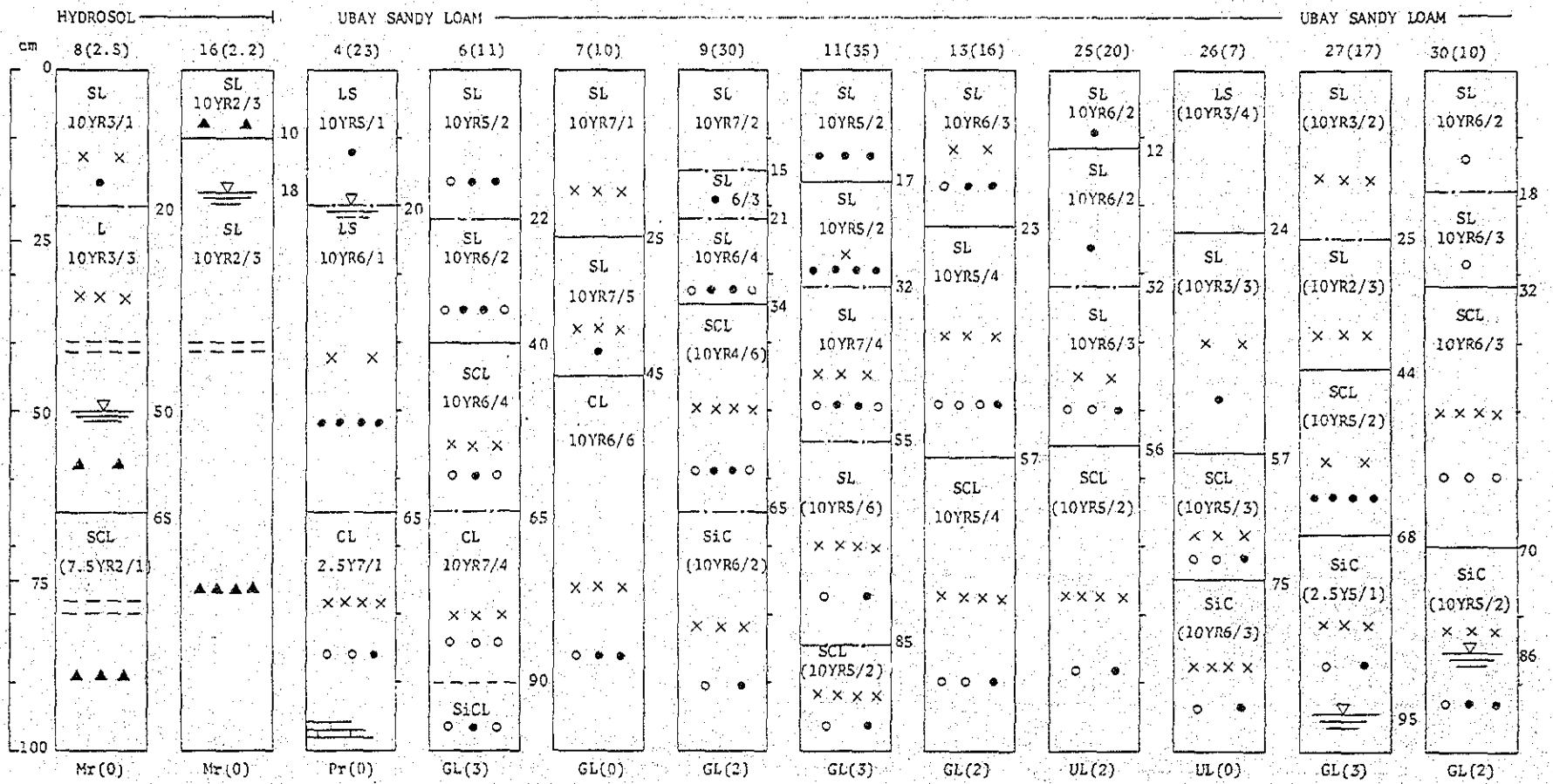


FIGURE D 5 - 4 SOIL-TYPEWISE PROFILE DIAGRAMS OF THE OTHER PITS OBSERVED IN THE PROJECT AREA (1)

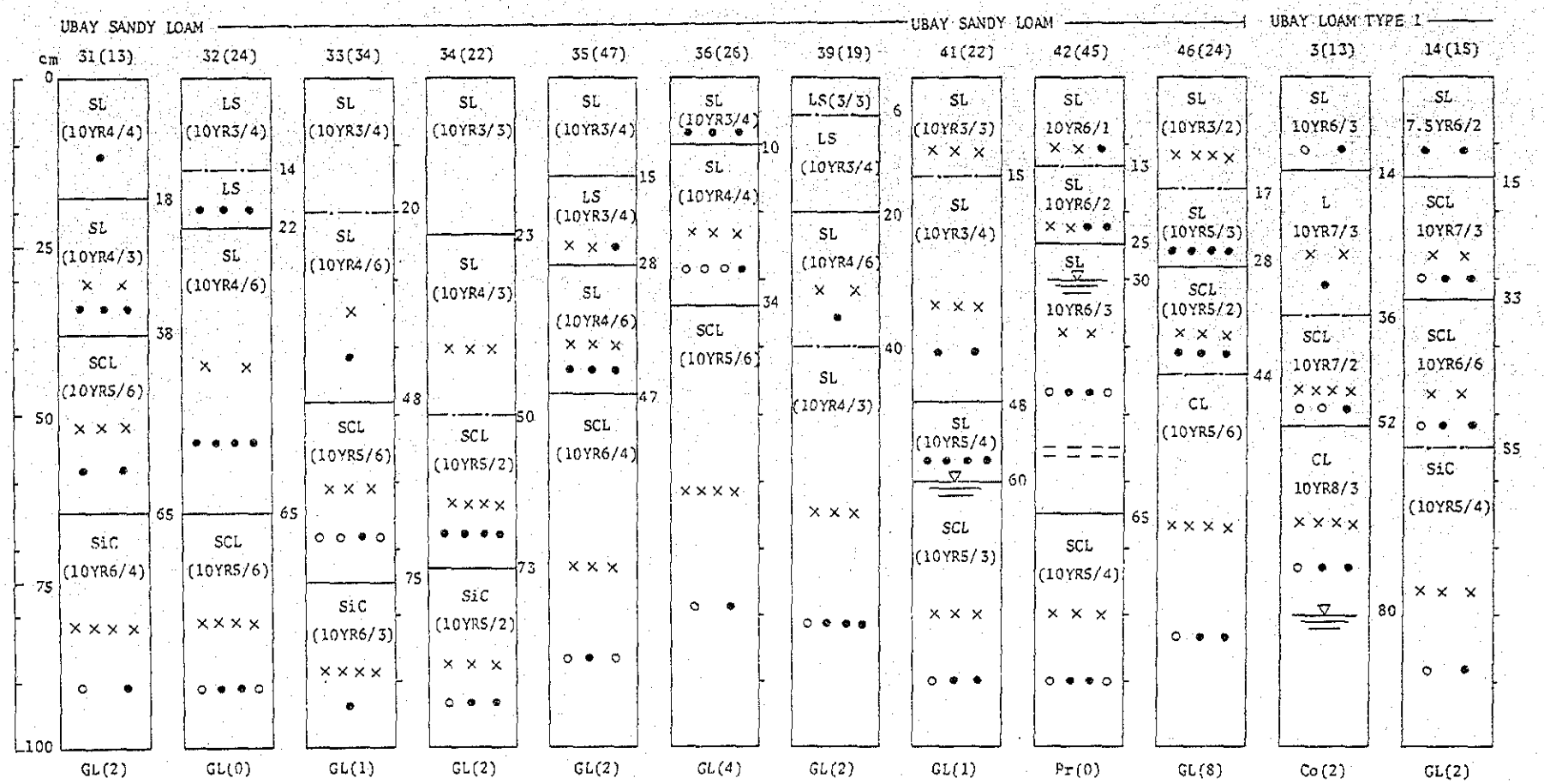


FIGURE D 5 - 4 SOIL-TYPEWISE PROFILE DIAGRAMS OF THE OTHER PITS OBSERVED IN THE PROJECT AREA (2)

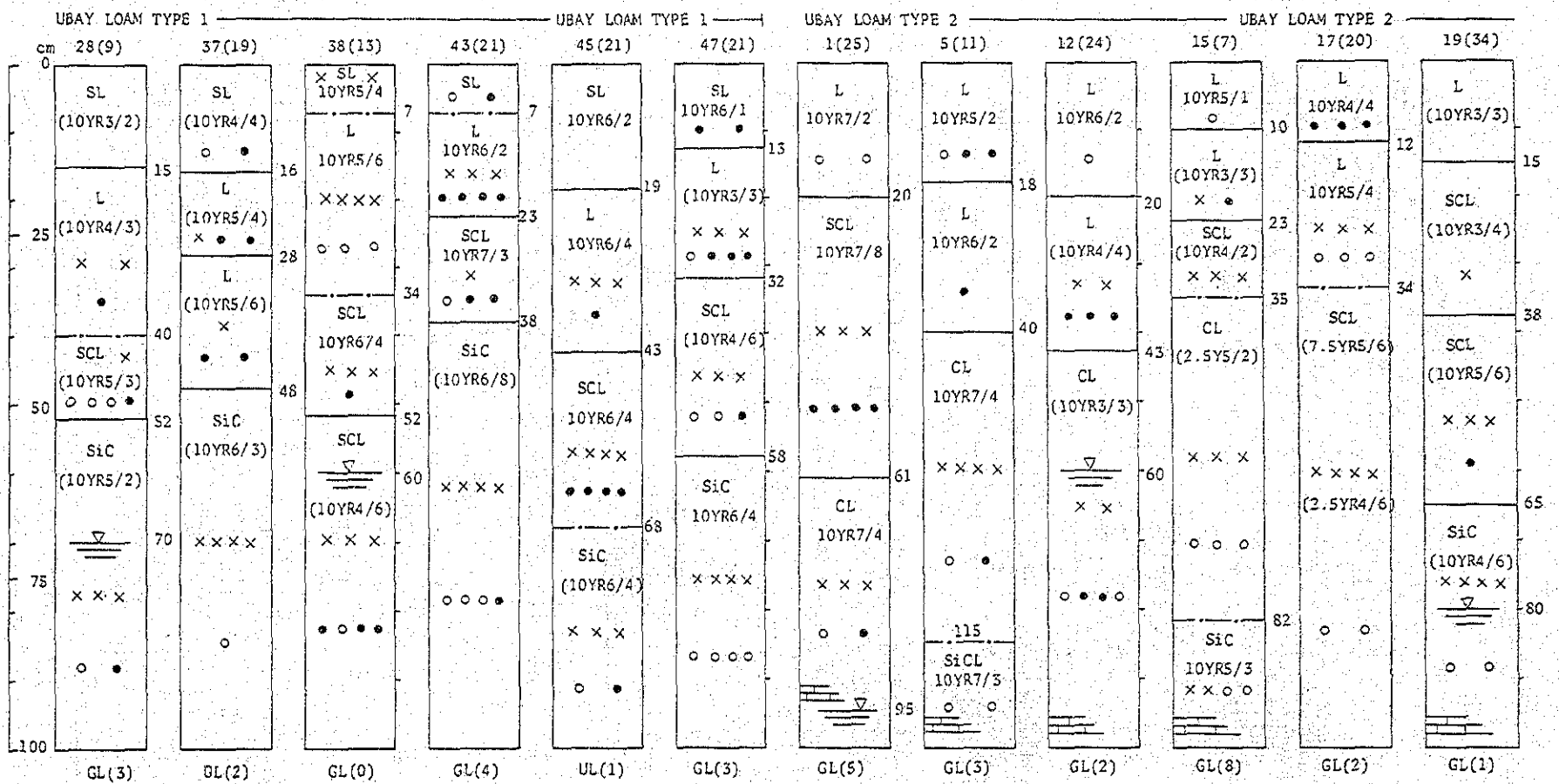


FIGURE D 5 - 4 SOIL-TYPEWISE PROFILE DIAGRAMS OF THE OTHER PITS OBSERVED IN THE PROJECT AREA (3)

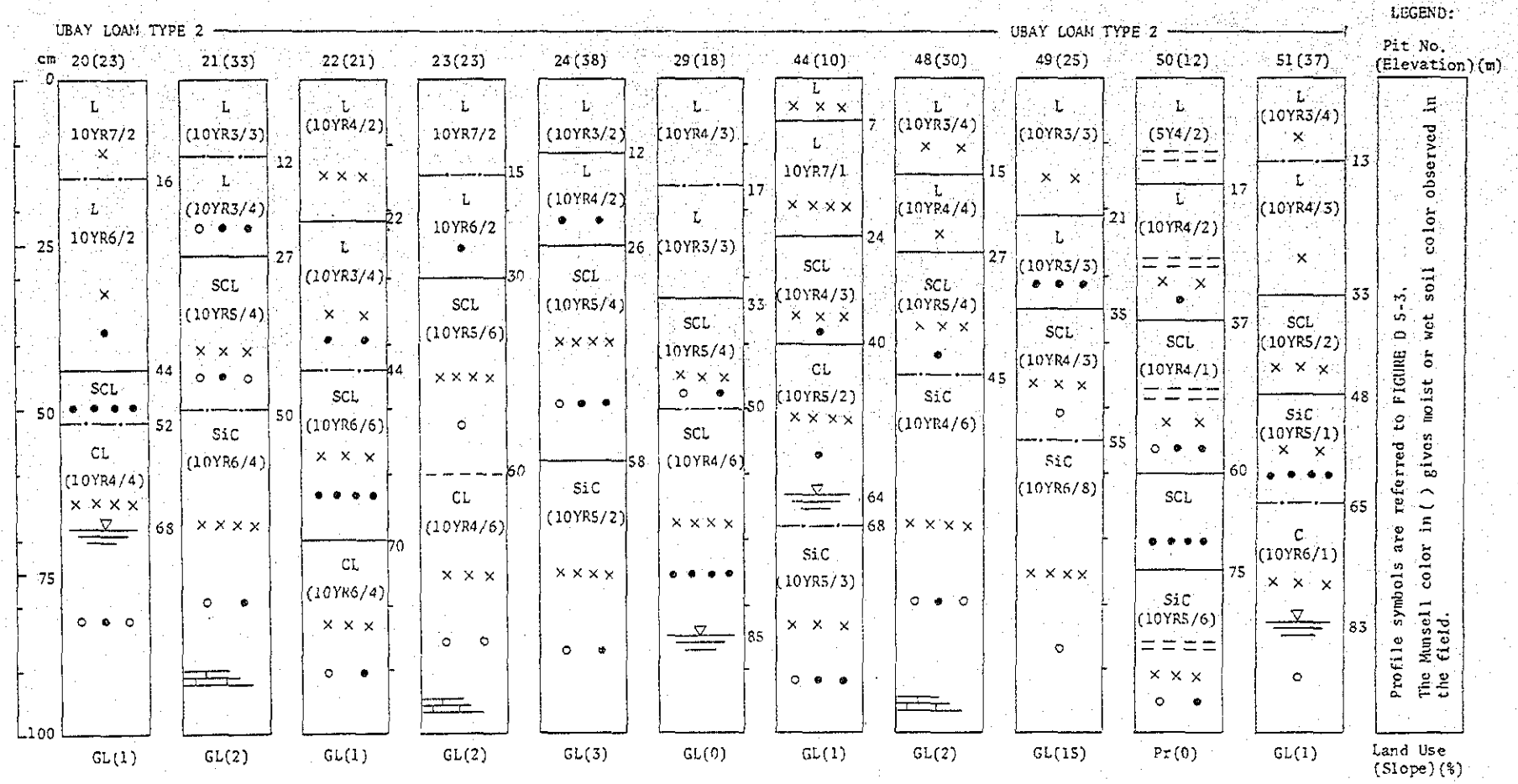
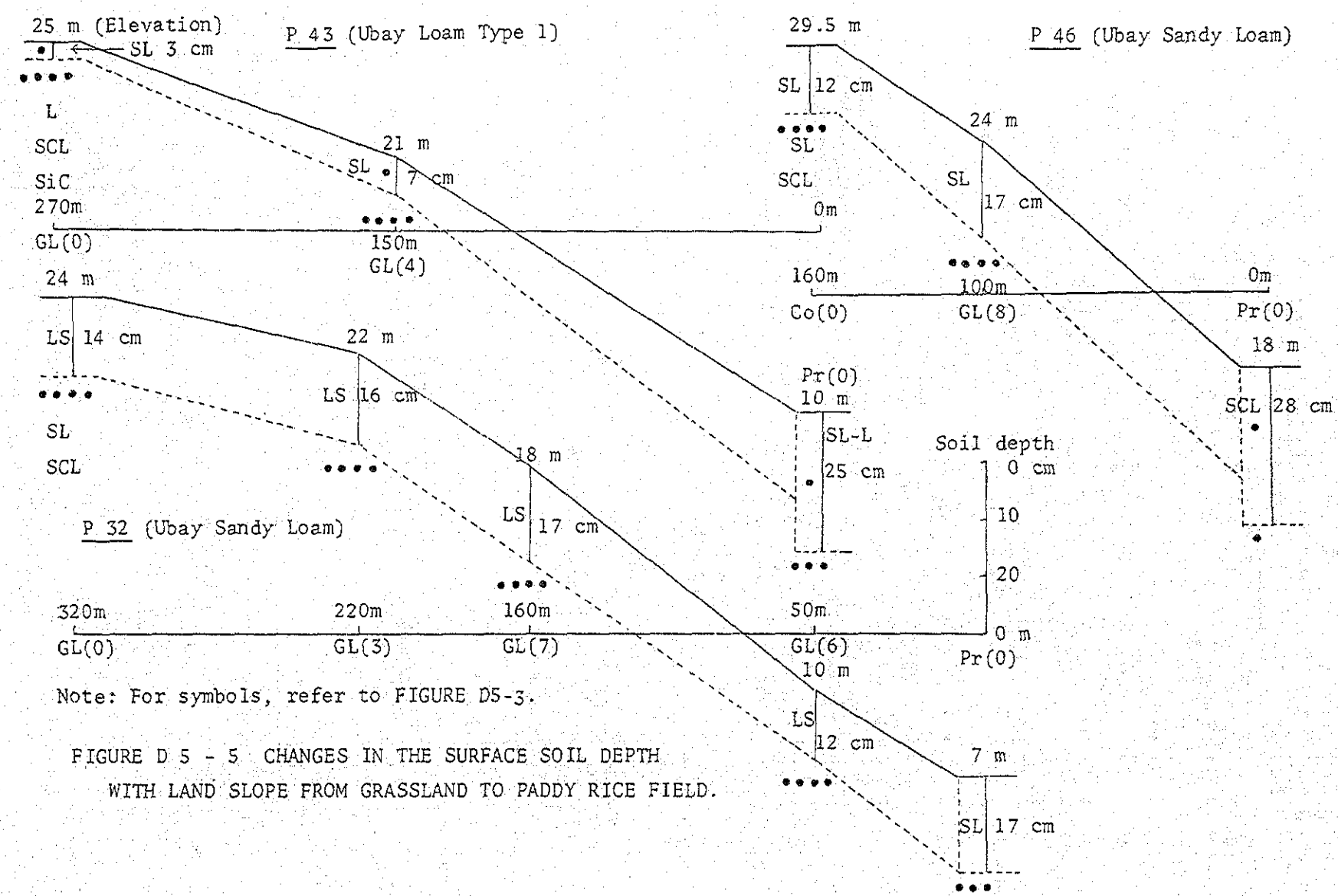
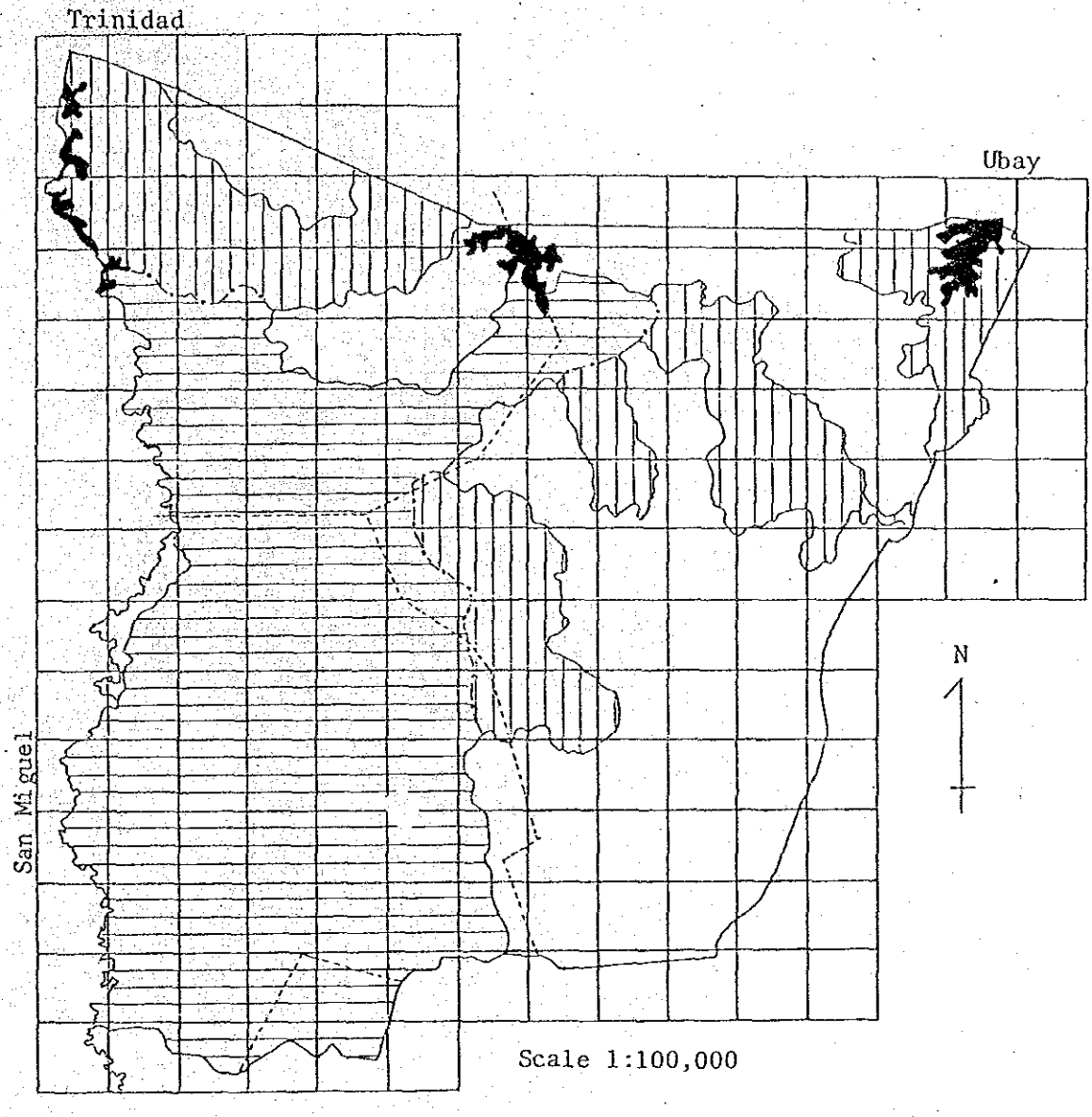


FIGURE D 5 - 4 SOIL-TYPEWISE PROFILE DIAGRAMS OF THE OTHER PITS OBSERVED IN THE PROJECT AREA (4)



Note: For symbols, refer to FIGURE D5-3.

FIGURE D 5 - 5 CHANGES IN THE SURFACE SOIL DEPTH WITH LAND SLOPE FROM GRASSLAND TO PADDY RICE FIELD.



LEGEND: Map Symbol	Order	Suborder	Sub-Group	Series - Type
	ENTISOLS	Aquents	Typic Hydraquent	Hydrosol
	ULTISOLS	Udults	Typic Tropudults	Ubay Sandy Loam
				Ubay Loam Type 1
				Ubay Loam Type 2

FIGURE D 5 - 6 GENERAL SOIL MAP OF THE PROJECT AREA

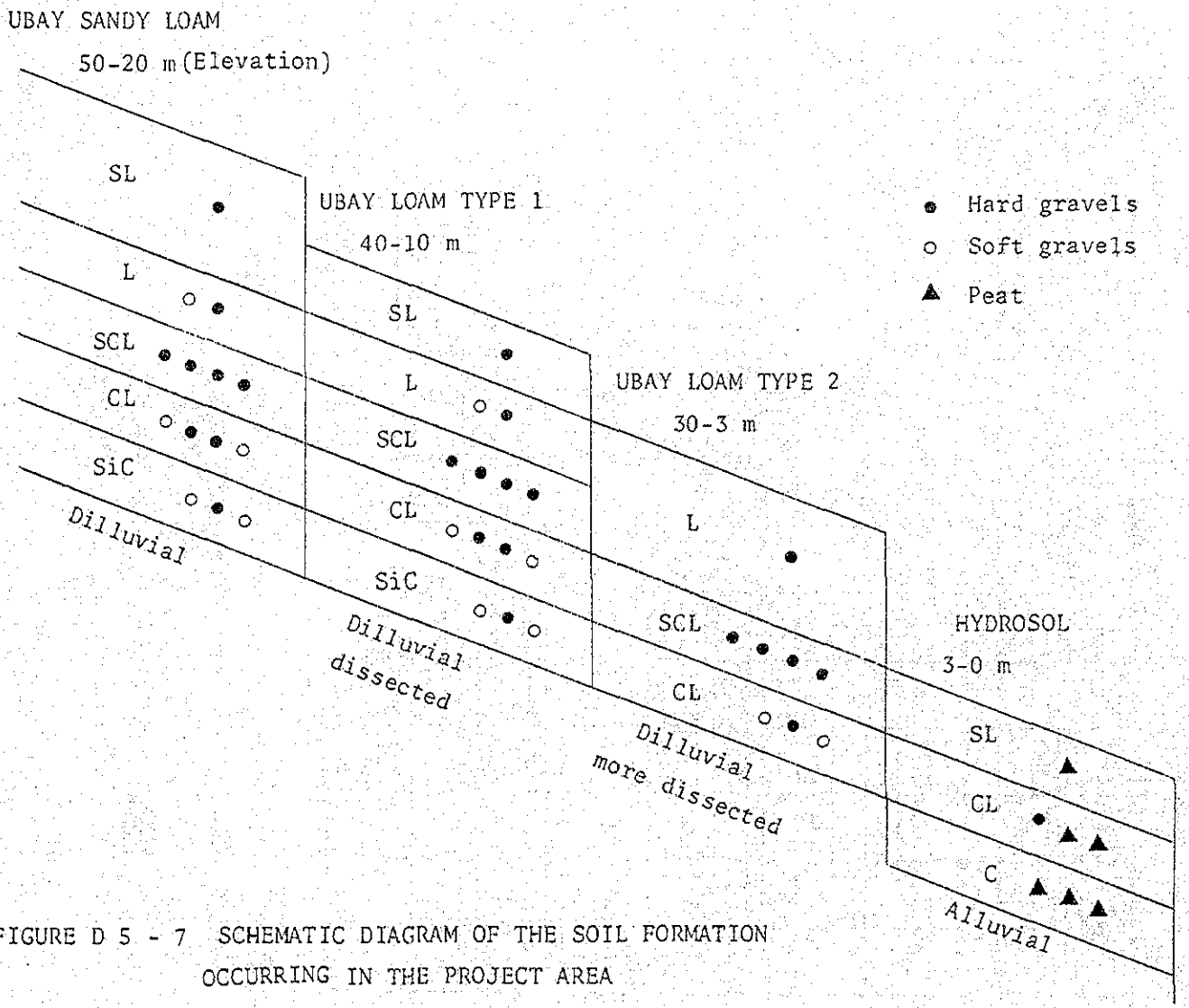


FIGURE D 5 - 7 SCHEMATIC DIAGRAM OF THE SOIL FORMATION OCCURRING IN THE PROJECT AREA

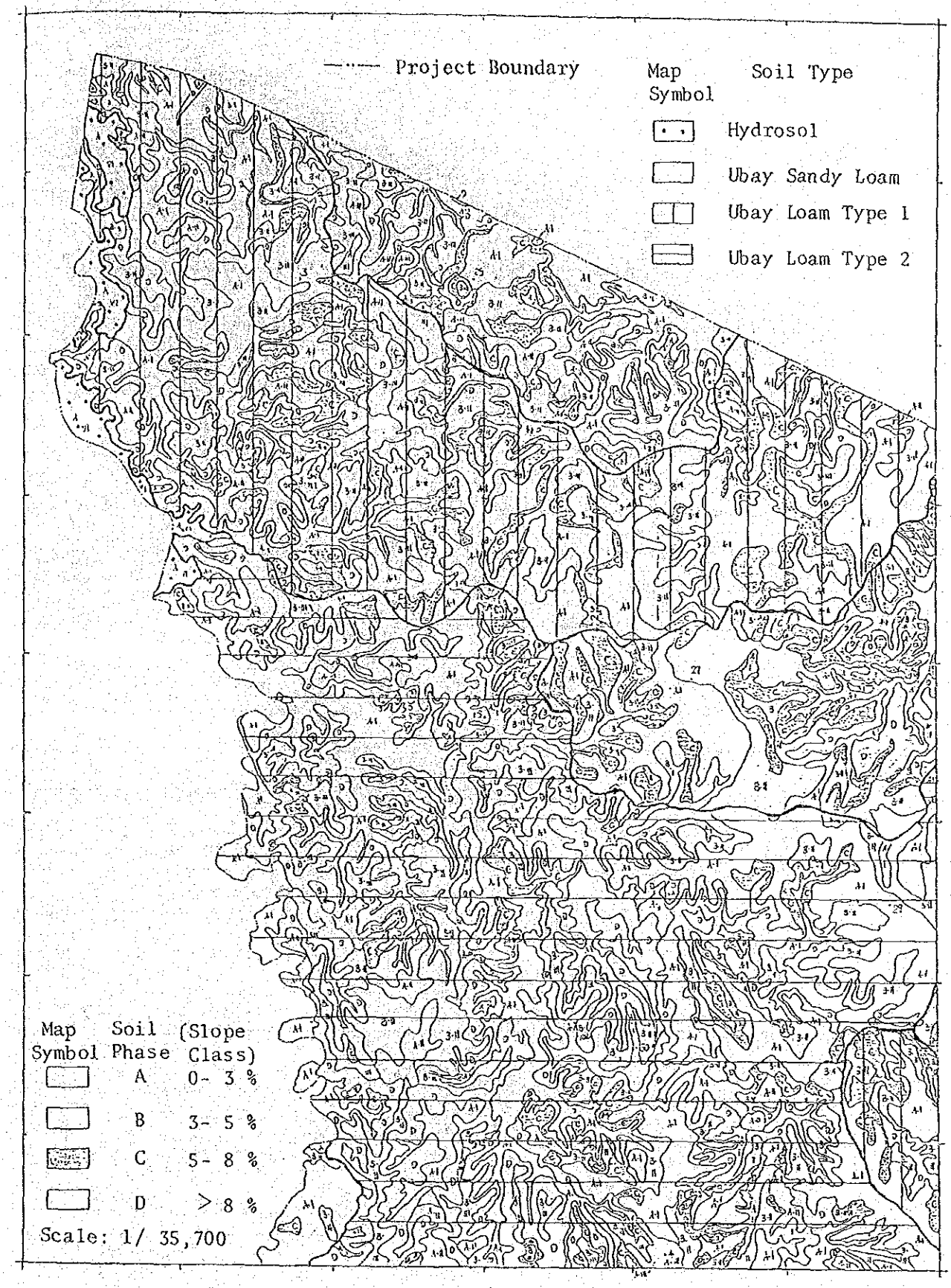


FIGURE D5-8 SOIL MAP OF THE PROJECT AREA - SHEET 1

(TRINIDAD AREA)

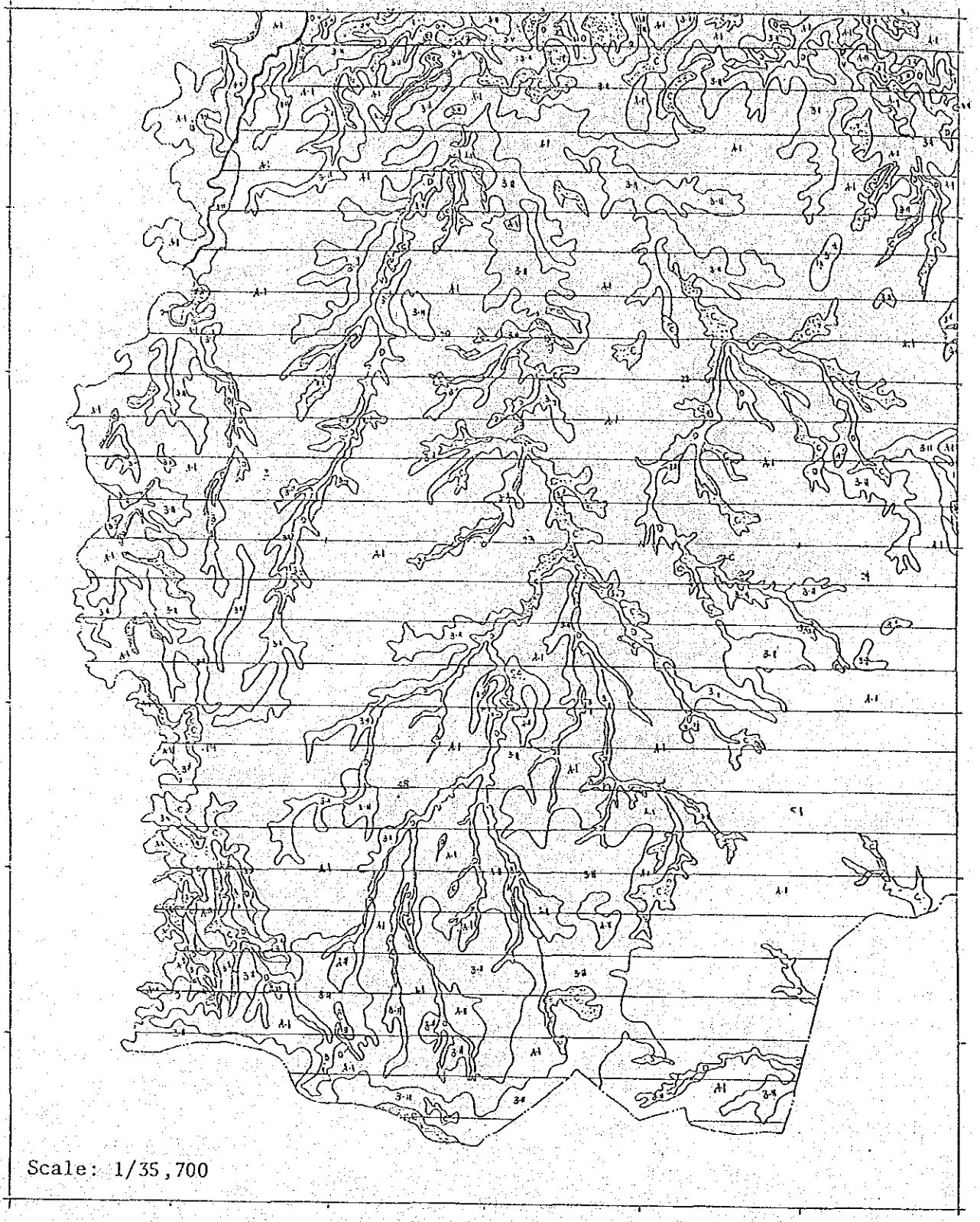


FIGURE D 5-9 SOIL MAP OF THE PROJECT AREA - SHEET 2
(SAN MIGUEL AREA)

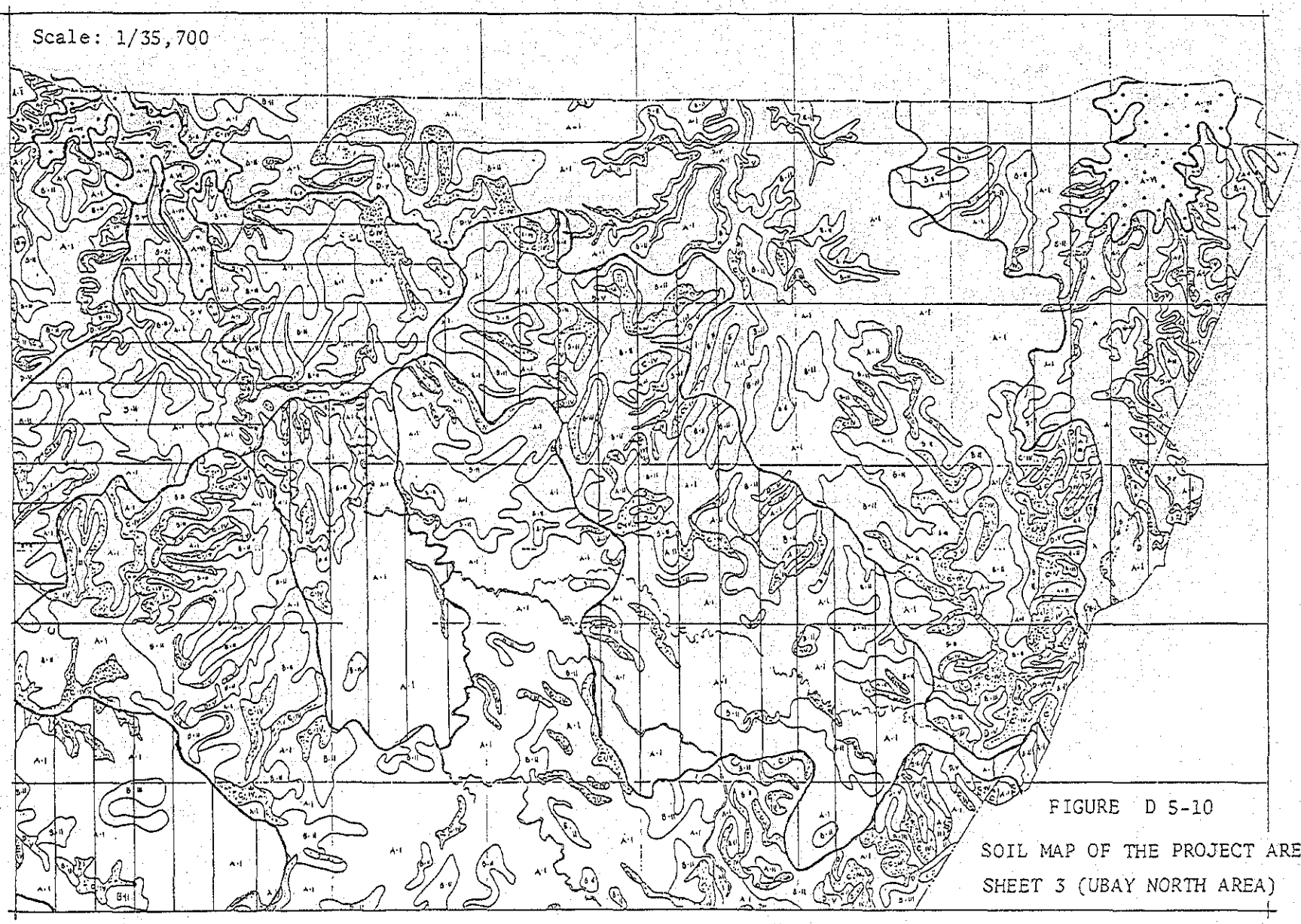
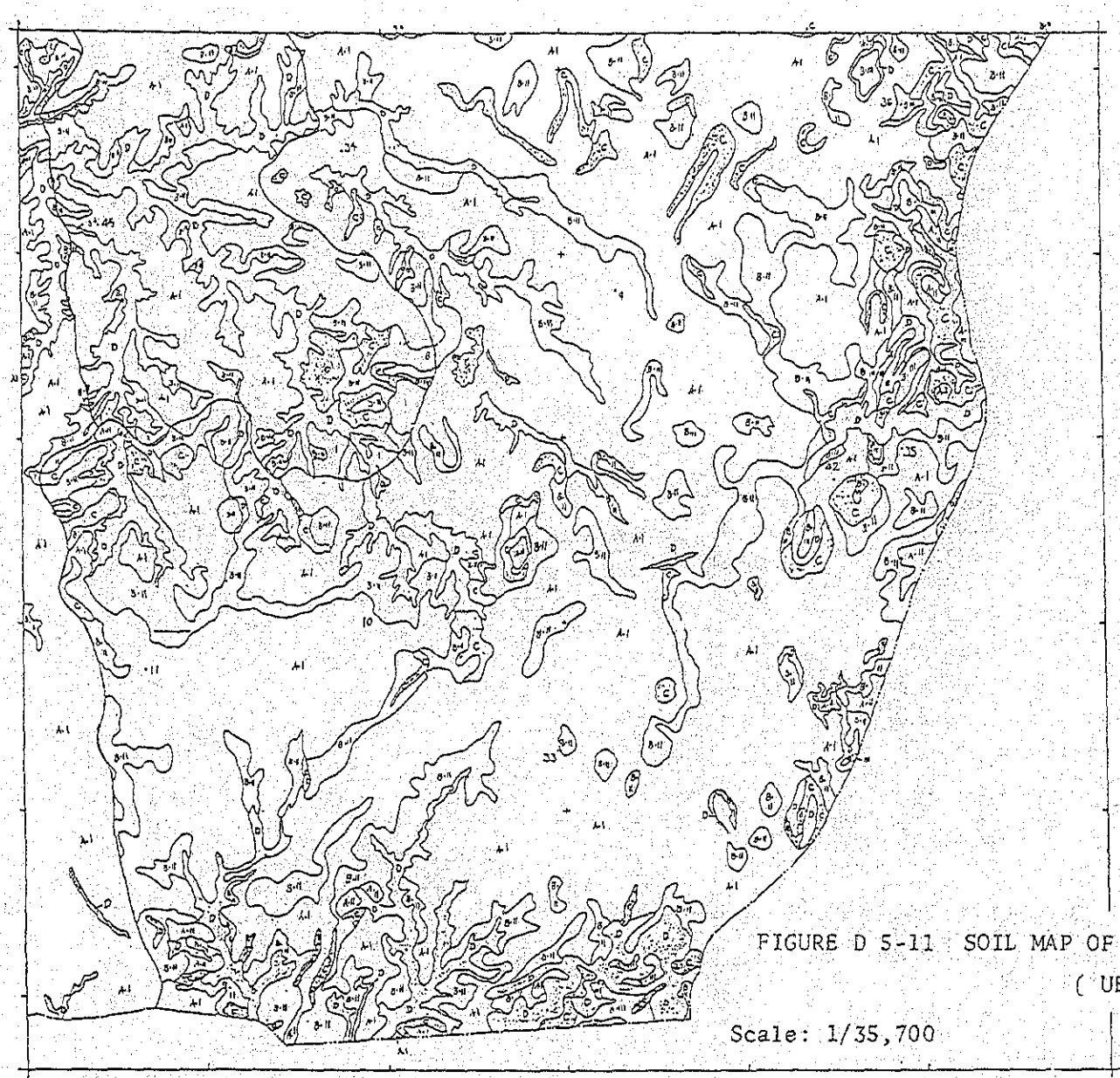
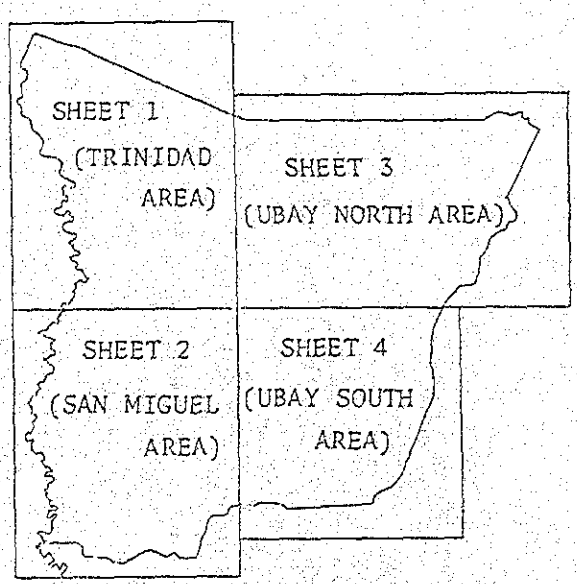


FIGURE D 5-10

SOIL MAP OF THE PROJECT AREA - SHEET 3 (UBAY NORTH AREA)





Scale 1:200,000

THE PROJECT AREA

FIGURE D 5-11 SOIL MAP OF THE PROJECT AREA - SHEET 4
(UBAY SOUTH AREA)

Scale: 1/35,700

CHAPTER VI LAND CLASSIFICATION

Land classification requires examination and appraisal of the physical and chemical characteristics of the land, which include soil properties and qualities of the topographic and drainage features.

6.1 Land Classification Method

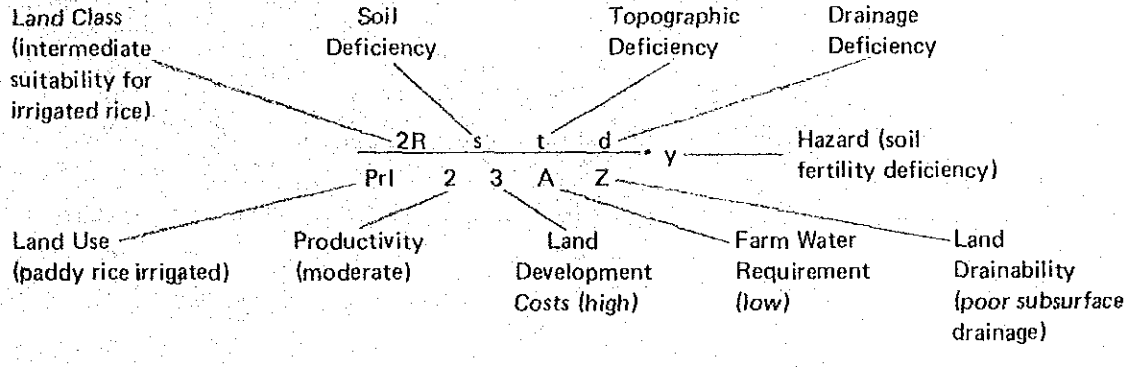
The classification method practiced in the Philippines has been patterned after the field and laboratory procedures employed at the Bureau of Reclamation, USDA, with some modifications to meet the local conditions.

6.1.1 Classification Specification

For gravity irrigation of the paddy field, the classification specification established by NIA in 1984 was somewhat modified according to the results of field investigation and analysis, as shown in TABLE D6-1. The major change is an increase in pH value (1:2.5) by 0.5 for each criterion. The revision is based on the comparison with those determined at 1:1 soil water ratio. Soil hardness of subsoil was newly used as an index for suitability in land reclamation. Some items such as salinity are omitted in the TABLE because of the least significance among the soils.

6.1.2. Classification Formula and Deficiency Symbols

Results of the land evaluation are expressed by special formula with symbols as given below:



Land classes and specific deficiency symbols pertaining to the project area are listed as follows:

a) Land class for wetland rice production

2R: moderately suitable for irrigated paddy rice

3R: marginally suitable for irrigated paddy rice

4R: unsuitable for irrigated paddy rice

6 : non-arable

b) Deficiency symbols

s--Soil deficiency

k--Restricted soil depth over sand, gravel or cobble

y--Soil fertility problem

t--Topography deficiency

g--Gradient or slope greater than optimum

j--Size and shape of the field

d--Drainage deficiency

c) Potentiality or development costs

First 1 - 3	Productivity, low to high
Second 1 - 3	Land development costs, low to high
A - C	Irrigation water requirement, low to high
X - Z	Drainability, good to restricted subsurface drainage

Class 4 is usually not set up because lands of this class have too serious deficiencies to be made to paddy field. In the project area, however, these lands have been sporadically used for upland crops and coconut though production is estimated very low. Therefore, this class may suggest future possibility of land use such as orchard, pasture and forest. Same land classes as for the paddy rice can be adopted for the upland crops except for the present paddy fields ranked at 2R, where subsurface drainage is moderately worse.

6.2 Results of Land Classification

6.2.1 Land class Grouping

With the specification and procedure described above, the lands of soil phase unit were subjected to class grading. Because of deviations in topography and soil deficiency, different class formulas were found even in one soil phase depending on the surrounding land conditions.

For examples, some narrow lands or ridge areas of Phase A and B on the rolling terrain area are rated at lower grades by one or two classes when they are surrounded by Phase C and D lands ranks of which are Class 3R and 4R, respectively. Such evaluation is based on results of the sampling survey on the relationships between topography and soil property. In this survey, the lands exampled above were found to have more serious limitations in soil depth and gravel appearance together with soil acidity.

So that for convenience of the land evaluation, many class grades were groupted into six groups, I to VI, as shown in TABLE D6-2.

6.2.2 Potential Area Under Irrigation System

Since the soils are overall poor in physical and chemical properties, no class 1R land was found in the project area. Extent of each class group was measured soil type- and phase-wise on every 100 ha grid of the topographical maps. The results are summarized in TABLE D6-3. Most parts of Phase A and B lands of Ubay soil types are rated to Group I and II, respectively. These are potential and moderately suitable areas for irrigation development, totaling to about 9,800 ha or 87 percent of the project area. In the gravity irrigation system, however, irrigable areas will be limited depending on their locations and canal alignments.

Based on these group evaluation detailed land class maps were drawn similarly as soil maps. Attached here with are the copies on a smaller scale which are presented in FIGURES D6-1, -2, -3 and -4.

TABLE D6-1 FEASIBILITY GRADE LAND CLASSIFICATION SPECIFICATION FOR GRAVITY IRRIGATION OF PADDY FIELD IN THE PROJECT AREA

Land Characteristics	Class 1R	Class 2R	Class 3R	Deficiency Symbol
Soils:				s
Texture: 0 - 30 cm	Loam to clay with fair tilth	Loam to clay	Loam to clay	f
Sub-surface	Silty clay loam to clay	Silty clay loam to clay	Silty clay loam to clay	f
Depth: To clean sand or Gravel	>90 cm	>45 cm	>45 cm	f,k
Cation Exchange Capacity: (0 - 30 cm)	>8 meq/100 g	4 - 8 meq/100 g	4 - 8 meq/100 g	f
Reaction: $_{p}H$ (1:2.5)	6.0 - 8.5	< 6.0 - >8.5	<6.0 - >8.5	f
Soil Hardness: Subsoil	<20	>20	>20	f
Topography:				t
Slope in General Gradient:	0 - 3 %	3 - 5 %	5 - 8 %	g,u
Field size or shape:	No restriction to cultivation or irrigation	Moderate restriction resulting from the irrigation surface feature	Moderate restriction resulting from the irrigation surface feature	j

TABLE D6-2 DOMINANT LAND CLASSES IN RELATION TO SOIL MAPPING UNIT AND THEIR GROUPING

Land Class Group	Land Class Formula	Soil Type-Phase
I	2Rs / 21AY·y	UL-A
	2Rs / 21BY·y	US-A
II	2Rs / 22AY·y	UL-A
	2Rs / 22BY·y	US-A
	2Rst / 22AY·gy	UL-B
	2Rst / 22BY·gy	US-B
III	3Rs / 31AY.y	UL-A
	3Rs / 31BY·y	US-A
	3Rst / 32AY·gy	UL-B
	3Rst / 32BY·gy	US-B
IV	3Rst / 33AY·gjy	UL-C
	3Rst / 33BX·gjy	US-C
V	4Rst / 33AY·gjky	UL-D
	4Rst / 33BX·gjky	US-D
VI	6 sd	Hydrosol

Note: Refer to Table D6-1. Land class groups were used as the map symbols of the land class map attached to this report.

Soil Type: UL--Ubay Loam, US--Ubay Sandy Loam
Soil Phase: A (0-3%), B (3-5%), C (5-8%), D (>8%) (slope grade)

TABLE D6-3 AREAS OF LAND CLASSES IN THE PROJECT AREA WITH SOIL TYPE AND PHASE

Land Class Group	Hydrosol	Ubay Sandy Loam				Sub-	Ubay Loam Type 1				Sub-	Ubay Loam Type 2				Sub-	Grand	
	A	A	B	C	D	Total	A	B	C	D	Total	A	B	C	D	Total	Total	%
I	-	2,611	-	-	-	2,611	1,444	-	-	-	1,444	3,001	-	-	-	3,001	7,056	55.5
II	-	37	1,008	-	-	1,045	82	481	-	-	563	105	1,002	-	-	1,107	2,715	21.4
III	-	21	84	-	-	105	11	116	-	-	127	42	142	-	-	184	416	3.3
IV	-	-	-	452	-	452	-	-	234	-	234	-	-	308	-	308	994	7.8
V	-	-	-	-	357	357	-	-	-	322	322	-	-	-	690	690	1,369	10.8
VI	150	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	150	1.2
Total	150	2,669	1,092	452	357	4,570	1,537	597	234	322	2,690	3,148	1,144	308	690	5,290	12,700	100
%	1.2	21.0	8.6	3.6	2.8	36.0	12.2	4.7	1.8	2.5	21.2	24.8	9.0	2.4	5.4	41.6	100	

NOTE: Soil Phase (Slope Grade): A (0-3%), B (3-5%), C (5-8%), D (>8%)

Land Class Group	Land Class Formula*	Suitability for Rice
I	2Rs/21AY·y - /21BY·y	Moderately suitable
II	2Rs/22AY·y or BY·y - 2Rst/22AY or BY·gy	Slightly suitable
III	3Rs/31AY·y or BY·y - 3Rst/32AY·gy or BY·gy	Marginally suitable
IV	3Rst/33AY·gjy - /33BX·gjy	Not suitable
V	4Rst/33AY·gjky - /33BX·gjky	Not suitable
VI	6 sd	Non arable

* Refer to the Philippines Recommends for Irrigation Water Managerment 1978, Vol. 1 Lowland Rice Conditions, page 98-102.

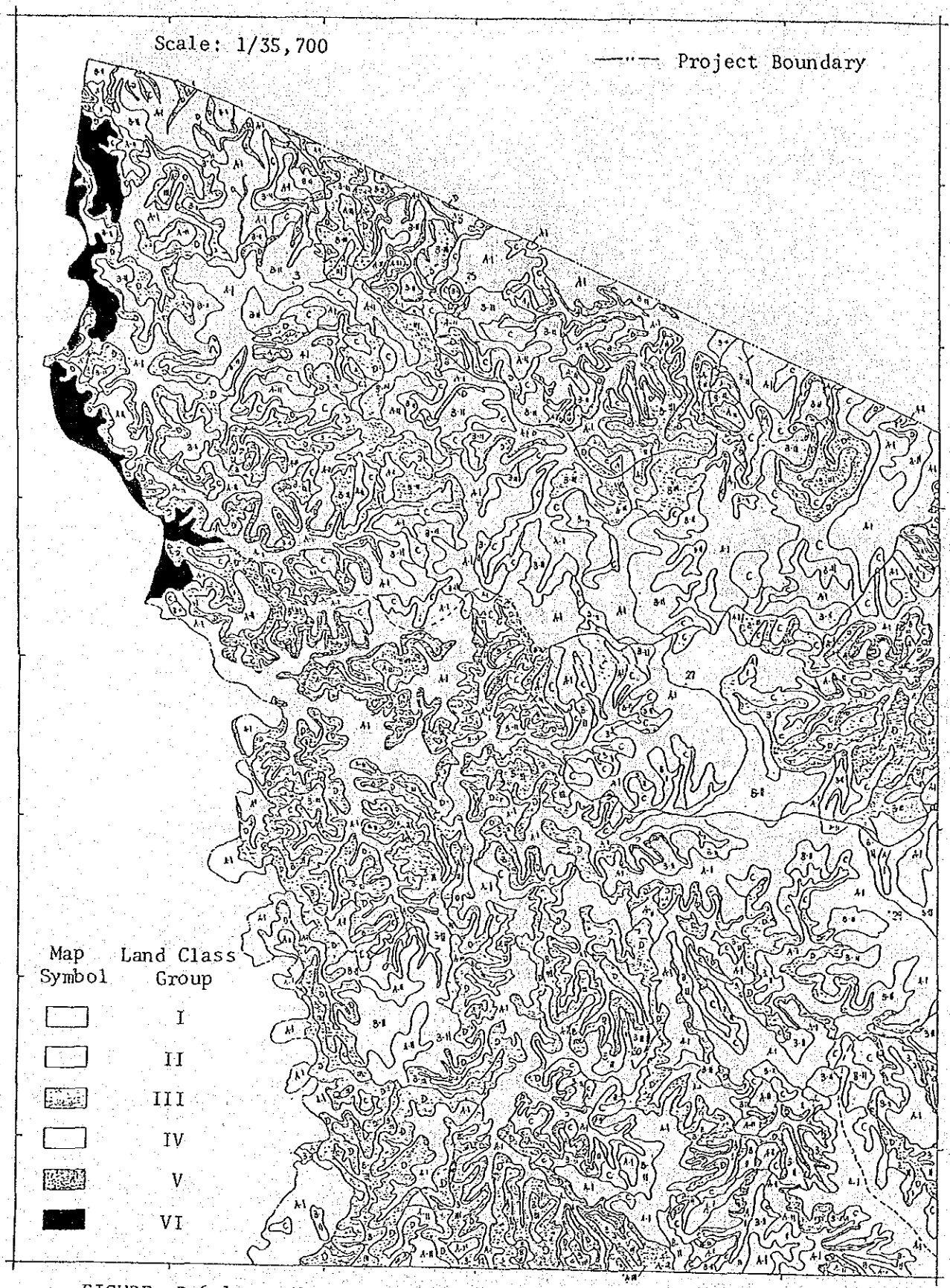


FIGURE D 6-1 LAND CLASS MAP OF THE PROJECT AREA - SHEET 1

(TRINIDAD AREA)

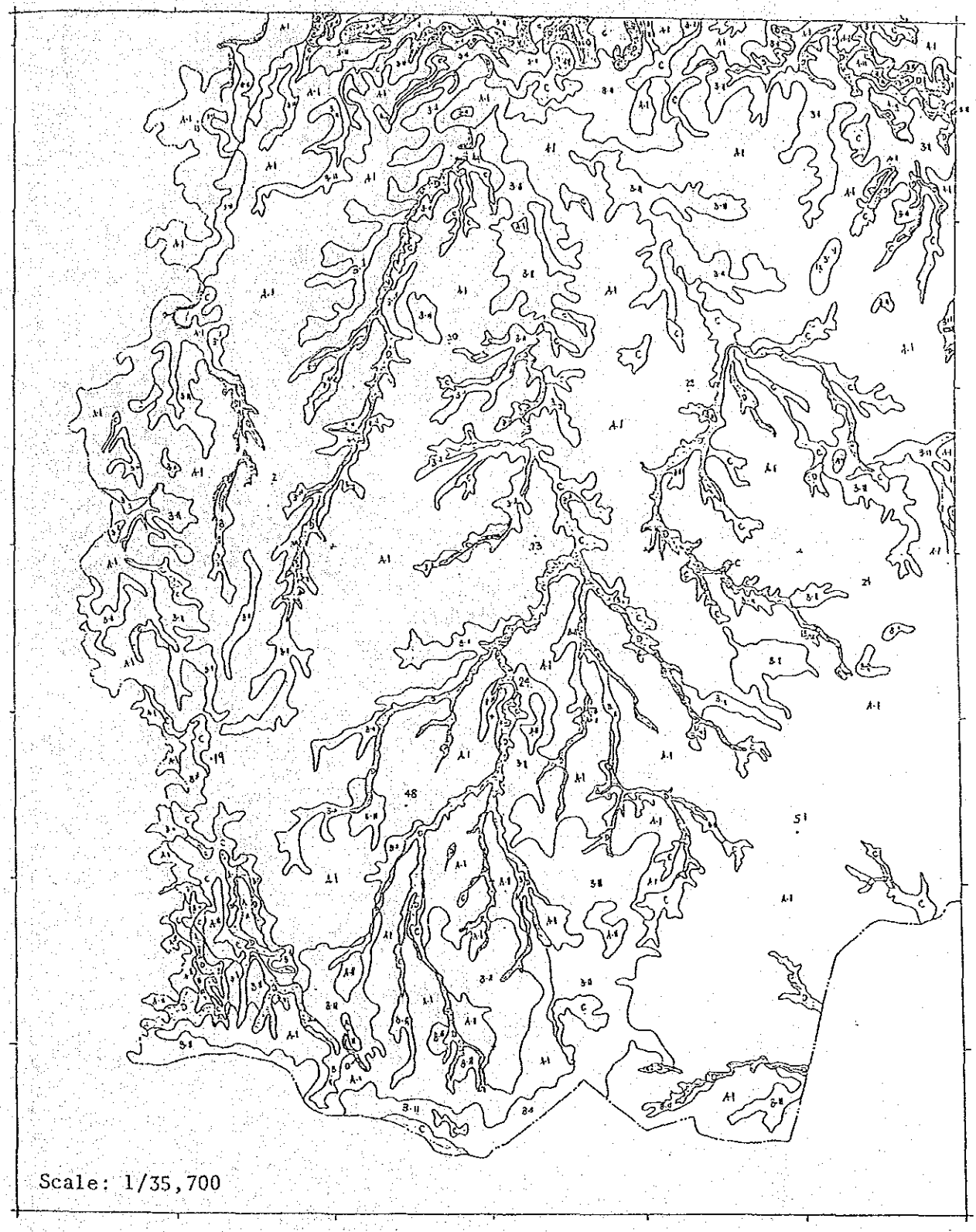


FIGURE D 6-2 LAND CLASS MAP OF THE PROJECT AREA - SHEET 2
(SAN MIGUEL AREA)

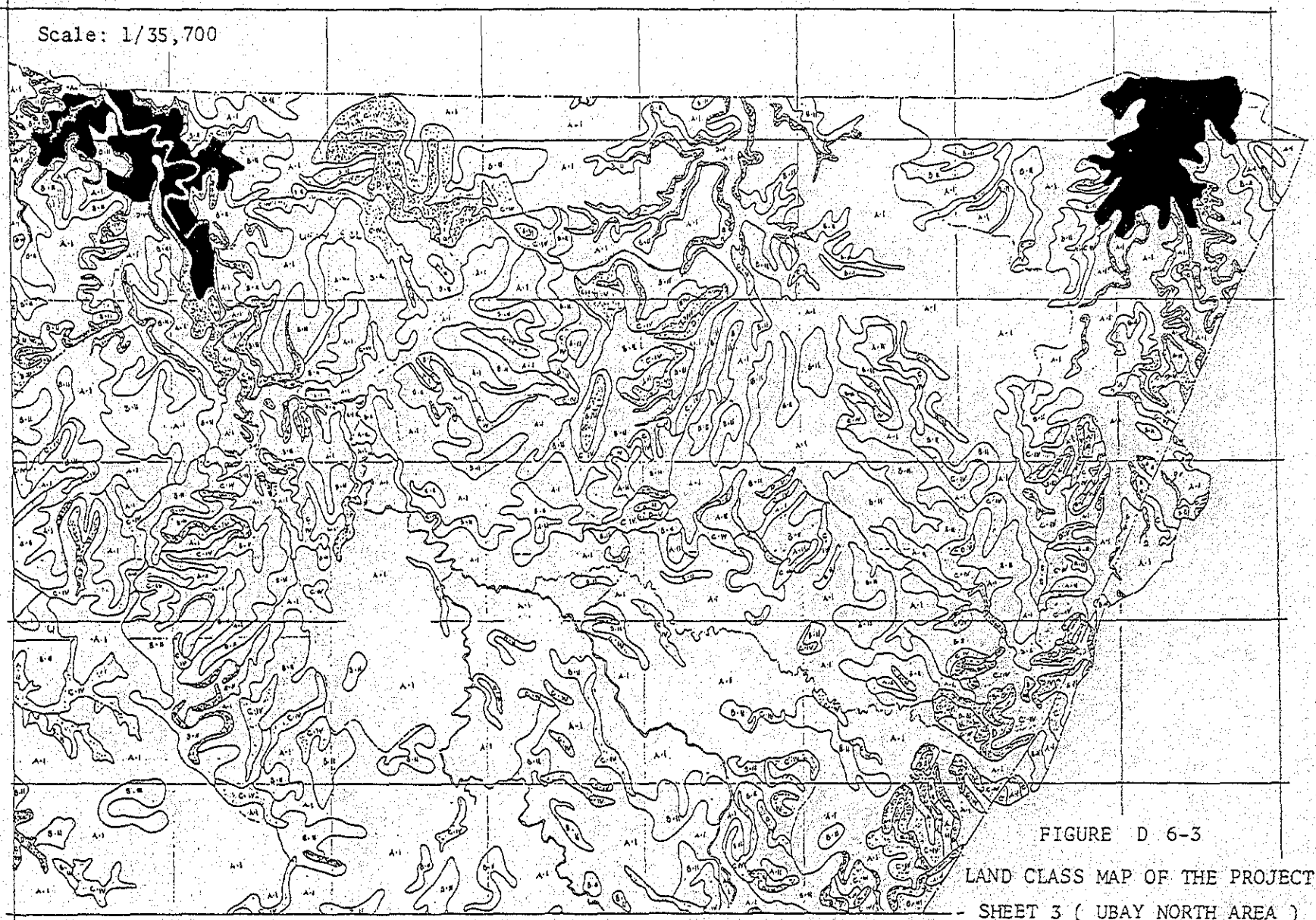
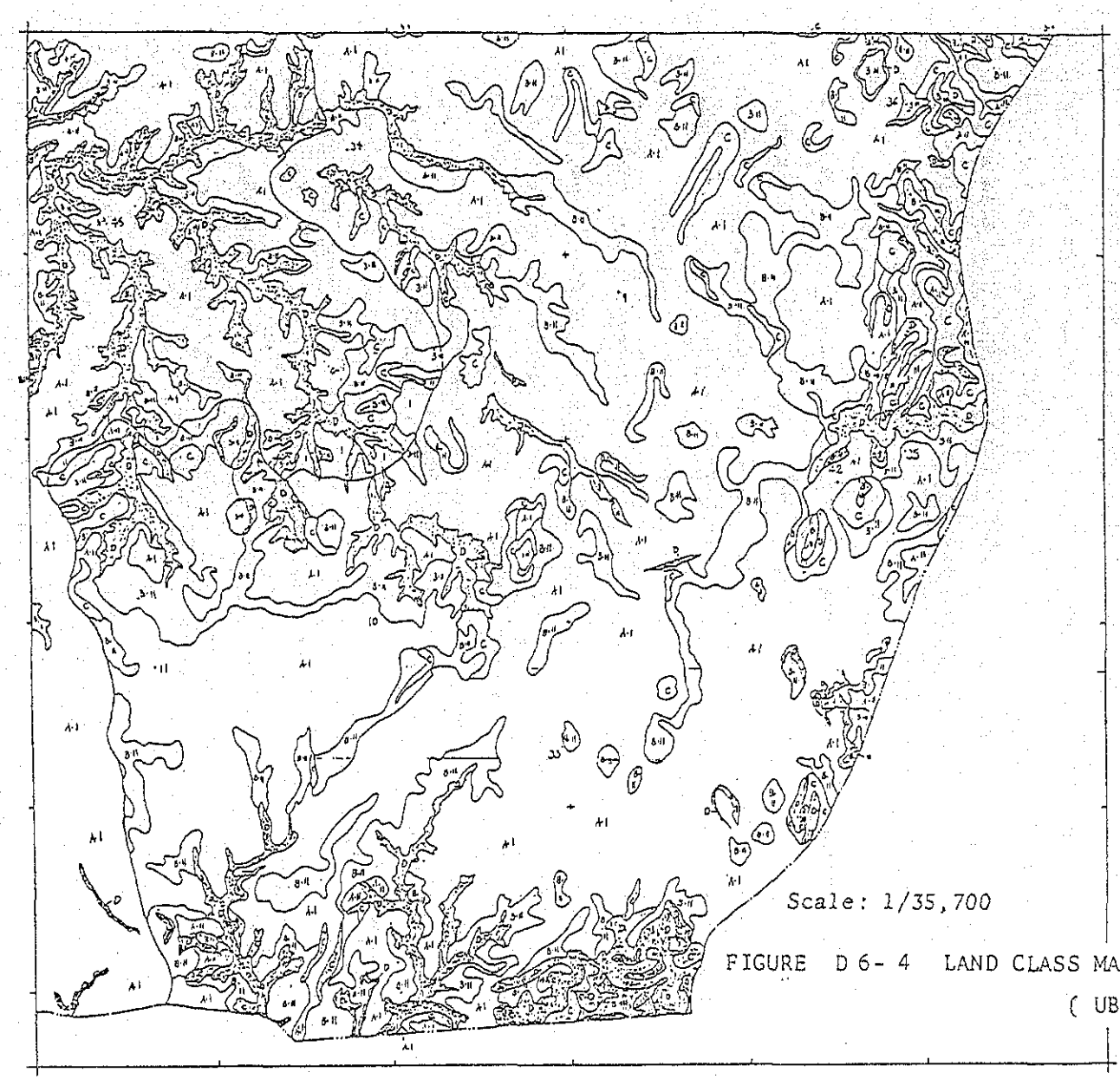
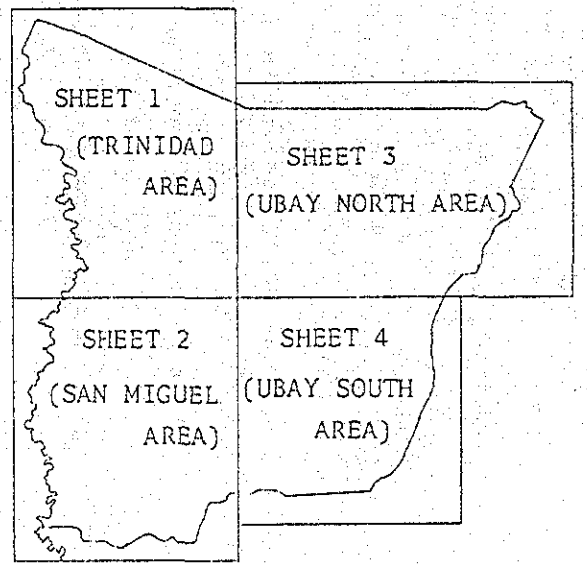


FIGURE D 6-3

LAND CLASS MAP OF THE PROJECT AREA

- SHEET 3 (UBAY NORTH AREA)





Scale 1:200,000

THE PROJECT AREA

Scale: 1/35,700

FIGURE D 6- 4 LAND CLASS MAP OF THE PROJECT AREA - SHEET 4
(UBAY SOUTH AREA)

CHAPTER VII PRESENT LAND USE

7.1 General Land Use and Area

Agriculture in Bohol Island was originally nomadic in nature. The postwar strides in agriculture was slow and intertered with several factors such as the lack of farm implements, work animals, seeds and capital. As of 1978, however, 30 percent of the total area of the Province were planted to temporary and permanent crops.

Area of the Phase II was likewise delayed in agricultural development. Attention of the farmers to the mechanization of their farms has just started though the existing tenure status and lack of irrigation facilities are still obstacles. No specific land use other than agriculture can be observed except for small scaled fishery along the sea coast.

Present land use was surveyed in the course of soil survey using the same topographical maps. Among various lands only paddy rice fields and upland crop fields seemed to undergo slight changes as compared with the land use delineated in the maps which were produced using aerial photographs flown in 1970. These fields are partly newly developed while partly left idle. According to the measurement survey on the model areas, a small increase in paddy field was noted presumably due to recent intention of the farmers. As a whole, however, the variations in land use area were estimated to be negligible. Area measurements were then conducted ot each land use delineated in details on the maps. The grid method was used on every 100 ha.

The following is the hectarage summary of the present land use:

Land Use	Hectares	Percent
Paddy Rice	2,180	17.2
Upland Crops	2,330	18.3
Coconut	1,560	12.3
Open Grassland	6,280	49.4
Forest	210	1.7
Mangrove, Nipa	130	1.0
Others*	10	0.1
Total	12,700	

* Including marsh, impounding reservoir, fish pond, and public area.

Area breakdown by municipality is given in TABLE D7-1. Among municipalities, San Miguel area has been least developed because of the prevailing open grasslands as well as topography and water resource deficiencies. In Trinidad and Ubay around 20 percent of the lands are used for paddy rice non-irrigated and a little more than 50 percent area planted to other crops including coconut. Most of the scattered residences were included in the coconut land. The project area is largely characterized by vast grasslands and few forests.

7.2 Vegetations

Wild grasses mainly consisting of graminaceous species cover almost all lands that are not utilized for any agricultural use than grazing though limited on few portions. Many of the open grasslands are predominantly occupied by a single vegetation, cogon grass (Imperata cylindrica). At least one third of these lands would be able to be reclaimed for paddy rice or upland crops under the systematic supply of irrigation water so far as the land slope is less than three percent.

Nevertheless reclamation of the grasslands will need special care for gravel layer management and erosion control.

There is no natural coniferous forest or reforestation. Some broad leaf forests like shrub type are found in scattered patches along creeks, rivers and other drainage ways, though their extents are very small, occupying less than two percent in total.

Mangrove and nipa are still thriving on the elevated lands stretching from the coastal swamps. The dominant trees found in magrove area are bakawan (Phizophora mucronata Lam) and Api-api (Avecinnia marina Forak). A few portions of the area have been converted to fish ponds. These are included in others together with marsh and small reservoirs, occupying only 10 ha or 0.1 percent of the total area.

7.3 Crops

Rice is grown over a wide range of topographic features from flat alluvial valleys to terraced rolling lands where small stream or spring water is available. The paddy fields are rainfed for the wet season rice, but most of them are transplanted even for the dry season in spite of almost no irrigation service system, expecting residual soil moisture and unexpected rainfall during the season. Due to abnormality in the annual precipitation direct seeding method is not a favorite practice especially for the dry season rice. Anyway, wetland rice is the first crop in terms of area coverage although good yields cannot be expected with the prevailing worse soil conditions unless remedy for soil acidity and proper fertilization are practiced.

Upland fields extent of which is compared with that of paddy fields are mainly planted to corn, cassava, upland rice and sweet potato. Peanut and other legumes are often planted in small areas. These are diversified each other including other vegetables for domestic consumption. The fields are distributed at higher portions than the paddy field, where the lands are slightly undulating. Therefore, their yields are very low under less soil fertility and water regime than those of lowland rice fields.

Coconut is the representative permanent crop in the project area, being grown even on the steeper lands than the upland fields. This crop is predominant especially in the vicinity of homestead area, and very important to sustain farmers' nourishment and economy. The extent ranges from 10 to 18 percents among municipalities.

TABLE D7-1 PRESENT LAND USE IN HECTARAGE WITH MUNICIPALITY IN THE PROJECT AREA

Land Use	Trinidad		Ubay		San Miguel		Total	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Paddy rice	588	20.4	1,214	19.9	378	10.2	2,180	17.2
Upland crops	377	13.0	1,350	22.1	603	16.3	2,330	18.3
Coconut	506	17.5	647	10.6	407	11.0	1,560	12.3
Open grassland	1,312	45.4	2,796	45.8	2,172	58.5	6,280	49.4
Forest	28	1.0	32	0.5	150	4.0	210	1.7
Mangrove, Nipa	78	2.7	52	0.9	0	0	130	1.0
Others*	1	0	9	0.2	0	0	10	0.1
Total	2,890	22.8	6,100	48.0	3,710	29.2	12,700	100
%	22.8	100	48.0	100	29.2	100	100	-

* Including marsh, impounding reservoir, fish pond, and public area.

CHAPTER VIII LAND USE CATEGORIES

Categorization of land use will provide informations with which to differentiate the agricultural characters in the area and to inventigate how to improve and/or develop the lands into the favorable status in future.

8.1 Results of Former Survey

Bohol Agricultural Land Resources Appraisal Project (1980) identified six major land use categories by estimating percentages of crops, vegetations and urban areas based on the field observation with the aid of topographic data. Each category was further divided into several types according to the dominant land use and relative percentages among the other land uses.

FIGURE D8-1 is copied from the report to show the classified categories and types around the project area. Three categories that are divided into six types are recognized in the project area.

8.2 Results of Present Survey

In the present survey, the percentages in land use were first calculated on every grid of 100 ha in the topography maps using area-measurement data described in Chapter VII.

The results were then categorized into types according to the forementioned process. Average percentages of types were found as listed in TABLE D8-1. Distribution of these types is presented in FIGURE D802. More than half of the grids (100 ha) gives new types, percentages of which are fairly different from those estimated by the Bohol Appraisal Project (1980). Main reasons for the difference are as follows:

a) There exists no paddy rice irrigated.

b) Open grasslands prevail in more extent in agricultural area.

c) Extents of shrubs are negligible at present.

d) Typical wetland area is very rare in the project area.

As a result, much different categorical map from FIGURE D8-1 was produced by delineating these land use types as presented in FIGURE D8-3. Agricultural areas are dominantly extending in Trinidad and Ubay where paddy rice, upland crops and coconut are playing a main role in land use. Categorical land use area and their percentages are summarized follows:

Land Use Category		Paddy Rice	Upland Crops	Coconut	Grass-land	Forest	Mangrove, Nipa	Total	%
Agricultural area	ha	1,320	1,280	840	1,850	--	--	5,290	41.7
	%	25	20	20	35	--	--	100	--
Wetland area	ha	30	20	60	70	--	130	310	2.4
	%	10	5	20	23	--	42	100	--
Grassland/ Agr. area	ha	690	930	530	3,000	--	--	5,160	40.6
	%	16	18	16	50	--	--	100	--
Grassland area	ha	140	100	130	1,360	210	--	1,940	15.3
	%	7	10	10	70	3	--	100	--
Total	ha	2,180	2,330	1,560	6,280	210	130	12,700*	100
	%	17	18	13	49	2	1	100	--

* 10 ha short correspond to the waste lands

FIGURE D8-4 illustrates clearly these categories by diagraphic method. Appeoximately 60 percents of the project area are considered not sufficiently developed for agricultural production. Especially the grassland are occupying almosts 56 percents should be subjected to further land reclamation in the future plan.

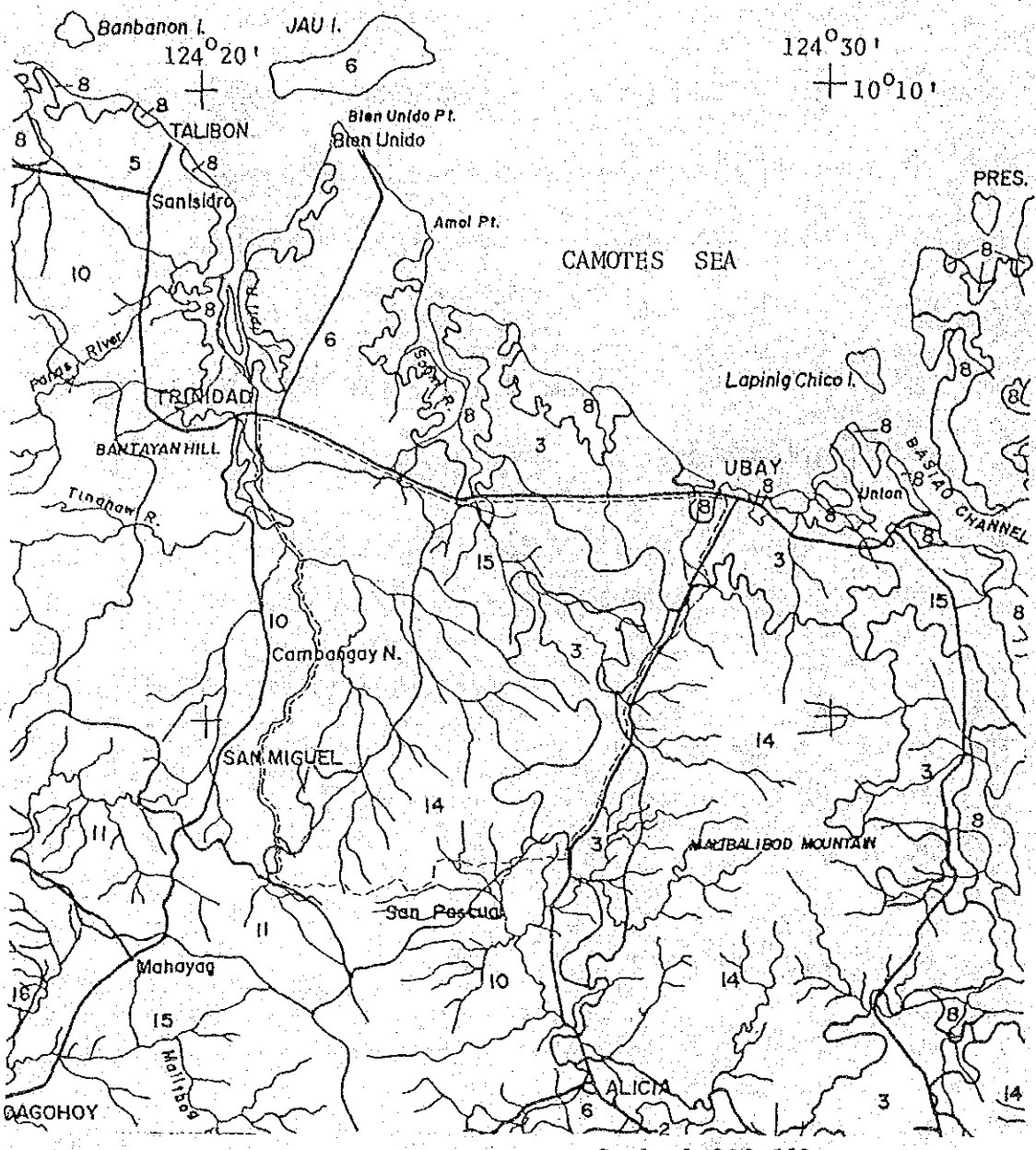
TABLE D8-1 AREA PERCENTAGES IN LAND USE CATEGORIES AND TYPES FOUND IN THE PROJECT AREA

(Unit: %)

Agricultural Category	Type No.	Paddy Rice** n	Paddy Rice** i	Upland Crops	Coconut	Open Glassland	Mangrove Nipa	Forest	Shrubs	Total
Agricultural Area	3*	40	2	5	15	22	-	5	11	100
	3	30	-	25	20	25	-	-	-	100
	4*	20	10	15	18	18	-	9	10	100
	4	20	-	15	22	43	-	-	-	100
	6*	12	1	3	45	21	-	5	15	100
	6	18	-	3	43	36	-	5	-	100
Wetland Area	8*	-	-	-	1	-	93	1	5	100
	8	10	-	5	20	23	42	-	-	100
Grassland/ Agricultural Area	10*	10	5	5	8	55	-	5	17	100
	10	22	-	20	8	50	-	-	-	100
	12*	1	-	5	35	30	-	11	18	100
	12	10	-	20	25	45	-	-	-	100
	13*	10	-	19	10	50	-	8	3	100
	13	16	-	24	12	48	-	-	-	100
Grassland Area	14*	4	-	2	4	74	-	5	11	100
	15*	3	2	4	10	64	-	5	12	100
	15	10	-	15	7	68	-	-	-	100

* These types give percentages estimated by Bohol Agricultural Land Resources Appraisal Project (1980). Among them, forest includes corn, cassava and fruit trees, and wastland and others are added to shrubs.

** n--non-irrigated; i--irrigated

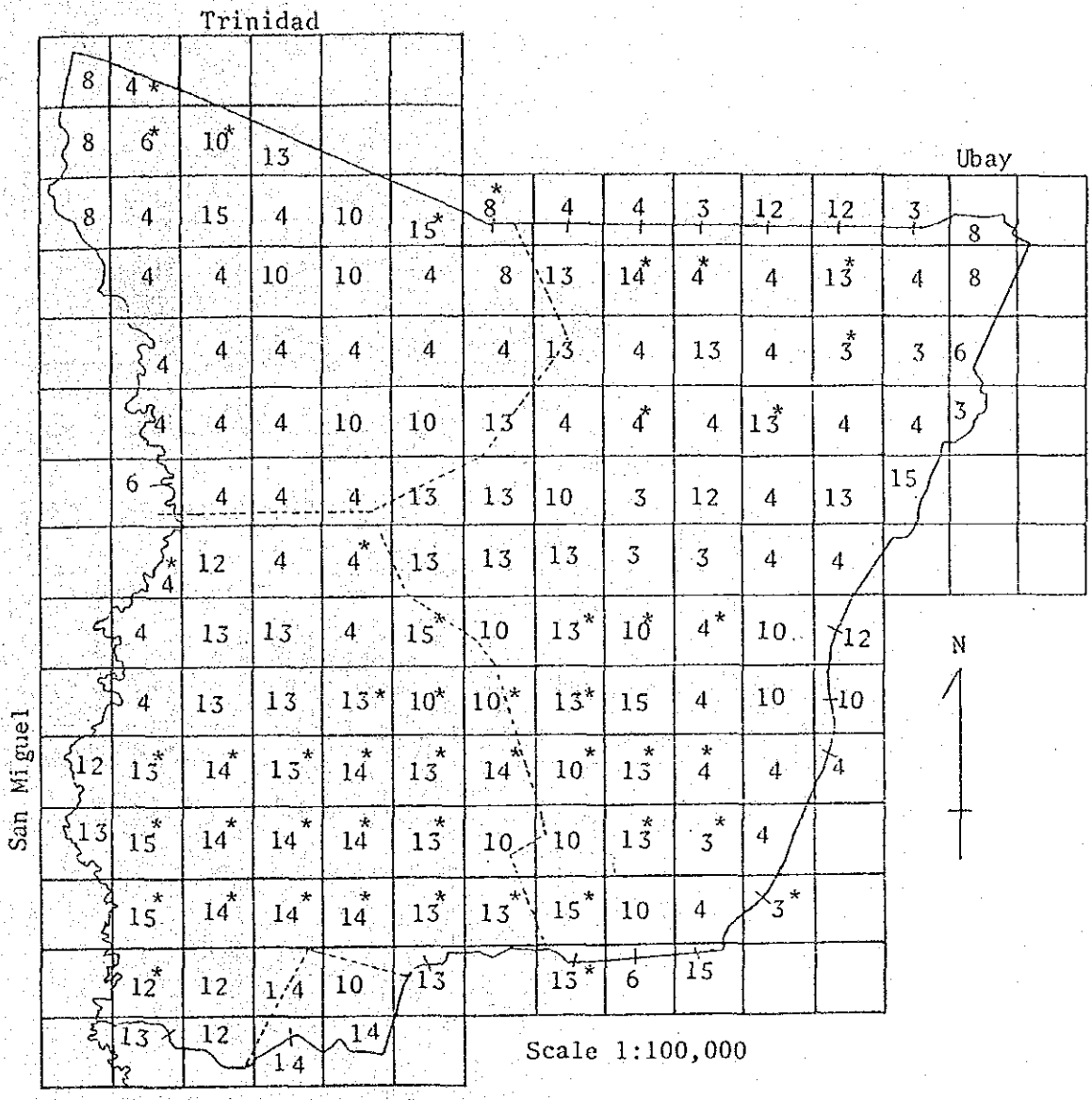


LEGEND:

Land Use Category	Symbol No.	Dominant Land Use (%)
Agricultural Area	3	Paddy rice non-irrigated (40)
	4	Ibid. (20)
	5	Coconut (75)
	6	Ibid. (45), Grassland (21)
Wetland Area	8	Mangrove (70), Nipa (28)
Grassland/ Agricultural Area	10	Grassland (55), Paddy rice non-irrig. (10)
	11	Shrubs (42), Grassland (20), Coconut (17)
Grassland Area	14	Grassland (74)
	15	Grassland (64), Shrub (12), Coconut (10)
Wooded Area	16	Secondary forest (15), Shrub (30), Grassland (35)

Source: Bohol Agricultural Land Resources Appraisal Project, Technical Report No. 4 (1980)

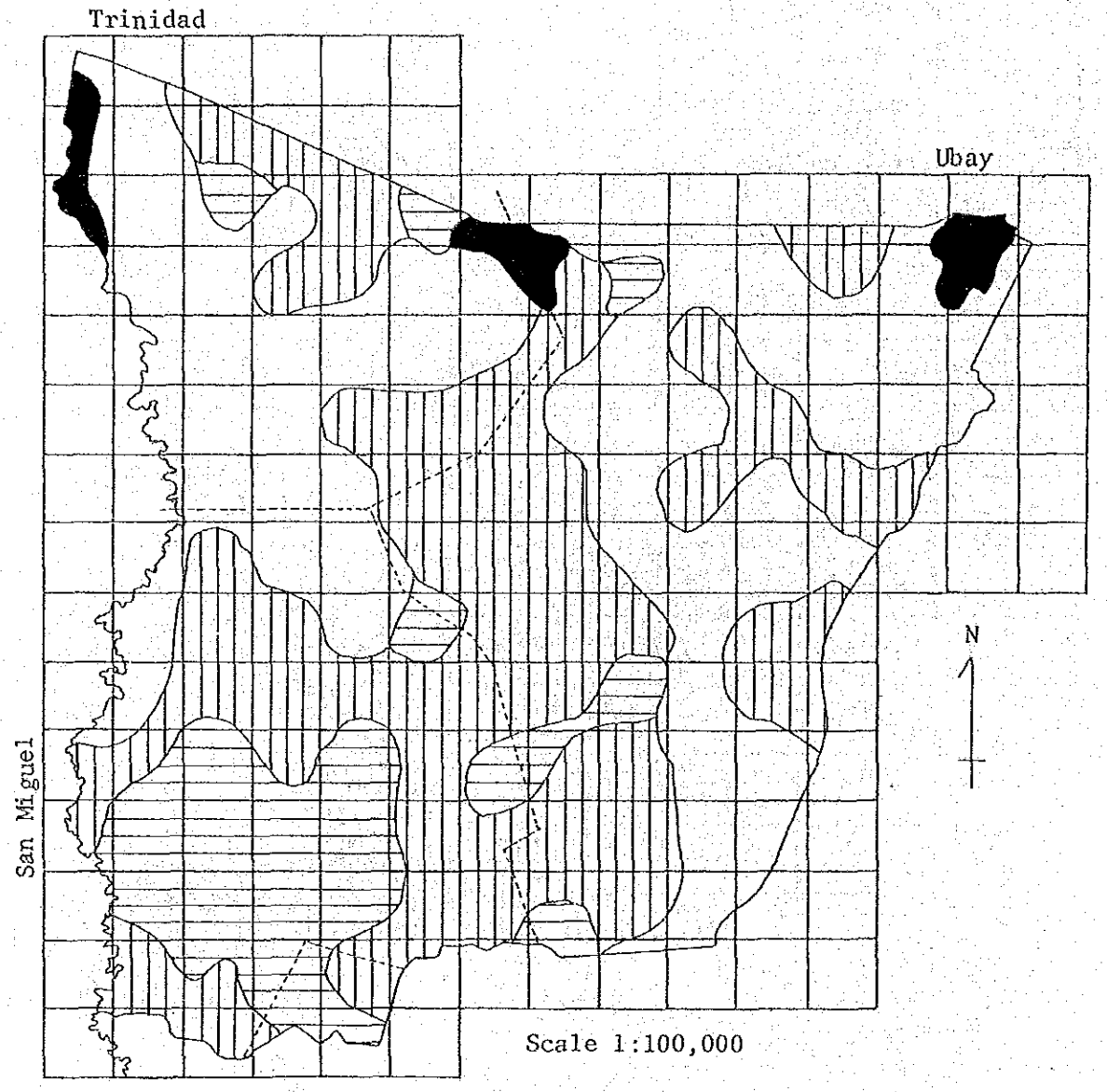
FIGURE D 8 - 1 LAND USE CATEGORIES AROUND THE PROJECT AREA (1980)



LEGEND:	Land Use Category	Dominant Crops	Type No.
I.	Agricultural Area	Rice, Coconut	3*, 3, 4*, 4
		Coconut	6*, 6
II.	Wetland Area	Mangrove, Nipa	8*, 8
III.	Grassland / Agricultural Area	Rice, Upland crops, Coconut (Grassland <55%)	10*, 10, 12*, 12, 13*, 13
IV.	Grassland Area	(Grassland >70%)	14*, 14
		(Grassland >55%)	15*, 15

* Similar types as identified by Bohol Agricultural Land Resources Appraisal Project (1980)

FIGURE D 8 - 2 DISTRIBUTION OF LAND USE CATEGORIES AND TYPES IN GRIDS (100 ha) OF THE PROJECT AREA



LEGEND: Map Symbol	Land Use Category	Dominant Crops
	Agricultural Area	Rice, Upland crops, Coconut
	Wetland Area	Mangrove/Nipa
	Grassland / Agricultural Area	Rice, Upland crops, Coconut (Grassland<55%)
	Grassland Area	(Grassland > 55%)

FIGURE D 8 - 3 CATEGORICAL LAND USE MAP OF THE PROJECT AREA

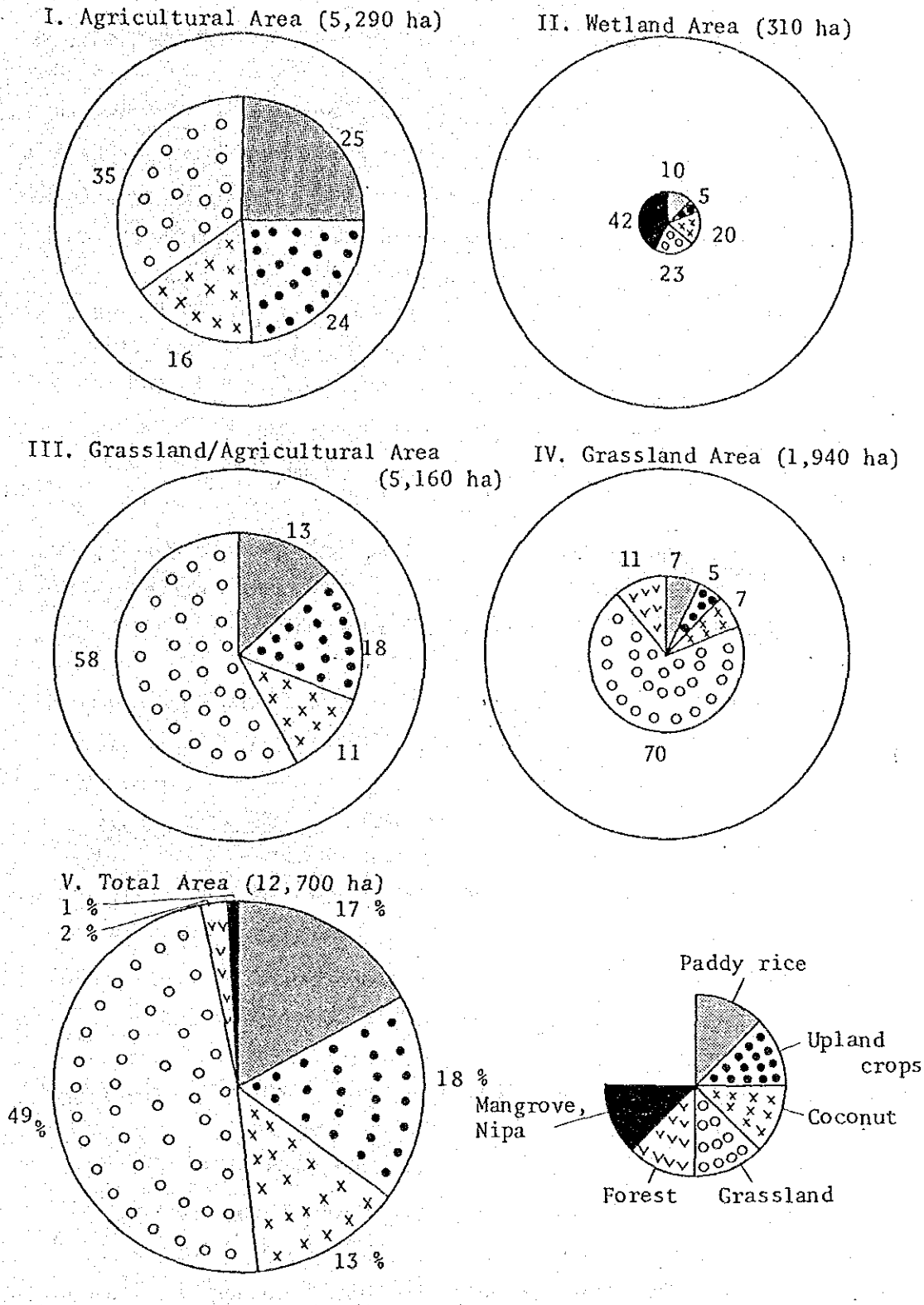


FIGURE D 8 - 4 DIAGRAPHIC LAND USE CATEGORIES AND THEIR PERCENTAGES IN THE PROJECT AREA

CHAPTER IX SOIL AND LAND DEVELOPMENT PROBLEMS AND RECOMMENDATIONS

9.1 Soil Problems and Its Improvement

Because of the sandy texture and moderately developed structure of the surface and subsurface layers the soils in the project area are generally good in internal drainage. Nevertheless, their chemical properties are not so favorable for plant growth including the other poor physical properties. Recommendations for soil improvement will be described below.

9.1.1 High Gravel Content and Soil Compaction

When hard gravel content of subsoil is less than 40 percent on weight basis, the land can be developed to crop field, since gravels are so small as less than one centimeter in diameter.

Deep ploughing is recommended for soil compaction where soil hardness exceeds 20 in index. In case of paddy field the subsoil gravels will sink to the lowest portion with repeated ploughing and puzzling.

9.1.2 Strong Acidity and Salinity

Remedy for soil acidity is of first importance in most of the project area. Pulverized calcium hydroxide or calcium carbonate is usually used for this purpose. These materials can be expected to be produced in the Island since there are the stratums of coral and marbly limestones.

The dose will range from one to five tons per ha, but must be determined area wise by means of the laboratory and field test. Most recommendable amendment is dolomite which can supply magnesium as well as calcium, though its production is uncertain in the Island.

Salinity is a serious hazard in the flat tidal areas when the lands are consolidated to fish pond or paddy field. For the latter development, a repeated leaching treatment is necessary to reduce salinity below four mmhos in the saturated water extract of the soil.

9.1.3 Low Fertility and Nutrient Deficiency

Soil fertility is resulted from endowment with available nutrients in addition to the soil depth that is physically good for root growth. As was pointed out already, the soils in the project area are deficient largely in phosphorus and potassium.

To realize higher yields of crops, 60 to 120 kg of P_2O_5 will be needed depending on the deficiency rate of phosphorus. Increase in nitrogen fertilizer use will give the cumulative effect with phosphate fertilizer. Potassium deficiency would not be so severe because this element can be expected from natural resources such as weathering of the parent soil materials and stream water.

So far as strong acidity and low base saturation are concerned, the soils of Ubay series resemble to volcanic ash soil, the most extensive in Japan. Therefore, emphasis is given on the use of fused magnesium phosphate. This is an ideal fertilizer for remedy of soil acidity and base deficiency as well though the unit cost is higher than the other phosphate fertilizers.

Another fertilizable method is to insert green manure crops of legume or gramineae into the rotation system. This method has been believed quite effective not only in increasing nutrients but also in improving physical conditions of the soil.

9.2 Land Development

9.2.1 Proper Land Use

The land must be developed properly according to its land class decided by soil characteristics and surrounding conditions. Suitable land use in the project area shall be preferably selected as ollows:

Land Class Groups	Land Class*	Land Use
I	2Rs (2)	Paddy rice
II	2Rs-2Rst (2)	Paddy rice-Upland crops
III	3Rs-3Rst (3)	Upland crops-Orchard
IV	3Rst (3)	Orchard-Pasture
V	4Rst (4)	Non-use or Pasture or Forest
VI	6sd	Non-arable

* Class for upland crops is given in parenthesis.

9.2.2 Farm Size and Erosion Control

Farm plot size is limited with the land classes more than group II depending on the depth of gravel layer and slope gradient. In most cases, terraced plot making would be indispensable. The terracing should be worked along the contour lines of the sloping land. This is very important for protecting erosion. Open grasslands are now completely covered with wild grasses which enable to minimize the soil erosion. Therefore, when these lands are developed, care shall be taken not only to plow along the contour lines but also to leave a part of the grassland as a protection zone between the farm plots.

9.3 Investigation and Field Trials for Enhanced Crop Production

9.3.1 Investigation on Minor Elements

Including zinc problems, the other minor elements such as manganese and iron should be investigated from the viewpoints of nutrient deficiency and excess as well. The investigation shall

begin with laboratory analysis of the soil samples collected soil-typewise from the project area. Based on the analytical results, field trials shall be conducted using the model area.

9.3.2 Field Trials on Macro Elements

As described above, nitrogen and phosphorus should be investigated on the most suitable doses and time of split application to obtain the highest economic crop produces. Rice, corn, cassava and mungo are the first group to be subjected to field trials. Effects of organic manure use and green manure cropping are also preferably examined in the field. Trials which are to be conducted in the field of Agricultural Promotion Center will present useful data for the fertilizer doses.

With these data the present application manual shall be revised so as to be used in the extension activities of the project area.

LITERATURE CITED

1. Bureau of Soils/UNDP/FAO: Bohol Agricultural Land Resources Appraisal Project, Technical Report 1. Physiography and Soils (1980)

   Ibid: Ibid, Technical Report 2. Geology (1980)

   Ibid: Ibid, Technical Report 4. Vegetation and Land Use (1980)

   Ibid: Ibid, Technical Report 10. Field Fertility Trials (1980)

   Ibid: Ibid, Technical Report 12. Physical and Checmial Properties of Soils (1980)

2. Mariano, J. A. and A. T. Valmidiano: Classification of Philippine Soils in the Higher Categories, Bureau of Soils, Dept. of Agriculture and Natural Resources, Philippines, (1972)

3. USDA/SCS (International Soil Museum, Netherlands): Field Extract of Soil Taxonomy (1980)

4. FAO/UNESCO: Soil Map of the World, IX (1978)

5. FAO (LWDD): Guidlines for Soil Profile Description (1970)

6. Bureau of Soil Conservation, Department of Agricuture and Natural Resources: Soil Survey of Bohol Province (1947)

7. PCARR (Bureau of Soils, UPLB): The Philippines recommends for Soil Fertility Management (1978)

8. Ibid: The Philippines Recommends for Irrigation Water Management, Vol. 1. Lowland Rice Conditions (1978)

9. Takijima, Y. and H. Sakuma: Soil Strength and Sand-Gravel Content as Deciding Factors of Paddy Soil Productivity Classification, Proc. Intern, Seminar, ISSS, Tokyo (1977)

10. NIA-Angat-Magat Integrated Agricultural Development Project: AMIADP Land Classification Upgrading (1978)

11. JICA: Bohol Integrated Agricultural Development Project in the Philippines, Appendix 3B (1978)

12. Agricultural Promotion Center, Bohol: Past, Present and Future Problems of Bohol Agriculture (1985)

13. IBid: Accomplishment Report 1984 (1985)
14. Yoshida, S.: Fundamentals of Rice Crop Science, IRRI, 1981.

ANNEX E. WATER BALANCE STUDY

ANNEX E WATER BALANCE STUDY

LIST OF TABLE

LIST OF FIGURE

CHAPTER I REVIEW OF WATER BALANCE IN MALINAO DAM

The Water balance study of the Malinao reservoir, which is the Water sources for Phase I Project area, was reviewed because of the following reasons;

i) Daily runoff discharge at the Malinao damsite were reviewed based on additional newly observation data such as the rating curve of the Wahig-Pamacsalan river.

ii) Irrigation requirements were reviewed based on fixed demand method.

Since the surplus water from Phase I Project area is the key factor for planning the Phase II Project, the water balance study of the Malinao reservoir was carried out corefully by using above-mentioned results.

1.1 Operation Rule

The operation rule of the Malinao reservoir is established considering the following conditions;

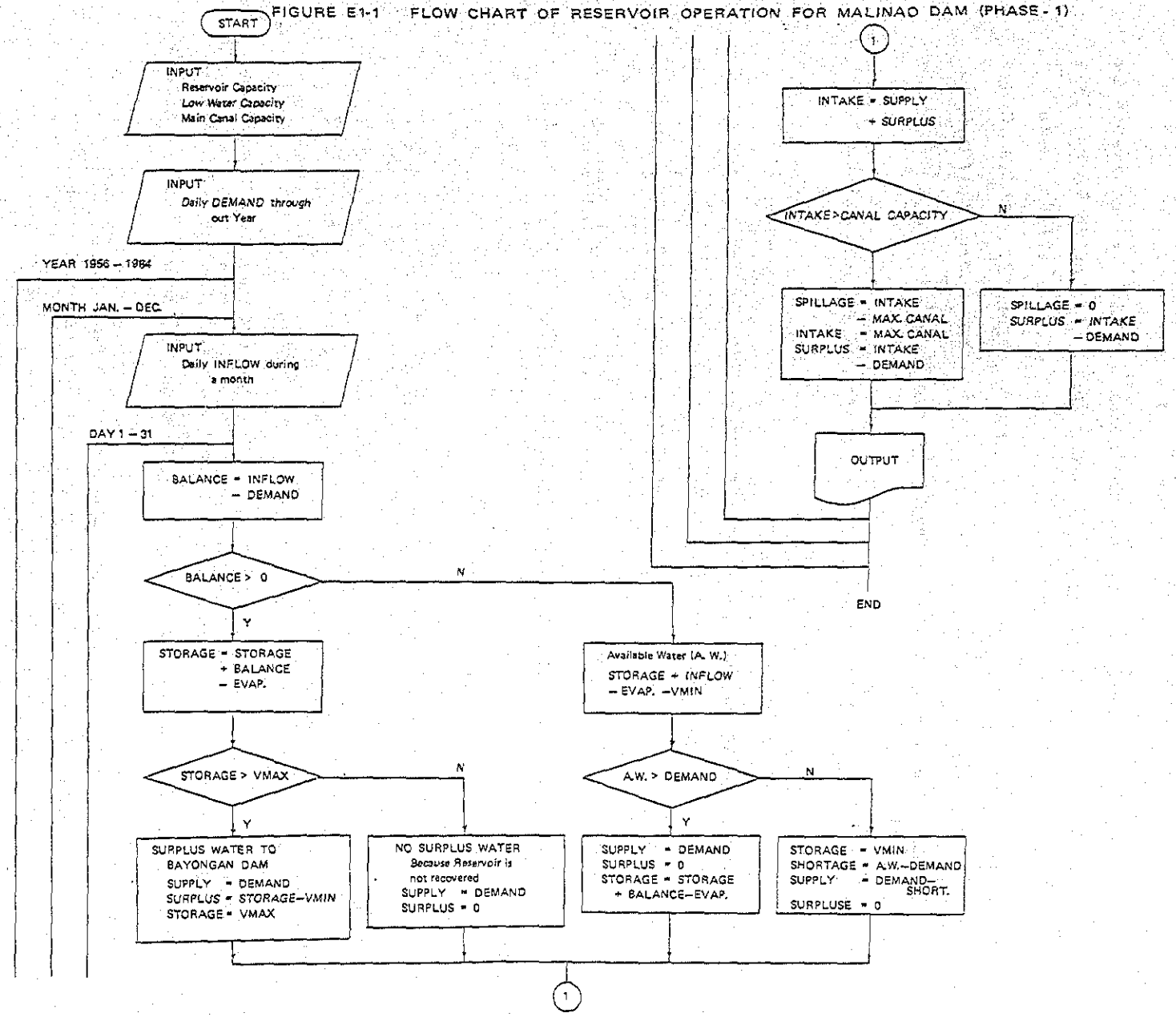
i) Effective reservoir capacity of the Malinao dam is 5.0 MCM which is the same capacity decided in the Detailed Design Stage of Phase I.

ii) In the reservoir operation, the Malinao reservoir should be firstly recovered up to the full water level with the inflow of the Wahig-Pamacsalan river, because the Malinao reservoir has a small effective capacity of 5.0 MCM and

should be kept the full water level as much as possible to meet the irrigation requirement of dry period in Phase I which will takes place frequently during irrigation season and can not be forecasted.

The flow chart of reservoir operation for the Malinao reservoir is shown in FIGURE E1-1.

FIGURE E1-1 FLOW CHART OF RESERVOIR OPERATION FOR MALINAO DAM (PHASE - 1)



1.2 Available Water

Available water at the Malinao damsite, which was estimated by applying the tank-model procedures for the period of 28 years (1956 - 1984), is shown in TABLE E1-1 and FIGURE E1-2. In this table, available water was tabulated in the such seasons from third 10-day in October to second 10-day in the next October, which corresponds to the proposed cropping pattern.

Following table indicates the summary of the estimation.

- Annual runoff
  Average of 28 Years ---------- 116.9 MCM
  Dry Year (6 years average)[1/] --- 92.2 MCM

- Monthly runoff Pattern
  Wet month from July to January --- 9.3 - 12.5 MCM/month
  Dry month from February to May --- 3.9 - 5.6 MCM/month

1/; See TABLE E1-1.

1.3 Surplus Water to Phase II Project

1.3.1 Alternative Plan

Water balance studies for the Malinao reservoir were made in the following six cases of alternative studies considering available water, irrigation water requirements for the Phase I Project area of 4,960 ha.

Alternatives	Wet Season Cropping Intensity	Dry Season Cropping Intensity
Case I-1	100%	50%
I-2	100	60
I-3	100	70
II-1	50	100
II-2	60	100
II-3	70	100

TABLE E1-1 ESTIMATED AVAILABLE WATER FOR MALINAO RESERVIOR

UNIT : MCM

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	TOTAL
56-57	1.804	12.135	20.939	15.614	13.001	7.561	11.445	5.532	14.166	21.844	8.841	7.632	14.351	154.865
57-58*	2.241	7.481	5.356	6.805	7.043	5.431	7.885	4.521	7.132	12.196	6.647	5.589	4.215	82.542
58-59*	1.287	6.062	4.497	11.663	5.657	9.173	3.525	4.198	3.538	20.816	10.438	7.622	4.804	93.279
59-60	1.381	6.453	7.858	12.873	7.106	5.176	9.834	7.841	13.739	7.588	7.935	11.071	3.458	102.312
60-61	3.578	13.248	7.183	9.367	7.791	4.526	4.340	5.269	6.247	16.342	8.247	10.092	9.590	105.820
61-62	7.907	8.326	8.346	7.727	13.645	11.590	5.213	3.474	14.772	13.195	14.104	15.242	4.199	127.741
62-63	2.336	19.764	8.961	18.389	9.897	12.398	7.785	4.221	5.441	10.660	15.253	14.264	16.123	145.491
63-64	3.288	11.597	5.786	7.105	16.055	4.846	4.235	12.666	7.813	10.005	5.624	12.149	6.722	107.891
64-65	2.097	51.381	17.001	19.985	8.844	10.067	5.705	4.488	15.706	10.064	8.547	7.145	9.668	170.699
65-66*	3.356	5.444	11.118	5.995	3.823	5.629	3.351	10.859	4.326	14.292	9.461	7.745	10.906	96.305
66-67	4.703	6.119	7.917	21.175	13.826	17.534	4.589	4.629	9.119	9.261	6.306	8.254	6.661	120.094
67-68*	1.122	9.466	14.424	7.574	4.970	4.909	3.112	3.224	6.344	7.673	6.009	10.773	9.553	89.153
68-69	1.407	22.269	17.034	5.285	3.333	7.300	4.285	5.617	5.122	10.215	6.711	6.492	2.522	97.592
69-70	3.896	6.482	12.136	5.626	9.012	3.977	3.247	4.065	13.826	16.368	8.263	6.721	5.424	99.043
70-71	11.093	13.150	9.936	12.136	7.735	6.996	4.277	12.948	19.300	13.851	8.573	10.374	7.785	138.156
71-72	7.110	18.801	6.905	19.077	5.417	9.716	4.531	10.463	9.543	12.300	9.154	12.672	6.686	132.377
72-73	4.235	9.930	12.693	6.033	4.002	4.039	2.630	3.428	9.020	9.180	10.506	11.462	15.623	102.782
73-74	1.110	30.642	16.507	7.026	18.228	9.359	8.371	6.832	10.295	6.941	5.610	6.408	4.385	131.714
74-75	3.784	13.284	14.699	22.055	10.393	7.103	7.296	3.886	9.772	11.285	8.494	13.647	7.594	133.292
75-76*	2.991	6.060	10.545	16.401	7.634	5.618	3.418	4.620	9.273	5.033	17.234	7.984	2.421	99.230
76-77	1.706	5.704	14.881	14.740	19.835	7.546	3.346	5.949	6.822	10.613	11.249	7.270	6.246	115.906
77-78	1.691	7.966	7.675	21.592	9.177	3.255	5.446	5.515	14.348	4.615	5.172	28.080	12.757	127.290
78-79	3.288	7.480	11.934	8.336	3.221	4.707	4.626	7.410	20.744	14.327	5.247	7.639	4.747	103.706
79-80	2.145	6.564	8.704	12.296	10.530	3.443	3.626	2.591	19.021	16.223	17.282	8.422	8.631	119.477
80-81	5.889	15.359	17.038	29.725	9.011	4.864	4.612	3.548	7.806	8.124	3.726	7.632	11.592	128.925
81-82	2.511	8.840	26.663	8.508	11.495	12.500	4.727	6.094	7.810	12.123	16.356	5.424	8.129	131.178
82-83*	1.835	5.471	5.464	4.807	2.335	2.504	1.842	1.771	5.184	19.350	16.578	12.649	12.777	92.567
83-84	3.818	8.115	19.235	11.136	13.721	9.800	5.357	5.111	7.701	6.526	4.218	20.674	9.401	124.812
AVE.	3.343	12.271	11.837	12.466	9.169	7.199	5.095	5.742	10.140	11.822	9.349	10.397	8.106	116.937
DRY-YEAR	2.139	6.664	8.567	8.874	5.244	5.544	3.856	4.866	5.966	13.227	11.061	8.727	7.446	92.179

Note: Year with an asterisk shows the year with less surplus water amount (dry year)

FIGURE E1–2 MONTHLY MEAN AVAILABLE WATER FOR MALINAO RESERVOIR (1956 – 1984)