Folder Title:	Soil Survey of the Irrigation Project Area - Sitiung - S. Jujuhan (West Sumatera) - March 1979 - Ministry of Agriculture - Agency for Agricultural Research and Development - Soil Research Institute
Folder ID:	30090463
Series:	Indonesia project and research reports (English)
Dates:	03/01/1979 – 03/31/1979
Fonds:	Personal papers of Gloria Davis
ISAD Reference Code:	WB IBRD/IDA DAVIS-11
Digitized:	05/30/2025

DECLASSIFIED
WBG Archives

SOIL SURVEY OF THE IRRIGATION PROJECT AREA SITIUNG - S. JUJUHAN (WEST SUMATERA), No. 3/1979

3/1979

SOIL SURVEY OF THE IRRIGATION PROJECT AREA
SITIUNG - S. JUJUHAN
(WEST SUMATERA)

Within the framework of technical cooperation with the Directorate of Irrigation, Ministry of Public Works

Ministry of Agriculture

Agency for Agricultural Research and Development

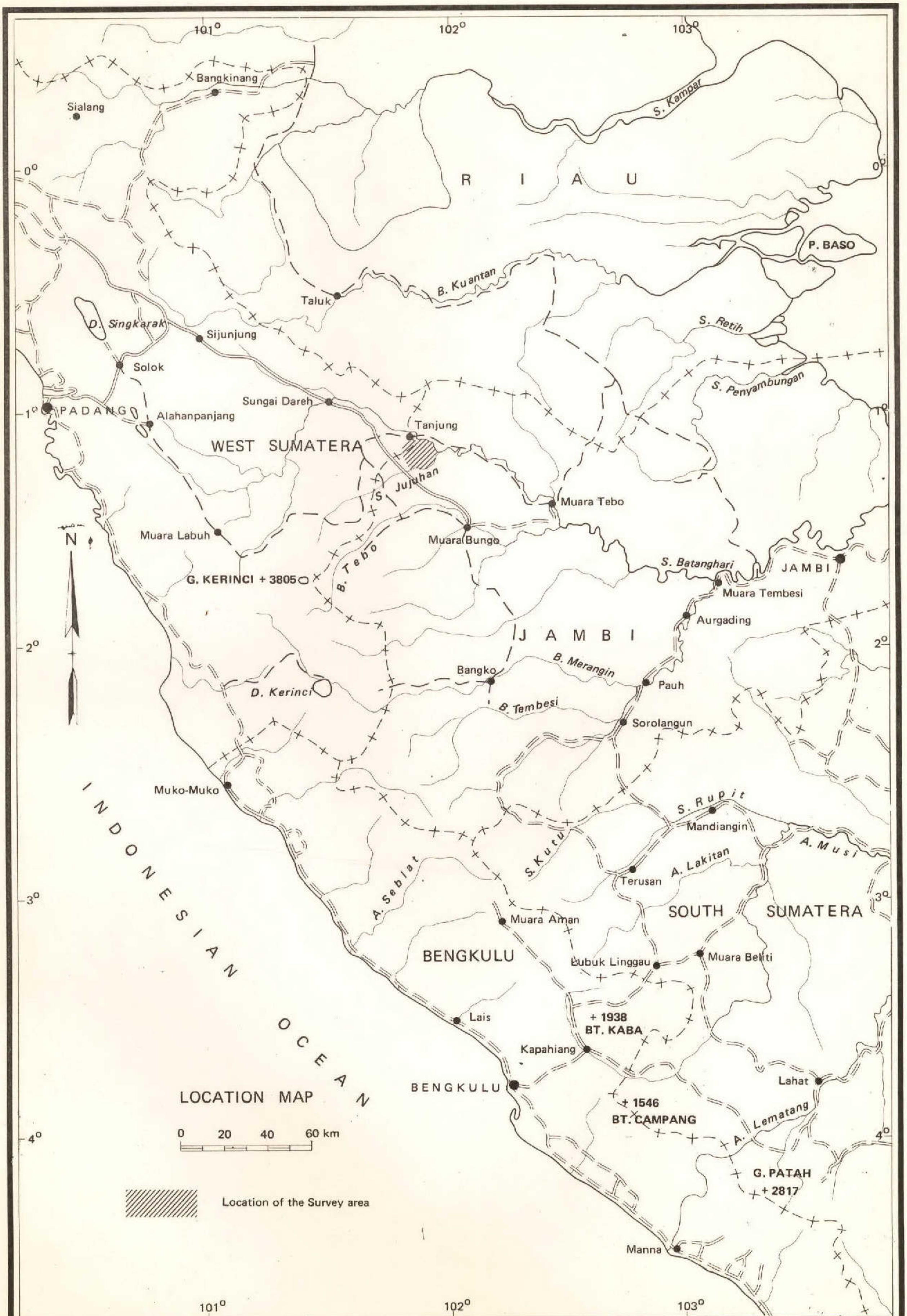
SOIL RESEARCH INSTITUTE

3/1979

SOIL SURVEY OF THE IRRIGATION PROJECT AREA
SITIUNG – S. JUJUHAN
(WEST SUMATERA)

Within the framework of technical cooperation with the Directorate of Irrigation, Ministry of Public Works

Ministry of Agriculture
Agency for Agricultural Research and Development
SOIL RESEARCH INSTITUTE



101°
102°
103°
0°
1°
2°
3°
4°
Bangkinang
Sialang
S. Kampar
R I A U
P. BASO
B. Kuantan
Taluk
D. Singkarak
Sijunjung
Solok
S. Retih
S. Penyambungan
PADANG
Alahanpanjang
Sungai Dareh
Tanjung
WEST SUMATERA
S. Jujuhan
Muara Tebo
N
Muara Labuh
Muara Bungo
B. Tebo
G. KERINCI + 3805
S. Batanghari
JAMBI
Muara Tembesi
Aurgading
J A M B I
B. Merangin
Bangko
D. Kerinci
Pauh
B. Tembesi
Sorolangun
Muko-Muko
S. Rupit
Mandiangin
A. Musi
S. Kutu
A. Lakitan
Terusan
A. Seblat
INDONESIAN OCEAN
Muara Aman
SOUTH SUMATERA
BENGKULU
Lubuk Linggau
Muara Beliti
Lais
+ 1938
BT. KABA
Kapahiang
BENGKULU
Lahat
LOCATION MAP
+ 1546
BT. CAMPANG
A. Lematang
0 20 40 60 km
G. PATAH
+ 2817
Location of the Survey area
Manna

PREFACE

The soil investigation in the Sitiung - S. Jujuhan area was carried out by the Soil Research Institute to support the development of the proposed irrigation project in particular and transmigration program in general.

The soil survey and mapping was conducted from September 20, 1978 - October 31, 1978, consisting of :

(1) Detailed survey (scale of 1:5,000) for 7 (seven) sample blocks (5 blocks in Sitiung I and 2 blocks in Sitiung II) covering approximately 700 ha;

(2) Semi-detailed survey (scale of 1:45,000) in Sitiung II - S. Jujuhan area covering approximately 20,000 ha.

This report is based upon the data and information collected from the field and laboratory investigations consisting of soil mapping and soil fertility as well as soil physical evaluation.

We wish to express our sincere thanks to the Head of Directorate of Irrigation and his staff, the Governor of the West Sumatera Province and his staff, the Head of Agricultural Extension Service of the West Sumatera Province and his staff for their supports and cooperations, and to the Soil survey team which has completed the report. We also wish to extend our thanks to Sir William Halcrow Engineering Consultant and Partners, and PT Indah Karya counterparting team in Sitiung for their cooperation during the field operation.

We hope that the findings of this study will be useful for further development of the transmigration project.

Bogor, May 1979

DEPARTEMEN PERTANIAN LEMBAGA PENELITIAN TANAH BOGOR

Soil Research Institute

Director,

D. Muljadi

SUMMARY

Detailed and semi-detailed soil mapping (scales 1:5,000 and 1:45,000) in the Sitiung I and Sitiung II - S.Jujuhan area covering approximately 700 ha and 20,000 ha respectively, were carried out by the Soil Research Institute to support the irrigation and agricultural development programs for the resettlement and transmigration projects.

The north-western part of the area belongs to the Kecamatan (Subdistrict) Kotabaru and Sungai Dareh of the Regency Sawahlunto - Sijunjung, West Sumatera Province, while the south-eastern part belongs to the Kecamatan Tanah Tumbuh, Regency Bungo-Tebo, Jambi Province. The area is located about 260 km southeast of Padang the capital of West Sumatera Province; and accessible by road.

The purpose of the survey and mapping was especially to collect soil and environmental data for irrigation purposes in particular and agricultural development in the transmigration area in general. The soil data and information will be used as a basis and a guideline for the physical planning and implementations of the project.

The field work was carried out from September to October 1978. During the survey a total of 103 soil pits and 1,332 augerings were observed; infiltration rate and shear strength value were measured in 12 sites mainly in the subrecent river terrace. A total of 500 selected soil samples, 305 undisturbed ring samples, and 5 river water samples were collected and analyzed.

The survey area consists of recent river floodplain and terrace, subrecent river terrace, peneplain and peneplain volcanic cover. The relief of the largest area is undulating to rolling dissected with narrow valley bottoms and steep slopes (25-40%). The river terrace is relatively level. The elevation ranges from 60 to 150 m above sea level. The lowest points are located on the recent floodplain, and the highest points are on the peneplain volcanic cover.

The climate of the survey area is humid tropic (A) with annual rainfall approximately 2500 mm and the dry month ($P < 5\%$) is less than 3 months. Supplemental irrigation especially during these months is considered still necessary depending on the type of crops and growth stage. The quality of Batanghari river water is medium which seems very beneficial for soils in the area. However, the water of the other rivers has lower quality. It seems that during the first few years of irrigation most of the soils require considerable amount of water.

Land use in this survey area consists of (1) dry field and settlement(3,651 ha; 18.2%), (2) rubber (1,510 ha; 7.5%), (3) alang-alang (352 ha; 1.7%), (4) brushwood and shrub (445 ha; 2.2%), (5) secondary forest and rubber (4,623 ha; 23.1%), (6) secondary forest (1.459 ha; 7.3%), and (7) exploited primary forest (7,996 ha; 40.0%).

The agricultural practice of local people is simple and require extensive land. This kind of practice is suitable for soils in the survey area without any soil management measure. However, this practice cannot be continued and an improved agricultural technology for intensive cultivation should be developed including processing and marketing system. The IPB, LP3 and Halcrow's field trials constitute good preliminary steps for the future development. ADP (Agricultural Development Project) in Abaisiat is a good pilot project to improve local/traditional agricultural system. This new system probably can be extended for other crops such as coffee and cloves.

Soils on the recent and subrecent terrace/floodplain are derived from alluvium which seem to be dominated by acid volcanic materials,while soils on the peneplain volcanic covers are derived from acid volcanic tuff, and in a small area the soils are developed from tertiary river terrace materials. Six great soil groups were recognized i.e.: Organosols, Alluvial soils, Gley soils, Acid Brown Forest Soils, Red-Yellow Podzolic soils, and Latosols. Twenty one dominant soil series are derived from these great soil groups. Those soils are equal to Histosols (Tropofibrists), Tropofluvents, Fluvaquents, Tropaquepts, Tropaquults, Dystropepts, Tropudults and Haplorthox (USDA, 1975).

The natural soil fertility status is very low and it depends on soil organic matter which is very unstable. On the other hand aluminum and in some places manganese are very high which may be toxic for plant growth. Irrigation will improve water supply for plant growth and soil productivity to a certain extent. The well drained soils generally have good physical properties, while the moderately well to poorly drained soils have poor physical properties. Improvement of physical and chemical properties, especially for arable crops, and the addition of organic matter are very important for a sustained agricultural system. Liming and balanced fertilization are required to maintain soil productivity.

Based on the interpretation of the soil maps, most of the land are not suitable for irrigation. Only the subrecent and lower terrace are generally suited for irrigation. For arable crops the area are marginally suited (in the subrecent and recent terrace soils) and poorly suited (in the Latosols). Tree crop especially rubber is highly recommended. The relation between each soil series/ mapping unit and their suitability is presented and briefly discussed.

The greater part of the survey area is expected to be not suitable for gravity irrigation mainly due to unfavourable topography, which is only 4,877 ha (gross area) is moderately suitable for irrigation. In the other area there is a limited land which is still possible for simple (traditional) irrigation. The actual and potential suitability for arable crops and rubber are as follow:

Actual soil suitability for arable crops and rubber

Description	Class	Arable crops		Rubber	
		Ha	%	Ha	%
Moderately well suited	III	1,120	5.6	4,877	24.4
Marginally suited	IV	4,877	24.4	12,826	64.0
Poorly suited	V	11,706	58.4	-	-
Generally not suited	VI	977	4.8	977	4.8

Potential soil suitability for arable crops and rubber

Description	Class	Arable crops		Rubber	
		Ha	%	Ha	%
Well suited	II	-	-	8,887	44.4
Moderately well suited	III	6,687	33.4	7,696	38.4
Marginally suited	IV	11,134	55.5	1,120	5.6
Poorly suited	V	-	-	118	0.5
Generally not suited	VI	859	4.3	859	4.3

Land utilization should be based on soil suitability classes with their limitations and hazard to ensure the efficient utilization of the land and water resources. Contour planting/strip cropping, construction of stop wash bunds especially in perennial/tree crops on the undulating and rolling areas are recommended. Terracing should be done carefully with due attention to the soils because of high aluminum content in the subsoils.

To obtain sustained good crop yields, special attentions are required mainly on soil and water management, application of proper and balanced fertilizers, liming, suitable cropping system to maintain or build up organic matter, high yeilding/short growing period varieties adapted to the adversed soil conditions.

TABLE OF CONTENTS

	Page
PREFACE	v
SUMMARY	vii
TABLE OF CONTENTS	xi
LIST OF TABLES, FIGURES, APPENDICES AND MAPS	xii
I. INTRODUCTION	1
1.1 Background	1
1.2 Methods and procedures	1
II. GENERAL FEATURES OF THE AREA	5
2.1 Location	5
2.2 Administration and population	5
2.3 Transportation	6
2.4 Landforms	7
2.5 Geology and parent material	9
2.6 Climate	10
2.7 Hydrology	15
III. SOIL	17
3.1 General	17
3.2 Soil map and soil classification	21
3.3 Mapping Unit descriptions	31
3.4 Soil physical properties	46
3.5 Soil fertility	59
IV. SOIL SUITABILITY	66
4.1 General	66
4.2 Irrigability for wetland rice in relation to present limitations	66
4.3 Soil suitability for arable crops and rubber	68
V. DISCUSSIONS	71
5.1 Location and topography	71
5.2 Soil and landforms	72
5.3 Climate and agriculture	76
5.4 Land use and agriculture	79

Page

5.5 Soil physical properties and irrigation 82

5.6 Soil fertility 86

5.7 Soil suitability 90

VI. CONCLUSIONS AND RECOMMENDATIONS 93

6.1 Conclusions 93

6.2 Recommendations 95

VII. REFERENCES 99

APPENDICES 103

LIST OF TABLES, FIGURES, MAPS AND APPENDICES

Tables

Table 1 : Temperature (^{o}C), relative humidity (%) and sunshine duration (hours) in Kotabaru 11

Table 2 : Average monthly rainfall & percentage, raindays and intensity. 12

Table 3 : Potential evapotranspiration in the specific Kotabaru area in mm (Team IUTP, 1977) 15

Table 4 : Analytical data of water samples 16

Table 5 : Soil analysis of typical well drained upland soils 18

Table 6 : Dominant soil series found in the survey area (Sitiung I and Sitiung II - S. Jujuhan) 25

Table 7 : The grouping of the soil series in relation to physical properties . . . . 50 - 51

Table 8 : The grouping of the soil series under the present condition in relation to the gravity irrigation 53

Table 9 : Strength values of some soils of the Sitiung - S.Jujuhan area . 56

Table 10 : Water requirement for soil preparation of lowland rice 58

Table 11 : The mean values of analytical data of the topsoils of each soil series in the semi-detailed survey area 60

Table 12 : The mean values of analytical data of the topsoils of each soil series in the detailed survey area 60

Table 13 : Average lime requirement of each soil series 61

Table 14 : Irrigability for wetland rice in the Sitiung II - S.Jujuhan survey area 67

Table 15 : Actual and Potential soil suitability subclasses for Arable crops and Rubber in the semi-detailed Sitiung II - S.Jujuhan area 70

Page

Table 16 : Actual and Potential soil suitability subclasses for Arable crops and Rubber, and Irrigability subclasses for wetland rice in the detailed sample blocks 70

Table 17 : Landforms and proposed land utilization types of the semi-detailed survey area 71

Table 18 : Average crop growing periods 77

Table 19 : Suggested sequence of some suitable crops in various growing periods in the survey area 78

Table 20 : Present land use and the acreage in the semi-detailed survey area (1978) 80

Table 21 : Landforms (soils) and their traditional land use 82

Table 22 : Result of plant analyses of wetland (flooded) rice from the Halcrow's trial plots in the Sitiung I 89

Table 23 : Actual and Potential soil suitability for Arable crops in the semi-detailed Sitiung II - S.Jujuhan area 91

Table 24 : Actual and Potential soil suitability for Rubber in the semi-detailed Sitiung II - S.Jujuhan area 91

Figures

Figure 1 : Schematic landform and cross section 8

Figure 2 : Climadiagram 14

Figure 3 : Schematic soil pattern in subrecent river terrace (A) and peneplain (B) 32

Figure 4 : Soil moisture retention curves of some soil series in the survey area 48

Figure 5 : Infiltration rate curves of the Sitiung I and Sitiung II - S.Jujuhan area 52

Figure 6 : The mineralogical composition of soil samples of each typical geomorphological unit 64

Maps

Map 1 : Location map iii

Map 2 : Location map of the detailed and semi-detailed soil maps (Sitiung I and Sitiung II - S.Jujuhan area) 4

Map 3 : Present land use and vegetation map of the Sitiung II - S. Jujuhan area . . . . *)

Map 4 : Semi-detailed soil map of the Sitiung II - S.Jujuhan area . . . *)

*) Separate sheets enclosed in this report.

Page

Map 5 : Detailed soil map of Block Piruko - Sitiung I 175

Map 6 : Schematic detailed soil map of Block R.Atang II - Sitiung I. . 177

Map 7 : Detailed soil map of Block R.Atang I - Sitiung I 179

Map 8 : Detailed soil map of Block Sipangkur - Sitiung I 181

Map 9 : Detailed soil map of Block Kotabaru - Sitiung I 183

Map 10 : Detailed soil map of Block E - Sitiung II 185

Map 11 : Detailed soil map of Block F - Sitiung II 187

Appendices

Appendix 1 : Soil survey team of Sitiung - S.Jujuhan 105

Appendix 2 : Morphological characteristic of representative soil profiles
A. Semi-detailed Sitiung II - S.Jujuhan area 106-125

B. Detailed Sitiung I area 126-136

Appendix 3 : A. Chemical data of soil series in the semi-detailed survey area 137-139

B. Chemical data of soil series in the detailed survey area . . 140-142

Appendix 4 : A. Mineral composition of the sand fraction of the detailed survey area 143-145

B. Mineral composition of the sand fraction of the detailed survey area 146-148

Appendix 5. Placement for comparison of tentative soil series in the Sitiung - S. Jujuhan soil survey according to Great Soil Group as used in Indonesia, the USDA system of soil classification and the units of the Soil Map of the World . . 149

Appendix 6 : Permeability, bulk density and moisture characteristics of some soil series of the Sitiung - S.Jujuhan area 150

Appendix 7 : Stability index and Atterberg value of some soil series of the Sitiung - S. Jujuhan area 151

Appendix 8 : Infiltration rate (cm/hour) of some soils of the Sitiung - S.Jujuhan area 152

Appendix 9 : Criteria of soil chemical data 153

Appendix 10 : Criteria to evaluate the soil physical characteristics . . . 154

Appendix 11 : Rating of soil properties and environment for soil suitability classes 155-161

Appendix 12 : Actual and Potential soil suitability rating for Arable crops (A) and Rubber (R) of mapping units in the semi-detailed Sitiung II - S.Jujuhan area 162-163

Appendix 13 : Actual and Potential soil suitability rating for Arable crops (A) and Rubber (R) of the soil series (mapping units) in the detailed sample blocks 164-165

Appendix 14 : Draft instruction for soil surveys of the Sitiung transmigration project area 166-173

I. INTRODUCTION

1.1 Background

Within the framework of technical cooperation between the Soil Research Institute of the Agency for Agricultural Research and Development, Bogor, and the Directorate of Irrigation, Jakarta, the Soil Research Institute based on the recommendation of the Governor of West Sumatera Province No. DSP/372/VII/SP.IV/5-78, of November 25, 1978, has carried out soil survey in the Sitiung I and Sitiung II - S.Jujuhan area in West Sumatera Province.

The Terms of Reference constitute the base for a detailed soil survey consisting of six sample blocks in the Sitiung I and Sitiung II areas, and one semi-detailed soil survey in the Sitiung II - S.Jujuhan area. The detailed survey (scale 1:5,000) and the semi-detailed survey (scale 1:40,000) covered a total area of ± 600 ha and ± 20,000 ha respectively.

The main objective of this survey was to carry out soil survey and mapping, and evaluate soil data for irrigation purposes in particular, and transmigration development in general.

1.2 Methods and procedures

The methods and procedures of collecting data and soil survey of the area are divided into three steps, i.e. (1) preparation, (2) field work, and (3) laboratory analyses and data processing.

(1) Preparation

The preparatory stage consists of technical and non-technical preparations were carried out in August - September 1978. The technical preparation consists of literature study, preparation of base (field) maps, air-photo interpretation, and slope analyses. While non-technical preparation consists of administrative and financial preparations.

Contour maps of scales 1:5,000 for the detailed surveys (Sitiung I and Sitiung II) and 1:25,000 for the semi-detailed survey (Sitiung II) prepared by PT Indah Karya in 1977 were received from the Directorate of Irrigation. The topographic maps made earlier were available only of scale 1:100,000 (1938). Slope maps were then made from those 1:5,000 contour maps.

Air-photographs of scale 1:10,000 taken by PT Rio Tinto Betlehem Indonesia in 1975 were also received from the same institution. These photographs cover the planned semi-detailed Sitiung II - S.Jujuhan survey area. Since these photos were considered to be too large for the purpose of semi-detailed survey, therefore the scale was reduced to 1:20,000. These reduced photographs were interpreted for the purposes of soil survey and for land use/ vegetation map of the survey area.

(2) Field work

This stage was carried out in September - October 1978. Before the full team went to the field, an advanced team consiting of some members of the Soil Research Institute team and Sir William Halcrow and Partners Consult. Eng. with their counterparting team PT Indah Karya was sent to the field to select the location of sample blocks which were going to be surveyed in a detailed scale. Seven sample blocks covering a total acreage of ± 700 ha were selected, 5 blocks in the Sitiung I and 2 blocks in the Sitiung II (see location map).

The detailed and semi-detailed soil mapping involved careful examination of soils based on "draft Instruction" from Sir William Halcrow and Partners Consult. Eng. with some modifications adapted to local conditions and available maps (the draft Instruction is attached in Appendix 14). However, the team had some difficulties in using the contour maps of PT Indah Karya, because there were many discrepancies. Therefore air-photos of scale 1:5,000 borrowed from Sir Halcrow Consultant in the field and some agrarian maps available were used as base maps in the detailed surveys of sample blocks. Nevertheless, the sample block of S. Atang II was not covered by agrarian map, and the air-photos available were still under primary forest so that it was impossible to use these photographs as base map for a detailed soil mapping. Consequently for the sample block of S. Atang II, a schematic map of a scale approximately 1:5,000 was used.

During the field work 37 soil pits and 568 augerings in the detailed survey, 66 soil pits and 764 augerings in the semi-detailed survey were observed. Five hundred soil samples, 305 ring samples, 45 undisturbed soil samples, and 5 water samples were collected. Percolation study in the field was tested in 12 sites mainly in the potentially irrigable areas, each with 3 replications. Groundwater table was measured in selected pits (The locations of these observations as well as the samples are presented in corresponding soil maps in the Appendices).

(3) Laboratory analyses and data processing

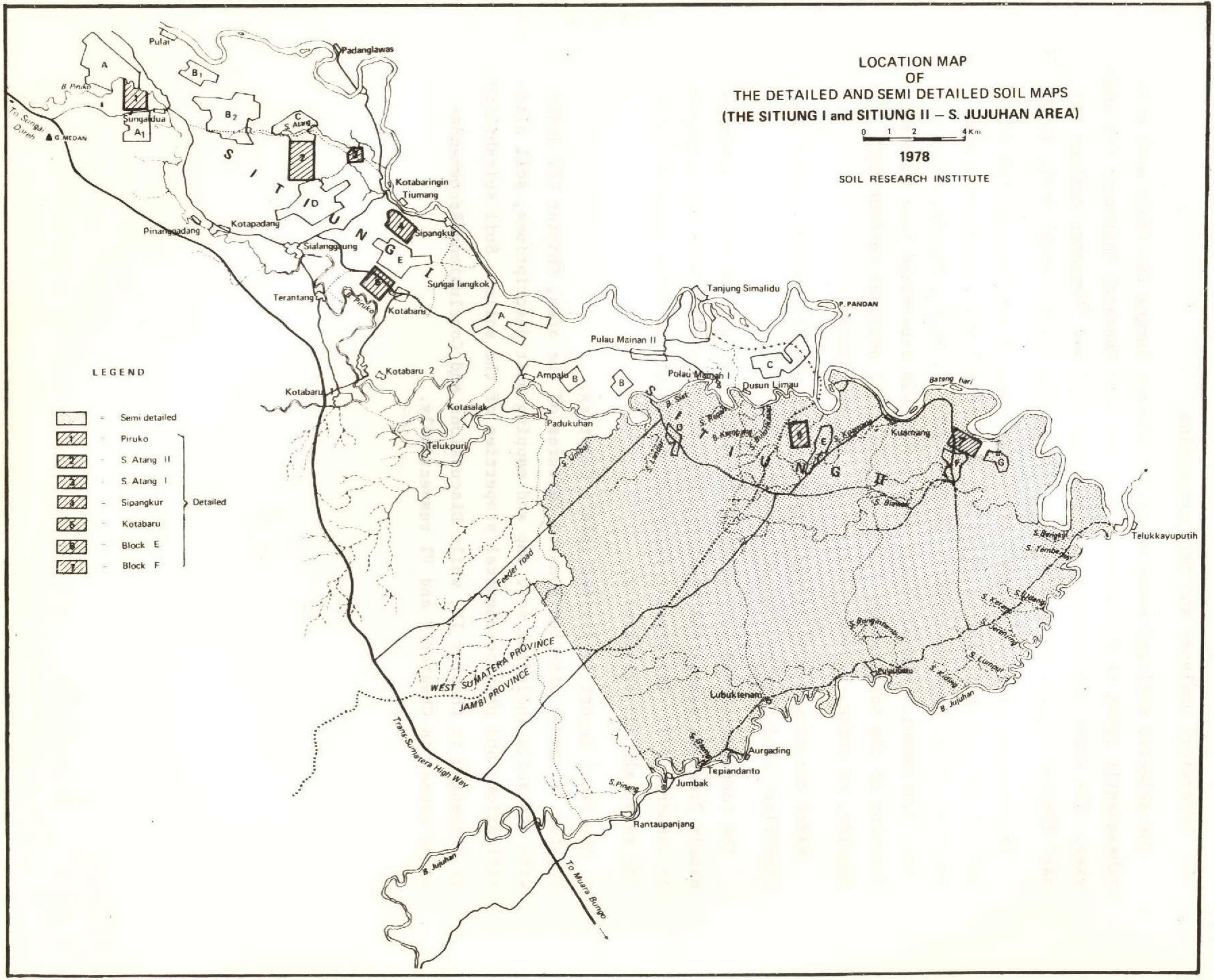
The selected soil and water samples collected during the field work were subsequently taken to the Laboratory of the Soil Research Institute for analyses. The kinds and procedures of analyses followed "Penuntun analisa tanah" (Sudjadi et al, 1971) and "Penuntun analisa fisika tanah" (LPT, 1974).

The analyses of soils consist of the analyses of soil texture, pH (H_2O and KCl 1N), C and N organic, P_2O_5 and K_2O (in 25% HCl), cation exchange capacity (CEC), base saturation, exchangeable Al, Fe_2O_3, Cu, Zn, Mn and lime requirement. Mineralogical composition was determined from the sand fraction of the soil samples. The physical soil analyses include bulk density, pF curve, permeability, and Atterberg limits.

Water analyses consist of the determinations of silt content, water pH, electrical conductivity, cation and anion contents.

The compilation and presentation of the results consist of two substages namely Progress Report and Final Report. The Progress Report was completed in January 1979. The present report is the final one which presents all of the materials and the results.

The Final Report is divided into 6 Chapters.
Chapter II deals with the general features of the area, Chapter III deals with the soils including soil map and mapping unit descriptions, soil classification, and physico-chemical properties of the soils. Soil suitability is presented in Chapter IV, while Discussions and Conclusions/Recommendations appear in Chapter V and VI respectively.


LOCATION MAP
OF
THE DETAILED AND SEMI DETAILED SOIL MAPS
(THE SITIUNG I and SITIUNG II – S. JUJUHAN AREA)
0 1 2 4 Km
1978
SOIL RESEARCH INSTITUTE
LEGEND
Semi detailed
1 Piruko
2 S. Atang II
3 S. Atang I
4 Sipangkur
5 Kotabaru
6 Block E
7 Block F
Detailed
SITIUNG I
SITIUNG II
Pulai
Padanglawas
Sungaidua
To Sungai Dareh
G. MEDAN
Kotabaringin
Tiumang
Sipangkur
Kotapadang
Pinanggadang
Sialanggaung
Sungai langkok
Terantang
Kotabaru
Kotabaru 2
Kotabaru 1
Kotasalak
Telukpuri
Padukuhan
Ampalu
Pulau Mainan II
Polau Mainan I
Dusun Limau
Tanjung Simalidu
P. PANDAN
Batang Hari
Kusmang
Telukkayuputih
Feeder road
WEST SUMATERA PROVINCE
JAMBI PROVINCE
Trans Sumatera High Way
Lubuktenam
Aurgading
Tepiandanto
Jumbak
S. Pinang
Rantaupanjang
B. Jujuhan
To Muara Bungo

4

II. GENERAL FEATURES OF THE AREA

2.1 Location

The survey area consists of (1) seven detailed survey areas as sample blocks and (2) one semi-detailed survey area.

(1). The detailed survey area consists of 5 blocks in Sitiung I and 2 blocks in Sitiung II as proposed by the Advanced Team. Each block covers an area of approximately 50 to 150 ha. The total acreage is $\pm$ 600 ha. The location of each block is presented in Map 2.

(2). The semi-detailed survey area is located between the Batang Siat/ Batang Hari (north) and the Batang Jujuhan (south), and on the north-eastern side of the Trans-Sumatera Highway. Two blocks of the detailed survey area are located in this area (Sitiung II).

The semi-detailed area is situated in the southeast of Kotabaru and it is crossed by the boundary separating West Sumatera from Jambi Province. The north part lies in the Kecamatan (Subdistrict) Kotabaru, Regency Sawah Lunto/Sijunjung, West Sumatera Province, while the southern part lies in Kecamatan (Subdistrict) Tanah Tumbuh, Regency Bungo-Tebo, Jambi Province.

The northern boundary is the Batang Siat and the Batang Hari, the south/ southeast boundary is the Batang Jujuhan, and the west/south west boundary is the R. Ambai and straight line from Jumbak village on the Batang Jujuhan to Ampalu on the Batang Siat. It is situated between $101^{o}48'30''$ and $101^{o}59'15''$ east meridian of Greenwich or $4^{o}49'13''$ and $4^{o}59'58''$ west meridian of Jakarta, and between $1^{o}7'40''$ and $1^{o}15'45''$ south latitude (Map 1). The total acreage is approximately 20,000 ha.

2.2 Administration and population

The Province is divided into Kabupaten (Regency), which is further sub - divided into Kecamatan (Subdistrict). The survey area is partly situated in the Kecamatan Kotabaru, Kabupaten Sawah Lunto/Sijunjung, West Sumatera Province, and partly in the Kecamatan Tanahtumbuh, Kabupaten Bungo-Tebo, Jambi Province.

The next administrative subdivision below the Kecamatan is "Kenegerian" which is headed by the "Wali Negeri". Kenegerian is based on "adat (traditional) law". The Kenegerian is further subdivided into Jorong/dusun which is headed by Kepala Jorong/Kepala dusun.

The Kenegerians situated in the semi-detailed survey area are Kotasalak, Teluk Kayuputih, and Jumbak. The arrival of transmigration people from Java (Wonogiri) has added the Kenegerians of Block D, E, F, and G.

The population of the survey area consists of local people and transmigrants. Local people generally have their villages along the main rivers such as on the Batang Siat (Kotasalak, Ampalu, Pulau Mainan), on the Batanghari (Kuamang, Teluk Kayuputih), and on the Batang Jujuhan (Pulaubatu, Lubuktenam, Aurgading, Tapiandanto, and Jumbak). Whereas the recent organized transmigrants have their settlements located in more inland areas, adapted to local rules.

The estimated total of the local population of the Kecamatan Kotabaru and Tanahtumbuh is about 11,000 and 23,000 respectively, and less than 1/10 are living in the survey area. The recent transmigrants in the survey area are about 2,000 families. Presently a new proposed resettlement area is being prepared for the new settlement Sitiung III located between Sitiung II and the Trans-Sumatera Highway.

2.3 Transportation

The survey area is connected to Trans-Sumatera Highway by a hardened feeder road, and to the old mainroad by river boats. In the survey area there is a network of transmigration roads mainly in the settlement area and a network of timber roads which is partly hardened.

There is a small number of buses irregularly connecting this area to neighboring villages or towns, mainly in the morning. Although there is a network of recent roads, the rivers are still an important mean of communication. Almost all of the timber and rubber products which are the main products of this region, are carried by the rivers to the port of Jambi after a minimum overland transportation. Also many villagers are entirely dependent on the rivers as a mean of communication. The Batang Hari and the Batang Jujuhan are the principal rivers in the survey area.

The Trans-Sumatera Highway when completed together with the connecting roads will play an important role in communication both within and from/to the survey area. The survey area is about 260 km southeast of Padang, the capital of West Sumatera Province and also one of the important ports; about 50 km west of Muara Bungo, the capital of Bungo-Tebo Regency; and about 380 km northwest of Jambi, the capital and port of the Jambi Province.

2.4 Landforms

The survey area is located between 60 - 120 m above sea level. The lowest point is on the river belts, while the highest point is in the western parts.

In general the survey area can be divided into:

(1). Recent flood plain.

(2). Subrecent river terrace/floodplain.

(3). Peneplain (tongue of peneplain).

(4). Peneplain volcanic cover.

(1). Recent floodplain

This unit consists of alluvium mostly composed of clays deposited by flooding periodically. The relief is level with micro topography caused by meandering river courses, including levees, back swamps and oxbow lakes.

(2). Subrecent river terraces/floodplain

This unit is formed of clayey alluvium derived from the tuffs of the peneplain and the hinterland (Bukit Barisan). Lenses of gravels and sands are interbedded in places. It is characterized by flat to slightly undulating terrains which are rich in meander scars.

(3). Peneplain

The tongue of peneplain has less networks of streams and rather wide valley floors; and it forms an undulating relief. Slopes are less than 15% and the amplitude is generally less than 10 meters. The relict of the tertiary terrace deposits contains lenses of old terrace gravels which often expose to the surface.

(4). Peneplain volcanic cover

This unit covers the largest area which can be subdivided into steeply dissected and moderately dissected peneplain volcanic covers. Most of the area is covered by the quarternary brown volcanic tuffs of different depth. On the foot slopes and valley floors, tertiary terrace gravels consist mainly of quartzites and older rock fragments which are often exposed to the surface.

The dissected peneplain volcanic cover has networks of small streams and complex steep slopes forming a hillocky relief with small and deep

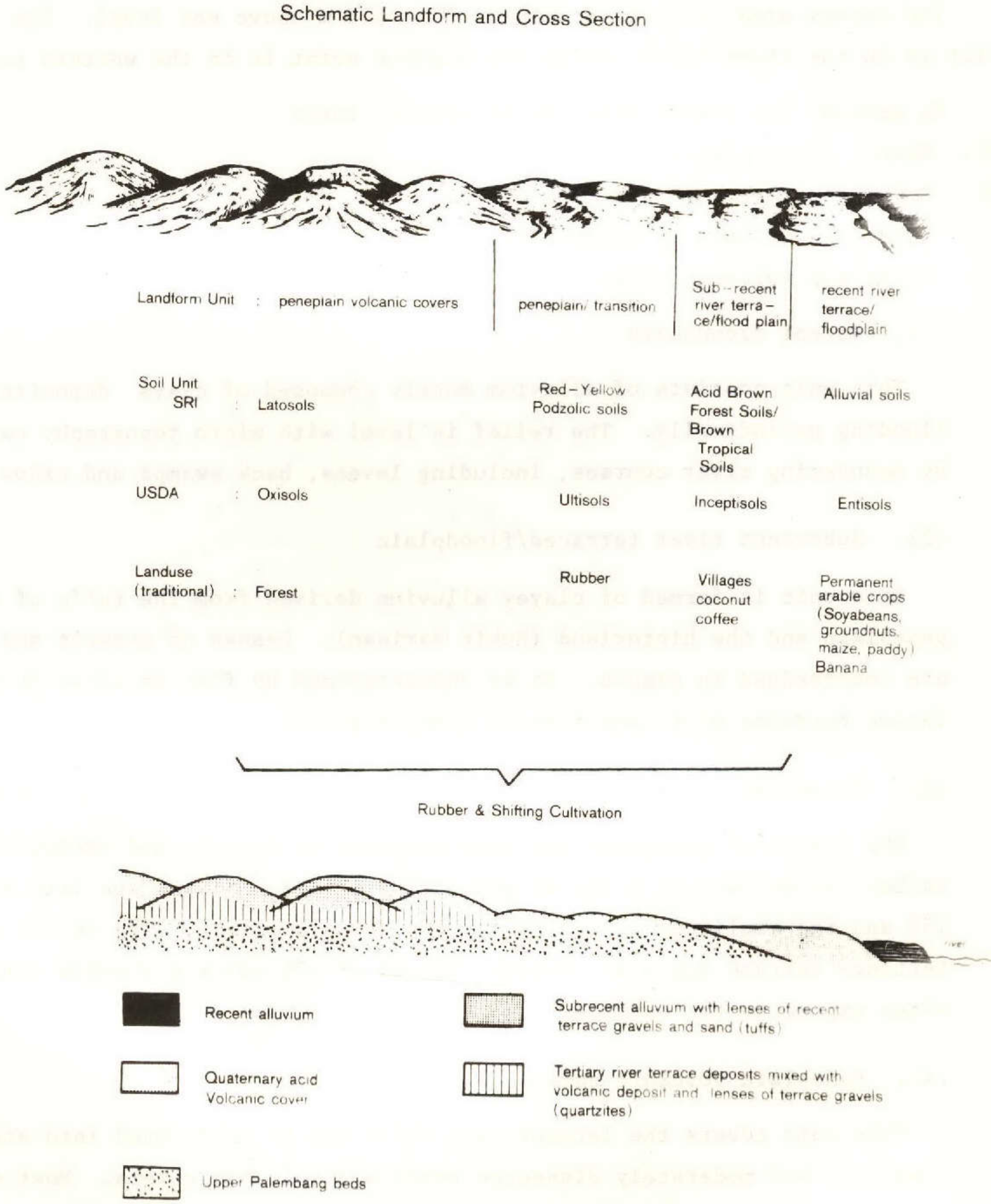

Schematic Landform and Cross Section
Landform Unit : peneplain volcanic covers
peneplain/ transition
Sub-recent river terrace/flood plain
recent river terrace/ floodplain
Soil Unit SRI : Latosols
Red-Yellow Podzolic soils
Acid Brown Forest Soils/ Brown Tropical Soils
Alluvial soils
USDA : Oxisols
Ultisols
Inceptisols
Entisols
Landuse (traditional) : Forest
Rubber
Villages coconut coffee
Permanent arable crops (Soyabeans, groundnuts, maize, paddy) Banana
Rubber & Shifting Cultivation
Recent alluvium
Subrecent alluvium with lenses of recent terrace gravels and sand (tuffs)
Quaternary acid Volcanic cover
Tertiary river terrace deposits mixed with volcanic deposit and lenses of terrace gravels (quartzites)
Upper Palembang beds

Figure 1.

valleys. The amplitude is generally more than 20 meters.

The moderately dissected peneplain has networks of small streams forming series of elongated ridges and a rolling relief.
The amplitude generally ranges from 10-20 meters. The upper slopes are generally convex and gently sloping becoming very steep on the footslopes.

2.5 Geology and parent material

The geology formation of the survey area consists of: (1) Recent and sub-recent alluvium and (2) Quaternary to recent acid volcanic ash and re-sorted deposit materials.

The recent and subrecent alluvium is sandy to clayey textured. It is found mainly along the Batang Siat, the Batang Hari, and the Batang Jujuhan rivers,it reaches 2-3 km wide along the rivers. This alluvium consists of a high terrace and a lower terrace/floodplain, which are easily recognized in the field. The lower terrace/floodplain is the younger. The relief is almost flat and dissected by tributary streams.

The catchment area of those rivers is composed of heterogeneous rocks belong to sedimentary, metamorphic, old igneous, and young volcanic rocks. Thus this alluvium is correspondingly of mixed origin. Interbedded sands and gravels in the subsoils at different depth consist mainly of pumiceous gravels and sands. The mineralogical composition of the soil samples consists mainly of turbid quartz sand, iron concretion, and rock fragments, small amount of opaque, transparent quartz, sanidine and kaolinite. Miscellaneous minerals seem to increase as the area is closer to the peneplain.

The quaternary to recent acid volcanic ash and re-sorted deposits cover a large area decreasing in thickness away from the centre of eruption. In the survey area it reaches more than 5 meters and decreases with the footslopes. The relief is rolling and very dissected almost in the whole area. The main component of the minerals is transparent quartz followed by medium amount of turbid quartz, and small amount of opaque, iron concretions and sanidine.

The lower beds often expose to the surface especially on the footslopes which are probably the Upper Palembang beds, and in the upper part they are characterized by quartz gravel/pebble beds of ancient river terraces. The main component of the minerals is turbid quartz followed by medium amount of transparent quartz, and small amount of opaque, miscellaneous and kaolonite.

Table 1. Temperature (^{o}C), relative humidity (%), and sunshine duration (hours) in Kotabaru

Data	Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Mean
Maximum temperature	1975	31.1	30.1	31.2	30.7	31.3	30.5	30.8	30.7	30.6	30.6	30.8	30.7	30.7
	1976	28.0	31.2	30.2	30.7	31.3	30.8	30.7	30.3	29.0	31.3	31.0	31.0	30.5
	1977	29.6	29.0	29.9	31.1	31.6	30.7	28.3	28.2	28.5	29.3	28.9	28.2	23.5
	1978	29.7	30.7	31.4	31.6	32.5	32.5	-	-	-	-	-	-	31.4
Minimum temperature	1975	21.4	21.0	21.2	21.4	21.5	21.0	21.3	20.7	20.6	20.4	20.4	20.3	20.9
	1976	21.0	21.6	21.3	21.5	21.4	21.9	21.9	20.6	21.3	21.3	21.3	21.2	21.4
	1977	21.5	21.1	21.5	21.9	21.0	21.5	21.4	21.4	21.9	22.1	22.2	22.5	21.7
	1978	22.0	22.3	22.6	22.9	22.8	21.8	-	-	-	-	-	-	22.4
Mean temperature	-	26.4	26.0	26.0	26.1	26.3	26.1	26.2	25.6	25.4	25.9	25.9	25.8	25.9
Relative humidity (r.h.)	1974	78.4	76.0	75.4	70.8	72.1	73.5	68.3	67.7	73.1	75.8	67.1	66.1	72.0
	1975	78.8	85.9	85.1	86.6	85.8	84.9	76.7	76.5	67.2	66.9	63.7	65.3	78.9
	1976	77.3	82.9	79.5	68.6	77.6	80.0	62.9	60.6	61.2	58.8	60.3	55.2	68.7
	1977	81.0	76.0	79.0	79.0	77.0	82.0	73.0	72.0	73.0	71.0	72.0	78.0	76.1
	1978	79.0	69.0	86.0	86.0	83.0	79.0	-	-	-	-	-	-	80.3
Mean r.h.	-	78.2	81.3	80.0	75.3	78.5	79.5	69.3	68.3	67.2	67.0	63.7	62.2	72.6
Sunshine duration	1974	4.7	4.4	5.9	6.4	6.3	7.2	6.8	5.6	6.2	6.5	5.3	6.0	5.9
	1975	5.4	5.2	5.5	5.6	5.6	5.4	6.6	5.5	5.7	6.4	5.9	6.3	5.8
	1976	3.6	4.6	5.7	6.5	6.5	5.7	6.9	4.1	3.6	5.9	4.8	5.4	5.3
	1977	3.6	2.9	3.4	5.7	6.0	6.0	4.7	4.0	3.5	2.0	3.5	3.4	4.1
Mean sunshine	-	4.3	4.3	5.1	6.0	6.1	6.0	6.3	4.8	4.8	5.2	4.9	5.3	5.3

Table 2. Average monthly rainfall & percentage, raindays and intensity*)

Station and height a.s.l.	Rainfall data	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Kotabaru 77 m (1923-1941)	Rf	277	226	288	267	214	117	114	107	173	259	360	346	2748
	%	10.1	8.2	10.5	9.7	7.8	4.3	4.1	3.9	6.3	9.4	13.1	13.6	100
	Rd	16.4	13.2	15.4	14.8	11.0	6.0	5.2	6.6	8.5	13.1	15.4	18.1	143.7
	I	16.9	17.1	18.7	18.0	19.5	19.5	21.9	16.2	20.4	19.8	23.4	19.1	
Muara Tebo 36 m (1909-1941)	Rf	229	228	262	228	175	116	101	122	155	213	246	286	2361
	%	9.7	9.6	11.1	9.7	7.4	5.0	4.3	5.2	6.6	9.0	10.4	12.0	100
	Rd	13.3	10.3	11.8	10.5	8.9	6.1	6.0	7.4	9.2	11.2	13.0	13.6	121.3
	I	17.2	22.1	22.2	21.7	19.7	19.0	16.8	16.5	16.9	19.0	18.9	21.0	
Teluk Kayu-putih 57 m (1921-1941)	Rf	279	184	215	244	174	91	88	114	167	249	279	267	2351
	%	11.8	7.8	9.0	10.4	7.4	3.9	3.7	4.8	7.6	10.6	11.8	11.2	100
	Rd	9.6	7.2	7.7	7.4	5.4	3.8	3.4	4.7	6.5	9.1	9.6	9.2	83.6
	I	29.1	25.6	27.9	33.0	32.2	24.0	26.0	24.2	25.7	27.4	29.1	29.2	
Jambi 50 m (1925-1941)	Rf	222	222	239	276	213	102	128	172	163	241	373	322	2673
	%	8.3	8.3	8.9	10.3	8.0	3.8	4.8	6.4	6.1	9.0	14.0	12.0	99
	Rd	10.3	8.7	9.6	8.9	7.7	4.6	3.9	6.7	7.1	9.9	12.8	14.8	104.0
	I	21.6	25.5	24.9	31.0	27.7	22.2	32.9	30.2	23.0	24.3	29.1	21.8	
Muara Bungo 80 m (1909-1941)	Rf	268	235	276	268	209	109	120	140	150	214	257	316	2562
	%	10.5	9.2	10.8	10.5	8.2	4.3	4.7	5.4	5.8	8.3	10.0	12.3	100
	Rd	13.3	10.3	12.2	11.2	9.1	5.6	6.0	6.9	8.5	11.8	13.0	14.3	122.4
	I	20.2	22.8	22.6	23.9	23.0	19.5	20.0	20.3	17.7	18.1	19.8	22.1	
Tanah Tumbuh 100 m (1913 - 1941)	Rf	340	270	279	343	204	104	124	152	184	255	316	344	2915
	%	11.7	9.3	9.5	11.8	7.0	3.6	4.3	5.2	6.3	8.7	10.8	11.8	100
	Rd	14.8	11.6	12.8	11.9	8.8	5.2	5.7	7.1	8.8	11.3	13.0	14.3	125.3
	I	23.0	23.3	21.8	28.8	23.2	20.0	21.8	21.4	20.9	22.6	24.3	24.1	
Mean rainfall intensity (mm/day)		21.3	22.7	23.0	26.0	24.2	20.7	23.2	21.4	20.7	21.8	24.1	22.9	

*) Data from Berlage (1949).

Rf = Rainfall
Rd = Raindays
I = Rain intensity.

Table 1 that the low percentage of humidity occurs in the dry season and the transition period, whereas the high humidity occurs in the rainy season.

c. Sunshine

Table 1 shows that the area has sunshine hours almost from 4 to 6 hours per day. It seems that the sunshine hours are less in the wet season; the minimum is in January and the maximum is in July. It is probably less suitable for crops which need a long sunshine duration such as sugarcane.

d. Precipitation

The precipitation of the surrounding stations of the survey area (Table 2) is less than 2,500 mm/year in Muara Tebo (36 m asl), which increases with elevation following the watershed; except in Teluk Kayuputih which is the lowest.

The climadiagram (Figure 2) shows the simple way of presenting the distribution of rainfall. The maximum occurs in November and the minimum occurs in June or July for the Batang Hari subwatershed; and in December and June/July respectively for the Batang Tebo subwatershed. The differences of total rainfall, length of rainy period, and the beginning of rainy period, may due to different landform which causes a difference in the local circulation system. The period of rainfall with more than 8.3% is 6-7 months and the period of less than 5% is 2-3 months.

The range for the growth of most crops lies between values 5.0% and 15.0% (optimum is 8.3 - 11.5%). The value below 5.0% indicates that the condition is unsuitable for growth of most crops, but it may be ideally suitable for ripening and harvesting of cereal grain crops. The value above 15% indicates an excessive rain and sustained high humidity which will cause phyto-sanitary problems (plant diseases) in many crops susceptible to fungal diseases. This condition does not occur in the survey area.

September to March is a good growing period. February is a short and rather wet harvest period, especially for crops which do not require strong dry periods. The second harvest period being followed by a long dry spell would be favourable for cereal grain crops (June - August). The climadiagram gives a general idea to plan the planting time, cropping pattern, and rotation system in the survey area.

The calculated values of PE (Potential Evapotranspiration) given for the tropics show only a slight variation during the year, as a result of a slight variability in the basic elements of temperature and humidity. Consequently the water balance expressed by surplus or deficit (Table 3) shows little differences with rainfall distribution expressed in percentage. The deficit ranges from June to August which is low. Thus rainfall in this area is higher than evaporation almost of the year. Therefore the upland soils will subject to continuous leaching with warm water and poor organic matter in solution. Whereas soils on the recent floodplain/valley floors will be affected by stagnant warm water.

Climadiagram

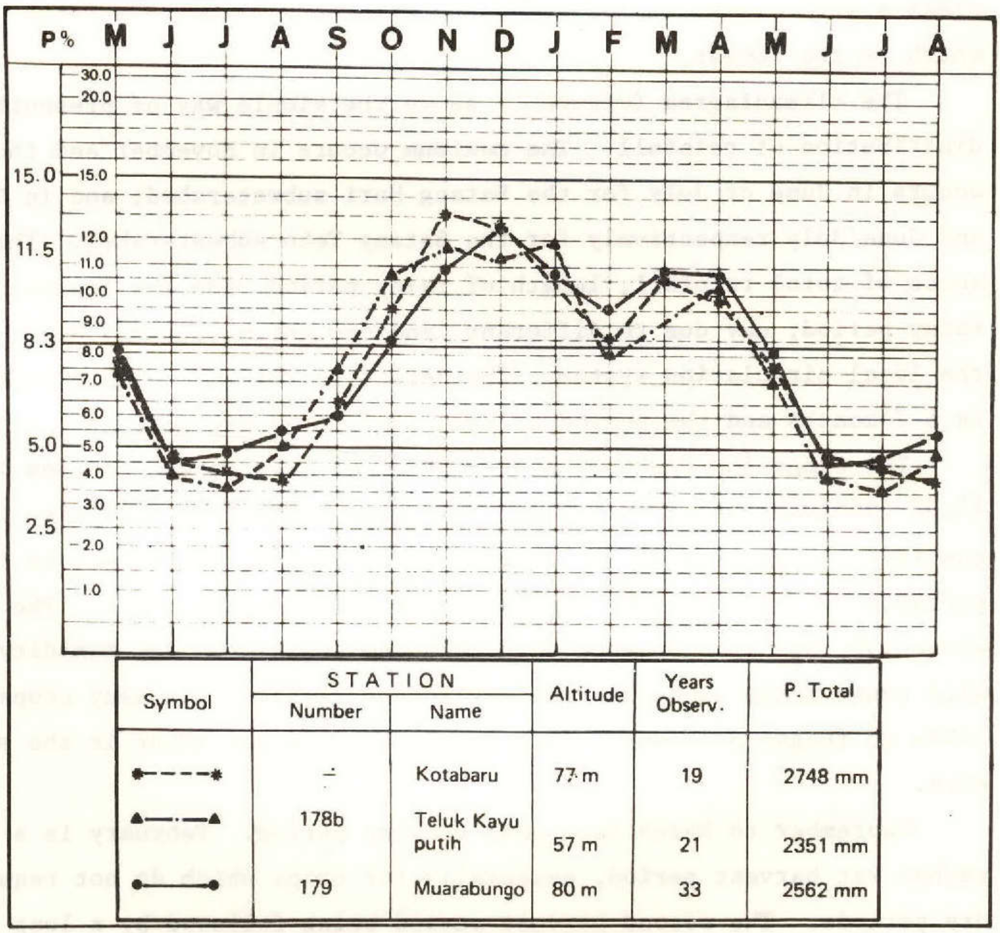


Figure 2

Table 3. Potential evapotranspiration in the specific Kotabaru area in mm (Team IUTP, 1977)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Mean monthly rain-fall	277	226	288	267	214	117	114	107	173	259	336	340
Potential evapotranspiration	115.7	125.6	125.6	127.3	130.8	127.3	129	119	115.7	124.6	124	122.3
Calculated water budget	161.3	100.4	162.4	139.7	83.2	-10.3	-15	-12	57.3	135.4	242	217.7

2.7 Hydrology

The survey area is drained by the Batang Siat, Batang Jujuhan, and Batang Hari rivers, and their tributaries. The first two rivers run to the northeast direction and enter the Batang Hari. The main tributaries of the Batang Siat in the survey area are the R. Ambai and R. Kembang, whereas the tributaries of the Batang Jujuhan are the R. Pamusum and R. Lumpur. The tributaries of the Batang Hari found in the survey area are the R. Kuamang and R. Biawak. The downstreams of those rivers form swampy areas due to the low capacity of the outlets and the gradients are small.

The discharge of the river water has not been known yet. The river water level fluctuates significantly. The Batang Hari, Batang Jujuhan and Batang Siat originate in the Bukit Barisan complex, whereas the tributaries mentioned above have their sources in the survey area or its surroundings. The potential of groundwater supplies is not known. In the subrecent floodplain of the Sitiung area, the depth of free water in wells occurs at about 7 meters and it fluctuates with season. In the peneplain area it is generally more than 12 meters, and it also fluctuates with season.

Table 4. Analytical data of water samples

Water samples		mmhos/cm 25°C	pH	Cations (m.e/ liter)									Anions (m.e/ liter)							Silt mg/ ltr.	SAR
No. SRI	River			NH_4	K	Ca	Mg	Na	Fe	Al	Mn	Total	NO_3	PO_3	SO_4	Cl	HCO_3	CO_3	Total		
2310, 2519	Batang Hari	0.106	7.0	0.02	0.02	0.62	0.23	0.14	0.01	0.00	0.00	1.04	0.00	0.01	0.07	0.05	0.98	0.00	1.11	12	0.22
2311	Batang Siat	0.033	6.8	0.00	0.03	0.15	0.07	0.07	0.01	0.01	0.00	0.34	0.00	0.01	0.12	0.08	0.30	0.00	0.50	0	0.21
2312, 2520/ 522	Batang Pi- ruko	0.031	6.8	0.03	0.01	0.11	0.07	0.07	0.01	0.01	0.00	0.31	0.00	0.00	0.03	0.02	0.27	0.00	0.32	21	0.23
2313	Batang Mimpi	0.032	6.8	0.00	0.01	0.12	0.07	0.05	0.02	0.00	0.00	0.27	0.01	0.01	0.04	0.08	0.30	0.00	0.44	22	0.22
2515/516	R. Kuamang	0.007	5.1	0.04	0.00	0.00	0.00	0.00	-	-	-	-	-	0.00	0.03	0.02	-	-	-	16	0.10
2517/518	R. Biawak	0.007	5.3	0.04	0.00	0.01	0.01	0.01	-	-	-	-	-	0.00	0.04	0.04	-	-	-	12	0.10
2523	R. Jujuhan	0.029	5.9	0.03	0.00	0.11	0.07	0.04	-	-	-	-	-	0.01	0.03	0.02	-	-	-	16	0.13

The catchment area of the main rivers in the survey area is the Bukit Barisan Range . The Batang Hari catchment area is composed of acid and basic heterogeneous rocks; the Batang Jujuhan, Batang Siat, and Batang Piruko originate from the areas which are mainly composed of intermediate to acid igneous rocks. Whereas the Batang Kuamang and Batang Biawak for example, have their sources in the survey area or its surroundings which are composed of acid volcanic materials.

The quality of water depends primarily upon the content of silt and salt constituents. Among the most important salt factors in water quality are : (1) its total concentration, (2) the proportion of sodium to other cations, and (3) the presence of special toxic ions, such as borates, chlorides, sodium or bicarbonates. The results of water analyses from the main rivers in the survey area are presented in Table 4.

The main river waters are slightly acid to neutral (pH 5.9-7.3), electric conductivity is good (EC 0.025 - 0.105 mmhos/cm), and SAR (Sodium Adsorption Ratio) is excellent (0.13 - 0.27). Whereas the water of Batang Kuamang and Batang Biawak is strongly acid (pH ± 5.0), electric conductivity is good (EC 0.005 - 0.010 mmhos/cm), and SAR value is excellent (0-0.1). Those river waters according to the U.S. Salinity Laboratory are classified as C1 - S1 which means low salinity and low medium water. Either chlorides or bicarbonates are not harmful, silt is also very low in normal condition.

It can be concluded that the river water is suitable for agricultural crops, however the water is poor in plant nutrients.

III. SOILS

3.1 General

From Chapters 2.4 (Landforms) and 2.5 (Geology and parent material) it has been indicated that the survey area has a rather simple pattern of landform and parent material of the soils. Based on these two factors, the general condition of the soils will be discussed, and the general characteristics of these soils are presented in Table 5.

(1) Soils on the recent river terrace/floodplain

These soils have developed from recent alluvium deposited by rivers which are still occuring periodically. Therefore stratifications due to series of depositions were generally observed clearly.

The materials are composed of clay, silt, and sand derived from weathering products of different rocks of the catchment areas. The soils on the recent river terrace/floodplain of the Batang Hari, Batang Siat and Batang Jujuhan have developed mainly from mixed acid volcanic products of the Barisan Range. It seems that the materials deposited by the Batang Siat are more acid. Whereas the soils on the recent floodplains along the R.Kuamang, R. Biawak, R. Ambai in Sitiung II, and the R. Piruko, R. Atang in Sitiung I have developed from acid materials derived from upland soils within the survey area and its surroundings.

The profile development of these soils is still very weak (A-C profile) which is predominantly restricted to physical alteration and colour development. Some chemical alterations (gleying) were identified in poorly drained sites (backswamps/oxbow lakes). These soils are subject to periodic additions of fresh alluvium. The soil texture ranges from sandy to clayey, the structure is massive to weak subangular blocky. The chemical composition is as follows: the soil pH increases with depth (ΔpH more than 1.0), the C/N ratio is constant, the exchangeable cation is dominated by Ca^{2+}, the CEC (cation exchange capacity) of clay is high (more than 40 me/100 gr clay), the base saturation is also high, and the Al-saturation is extremely low (less than 5%).

On the other hand, the soils on lower (recent) terrace have a rather advanced profile development as reflected by the more acid (lower pH), leaching, lower base saturation as well as CEC clay, but high Al-saturation. The clay mineral mainly consists of amorphous materials, kaolinite and quartz.

Table 5. Soil analysis of typical well drained upland soils

Soil sample		Texture	pH		Organic matter		Exchangeable cation: NH_4OAc pH 7.0				KCl 1N		Adsorption capacity		Base saturation	Al saturation	Free Fe_2O_3
SRI	Horizon	Clay (%)	H_2O	KCl	C (%)	C/N	Ca (me)	Mg (me)	K (me)	Na (me)	H (me)	Al (me)	me / 100 gr soil	me / 100 gr clay	tion (%)	tion (%)	(%)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
ALLUVIAL SOILS (Recent river alluvium)																	
195282	I	49	5.1	4.2	2.89	14	1.5	0.3	0.3	0.1	2.31	1.44	22.4	29.5	9	87	0.88
283	II	61	5.3	4.1	1.34	10	0.4	0.2	0.1	0.0	3.68	2.79	18.1	24.0	4	97	0.21
284	III	62	5.3	4.0	0.51	9	0.5	0.3	0.1	0.1	4.11	3.88	17.6	26.0	5	98	1.35
285	IV	56	5.3	4.1	0.29	10	1.2	0.5	0.1	0.1	5.00	4.15	19.0	32.4	9	70	1.46
286	V	48	5.4	4.0	0.14	5	1.4	0.1	0.1	0.1	5.19	4.49	28.0	57.9	9	74	1.42
195480	I	30	6.0	5.7	6.73	11	23.0	3.1	1.2	0.1	0.16	0.00	43.2	84.8	63	–	0.39
481	II	39	5.4	4.5	1.43	8	6.9	1.8	0.7	0.1	0.54	0.26	21.5	30.2	44	3	0.75
482	III	33	5.7	4.7	1.03	8	9.0	2.2	0.7	0.1	0.17	0.07	22.5	60.0	53	<1	0.76
483	IV	21	5.8	4.6	0.41	6	8.6	2.3	0.2	0.3	0.36	0.18	18.3	82.0	62	2	0.84
484	V	13	6.3	4.9	0.20	7	5.7	1.5	0.2	0.3	0.06	0.03	11.0	80.6	70	<1	0.81
ACID BROWN FOREST SOILS/BROWN TROPICAL SOILS (Subrecent river alluvium)																	
195349	Ap	61	4.5	3.7	2.66	12	0.8	0.4	0.2	0.1	5.90	4.98	21.2	23.2	7	78	1.12
350	B1	67	4.2	3.8	0.98	9	0.4	0.2	0.1	0.1	5.44	4.37	16.4	20.6	4	86	1.21
351	B2.1	nd	4.5	3.7	0.54	6	0.3	0.1	0.1	0.1	4.31	3.51	14.2	–	2	92	0.74
352	B2.2	nd	4.7	3.8	0.34	5	0.2	0.1	0.1	0.1	3.90	3.08	13.0	–	2	93	0.95
195500	A1	66	4.7	4.0	3.77	10	0.6	0.3	0.4	0.1	3.48	2.49	29.1	29.0	5	86	0.50
501	B1	67	4.5	3.9	1.39	8	0.4	0.1	0.1	0.1	4.31	3.34	21.7	27.0	3	85	0.61
502	B2.1	76	4.5	3.9	0.75	7	0.7	0.2	0.1	0.0	3.80	3.24	20.6	24.0	5	76	0.59
503	B2.2	75	4.4	3.9	0.37	5	0.2	0.2	0.1	0.0	4.66	3.89	19.7	25.0	3	89	0.75
504	B3	60	4.4	3.8	0.28	5	0.2	0.2	0.1	0.0	3.80	3.17	17.8	28.4	2	89	0.80
RED – YELLOW PODZOLIC SOILS (Subrecent river terrace materials)																	
195515	A1	54	3.8	3.5	4.43	12	0.2	0.2	0.2	0.1	5.26	4.16	16.9	9.6	4	86	0.35
516	B1.1t	65	4.3	3.8	1.52	11	0.1	0.1	0.1	0.1	4.27	3.23	10.0	8.9	3	81	0.40
517	B1.2t	62	4.5	3.8	0.84	12	0.1	0.1	0.1	0.1	3.75	2.66	8.1	9.5	2	93	0.33
518	B2.t	73	4.5	3.9	0.44	6	0.1	0.1	0.1	0.1	3.66	3.07	7.7	8.6	3	94	0.33
RED – YELLOW PODZOLIC SOILS (Tertiary river terrace mixed with colluvial acid volcanic materials)																	
195287	A1	71	4.7	3.9	3.05	13	0.2	0.1	0.1	0.0	4.76	3.78	22.1	19.7	2	90	0.82
288	B1.t	83	4.5	3.9	1.06	11	0.2	0.1	0.1	0.0	3.53	2.64	13.7	13.1	2	89	1.14
289	B2.1t	79	4.6	4.0	0.66	8	0.2	0.1	0.1	0.0	3.59	3.07	10.7	11.4	3	91	1.07
290	B2.2t	86	4.6	3.9	0.57	8	0.1	0.1	0.1	0.0	3.48	2.84	11.8	11.9	2	93	1.16
LATOSOLS (Acid volcanic tuffs)																	
195490	A1	66	4.3	3.9	4.26	13	0.1	0.1	0.0	0.1	4.63	3.55	22.1	16.4	1	95	0.46
491	AB	88	4.5	4.0	1.50	12	0.2	0.1	0.1	0.0	3.30	2.41	13.7	11.0	3	86	0.53
492	B2.1	88	4.6	3.9	0.89	10	0.2	0.1	0.1	0.0	2.24	1.99	11.6	10.5	3	87	0.53
493	B2.2	89	4.8	4.0	0.61	9	0.2	0.1	0.0	0.0	2.68	2.18	11.7	12.6	3	88	0.63
494	B2.3	89	4.8	3.9	0.55	9	0.1	0.1	0.1	0.1	2.05	1.37	11.5	11.3	3	82	0.64
195495	A1	62	3.9	3.6	3.94	13	0.1	0.1	0.1	0.1	5.66	4.46	20.2	15.5	2	92	0.58
496	B1	74	4.3	3.9	1.50	11	0.1	0.1	0.1	0.0	3.61	2.68	13.7	13.2	1	46	0.62
497	B2.1	69	4.3	3.9	0.85	9	0.2	0.1	0.1	0.0	3.17	2.46	11.2	13.0	2	92	0.56
498	B2.2	73	4.4	3.9	0.68	10	0.1	0.1	0.0	0.0	2.95	2.29	10.6	12.1	1	96	0.66
499	B2.3	72	4.5	4.0	0.54	9	0.1	0.1	0.0	0.0	2.68	2.04	8.7	10.1	3	87	0.50

The soils are classified as Alluvial soils (SRI) or Tropofluvents and Fluvaquents (USDA, 1975). Near Kuamang village the underlying strata consist of truncated Humic Podzol developed from quartz sand, and it varies in depth proving that the levelling of the river base has intensively occurred to inland areas.

In some valley floors where the drainage is very poor, the decomposition rate of plant residues is very low. This leads to the formation of organic soils Organosols (SRI) or Fibrists (USDA, 1975). The distribution is associated with Alluvial soils, therefore the composition of mineral materials varies with places.

(2) Soils on the subrecent river terrace

The soils of this landform have developed from subrecent river alluvium mainly composed of acid volcanic products from the Barisan Range. Most of the materials are fine to very fine textured. Gravelly sand layer (pumiceous tuffs) was frequently identified at a depth of more than 150 cm from the surface. Only in some places such as in the sample blocks of Kotabaru and S. Atang II it is very shallow or even exposes to the surface. The very extensive area of these soils are found along the Batang Hari, Batang Jujuhan and Batang Siat. These subrecent river terraces are relatively high above the normal river water (more than 10 m), therefore they are not influenced by flooding water anymore. Stratifications due to former successive series of sedimentations are not easily identified.

The profile development of these soils is more advanced having a well developed B-structure horizon (A-B-C profile). Physical and chemical alteration, slight podzolization process and some gleying were observed. The soil colour and structure are well developed. The soils are deep to very deep, relatively homogeneous, brown to reddish brown colour, clayey on the ridges. On the rather flat to concave areas, stagnant rain water is commonly observed in the field. This condition has influenced the development of the profile which is reflected by reddish to brownish mottles, iron-manganese concretions and gley, especially in the concave areas (depressions). Clay cutans are pronounced in some places may be due to the lack of biological activities in this area. The mottles found in the soils on sloping areas may be due to the lowering of the river water or seepage water. The clay content tends to decrease with depth, pH is constant or decreases with depth, C/N ratio decreases and abruptly changes from the A_1 to B horizon. The exchangeable cation is dominated by H^+ and Al^{3+}, Ca^{2+} is less than 0.5 me/100 gr soils. The leaching is more intensive in these soils. CEC is 20-30 me/100 gr clay.

These soils are classified as Brown Tropical Soils/Acid Brown Forest Soils (SRI) which can be separated into two groups, i.e. well drained and moderately well drained Brown Tropical Soils. Based on the US Soil Taxonomy these two kinds of soils are classified as Oxic Dystropepts and Aeric Tropaquepts respectively. While the soils found in the depressions which occupy relatively small areas are classified as Gley soils (SRI) or Aeric Tropaquults (USDA, 1975).

(3) Soils on the peneplain

The soils found in this landform have developed from tertiary river terrace alluvium, and in some places mixed with acid volcanic tuffs. They occur mainly on the foot slopes of the peneplain volcanic cover and vary with places. In the upper courses/streams they are less extensive than in the lower streams.

The relief is undulating with convex to slightly flat ridge crests, concave lower slopes, and wide valley floors.

The profile development of the soils is slightly advanced podzolization process with the A_2 horizon is very weak or absent. Clay cutans and maximum B-textured (Bt) were identified. Thus the zonation of the profile is an A-Bt-C. The profile depth varies with sites, but it is generally about 100cm. Reddish to yellowish mottles are common features, mainly in the subsoils increasing with depth. It seems that the mottles were derived from the parent materials or caused by the past fluctuation of ancient groundwater table. The underlying layer consists of gray to grayish brown clay mainly with quartzite gravels. The clay content and soil pH tend to increase with depth, while the C/N ratio tends to decrease. The exchangeable cation is dominated by H^+ and Al^{3+}, Ca^{2+} is ± 0.2 me/100 gr soils, CEC of clay is around 12 me/100 gr clay, and the base saturation is extremely low.

The soils are classified as Red-Yellow Podzolic soils (Chromic Podzolic soils) or Orthoxic Tropudults (USDA, 1975)

(4) Soils on the peneplain volcanic cover

These soils occupy the largest part of the survey area. They have developed from acid volcanic tuffs from the Barisan Range (Kerinci volcano complex).

The profile development shows an advanced stage. It is very deep and homogeneous in colour and texture. The soils have a high porosity, crumb to weak subangular blocky structure, fine stable aggregation, heavy texture, friable to very friable consistence and good drainage condition. Clay nodules were often observed in the profiles. The clay content tends to be constant with depth, pH increases with depth, the exchangeable cation is dominated by Al^{3+} and H^{+}, Ca^{2+} is about o.1 me/100 gr soils, CEC is about 10-15 me/100 gr clay, and the base saturation is extremely low. These conditions reflect the process of latosolization. Slight podzolization and clay cutans were also observed in the subsurface horizons in some sites.

The soils are classified as Latosols (SRI) or Tropeptic/Typic Haplorthox (USDA, 1975).

3.2 Soil map and soil classification

Soil map

The area delineated on soil maps are soil mapping units. The delineations were carried out during the course of the survey by field observation, air-photo interpretation, and then corrected after laboratory data were available. Therefore the legends of the soil maps presented in this final report are slightly different from those in the Progress Report.

In the semi-detailed soil map (scale 1:45,000) it is not possible to delineate every soil series individually. Consequently the soil mapping units consist of an association or complex of two or more soil series. Each individual soil series and general pattern of those series generally come out in the detailed soil maps (scale 1:5,000).

There are 7 detailed soil maps, i.e. 5 maps of sample blocks in Sitiung I and 2 maps of sample blocks in Sitiung II. In these detailed surveys impurities or inclusions are still present, but they are very small. The composition of materials and drainage classes in the floodplains and valley floors are heterogeneous and fragmented, so that they are grouped into one mapping unit.

Each soil map has a legend describing each mapping unit. Each mapping unit is indicated by a number and a symbol. The descriptions of the mapping units include a brief explanation of dominant soil series, parent material, and physical features. Detailed descriptions of each mapping unit are presented in Chapter 3.3.

The symbol of mapping units is the same as that used in the Kotabaru - Sungai Dareh area (1977) consisting of soil series and phases. The main elements of the soil series symbol are: characterization of parent materials, soil classification, drainage class, and epipedon of the soils. In addition, soil depth, substratum, and slopes are indicated as phases. This symbol is used both in the detailed and semi-detailed soil maps.

The differentiation of each element of the soil series symbol is as follows:

(1) Characterization of parent material:

Origin/Geomorphological Unit	Texture
A = alluvium (recent and subrecent)	U = very fine textured
T = tertiary terrace deposit (often mixed with volcanic weathering)	C = fine textured
	E = moderately fine textured
V = volcanic tuff (acid)	L = medium fine textured
	M = moderately coarse textured
	S = coarse textured
	O = organic debris

(2) Soil classification

Hf = Fibric Organosols/Histosols
Jd = Dystric Alluvial soils
Gd = Dystric Gley soils
Bd = Dystric Brown Tropical Soils/Acid Brown Forest Soils
Pc = Chromic Podzolic soils
Lc = Chromic Latosols
Lo = Oxic Latosols.

(3) Drainage class

1 to 9 with increasing poor drainage.
1 - 4 = well drained (decreasing in redness from 1 to 4).
5 = moderately well drained.
6 = imperfectly drained.

7 - 8 = poorly drained.

9 = very poorly drained.

(4) Epipedon

q = umbric

1 = ochric

h = histic

(5) Depth of soils

I = shallow (less than 50 cm)

II = medium (50 - 80 cm)

III = deep (80 - 120 cm)

IV = very deep (more than 120 cm).

(6) Slopes

A = 0 - 3%

B = 3 - 8%

C = 8 - 15%

D = 15 - 25%

E = more than 25%

Example of mapping unit symbol

Parent material: volcanic tuff (acid)

Texture of parent material: very fine textured

Soil classification: Oxic Latosols

Drainage class: well drained

Epipedon: ochric

VU - Lo - 3 1

IV B-C

Slope class: 3-8% to 8-15% (undulating to rolling relief).

Depth of soils: very deep (more than 120 cm).

Soil classification

The soil classification used in this survey is a modification of the National soil classification (Guideline for "Sungai Dareh - Kotabaru, 1976). As a reference, the US Soil Taxonomy (1975) and FAO/UNESCO system are also used at the level of subgroup (Appendix 5)

The soil units are classified at the level of soil series. A soil series is a group of soils having similarities in differentiating characteristics of their soil horizons, but may differ in the texture of surface horizon, and they have developed from a particular type of parent material. The soil series found in the survey area are not given names, but they are denoted with symbols.

There are 21 dominant soil series identified during the course of the survey. These soil series are derived from 6 Great Soil Groups. This differentiation is presented in Table 6 .

The six Great Soil Groups identified are: Organosols/Histosols (H), Alluvial soils (Jd), Gley soils (Gd), Brown Tropical Soils/Acid Brown Forest Soils (Bd), Podzolic Soils (Pc), and Latosols (L).

(1) Organosols/Histosols

These soils are found in the valley floors or small streams, such as in the sample block of Piruko (Sitiung I), and on the floodplain/backswamps of the R. Kuamang and R. Biawak. Their distribution is usually very small and commonly associated with Alluvial and/or Gley soils. Therefore in the semi-detailed soil map of the Sitiung II - S.Jujuhan area (scale 1:45,000) they are grouped into Mapping unit 2 as an inclusion. The Organosols/ Histosols can be delineated only in the detailed soil map of Block Piruko - Sitiung I.

These organic soils are a mesotrophic topogenic peat. They have developed from organic debris, wood and grasses. The soils are deep to moderately deep, loamy to silty and soft, fibric over hemic and sapric materials, very strongly acid, very high organic matter content. The C/N ratio is high (more than 15) increasing with depth, this means that the decomposition is low. This is due to a very poor drainage condition and an acid environment. The composition of mineral material and organic matter varies, nevertheless it is loamy peat. The mineral material is derived from alluvium and/or colluvium from the surrounding area which is very acid. They are classified as Fibrists (USDA, 1975) or Dystric Histosols (FAO/ UNESCO, 1974). They are grouped into one soil series i.e. AO-Hf-9h.

The area is usually used for wet ricefield or still under wetland forests.

Table 6. Dominant soil series found in the survey area (Sitiung I and Sitiung II - S.Jujuhan)

Symbol	Description	Parent material	Landform
HISTOSOLS			
AO-Hf-9 h	Histosols,fibric over sapric, very poorly drained, histic epipedon	Recent organic deposits	Valley floors
ALLUVIAL SOILS			
AE-Jd-3 1	Alluvial soils, moderately fine texture, well drained, ochric epipedon	Moderately fine textured recent alluvium	Recent floodplain
AE-Jd-5 1	Alluvial soils, moderately fine texture, moderately well drained, ochric epipedon		
AE-Jd-8 1	Alluvial soils, moderately fine texture, poorly drained, ochric epipedon		
AL-Jd-31	Alluvial soils, medium fine texture, well drained, ochric epipedon	Medium fine textured recent alluvium	Recent floodplain/ point bars
AC-Jd-3 1	Alluvial soils, fine texture, well drained, ochric epipedon	Fine textured recent alluvium	Recent floodplain/ terrace
AC-Jd-5 1	Alluvial soils, fine texture, moderately well drained, ochric epipedon		
AU-Jd-8 1	Alluvial soils, very fine texture, poorly drained, ochric epipedon	Very fine textured recent alluvium	Recent floodplain/ backswamps/oxbow lakes
AU-Jd-9 1	Alluvial soils, very fine texture, very poorly drained, ochric epipedon		
GLEY SOILS			
AU-Gd-7 1	Gley soils, very fine texture, poorly drained, ochric epipedon	Fine to very fine textured subrecent alluvium	Depression on subrecent river terrace
AU-Gd-8 1	Gley soils, very fine texture, poorly drained, ochric epipedon		
BROWN TROPICAL SOILS/ACID BROWN FOREST SOILS			
AC-Bd-3 1	Brown Tropical Soils, fine texture, well drained, ochric epipedon	Fine textured subrecent alluvium	Subrecent river terrace
AC-Bd-5 1	Brown Tropical Soils, fine texture, moderately well drained, ochric epipedon		
AU-Bd-2 1	Brown Tropical Soils, very fine texture, well drained, ochric epipedon	Very fine textured subrecent alluvium	
AU-Bd-3 1	Brown Tropical Soils, very fine texture, well drained, ochric epipedon		
AU-Bd-5 1	Brown Tropical Soils, very fine texture, moderately well drained, ochric epipedon		
AU-Bd-6 1	Brown Tropical Soils, very fine texture, imperfectly drained, ochric epipedon		
PODZOLIC SOILS			
AU-Pc-5 1	Chromic Podzolic soils,very fine texture,moderately well drained,ochric epipedon	Very fine textured subrecent alluvium(colluvium)	Recent and subrecent valley floors
TU-Pc-5 1	Chromic Podzolic soils,very fine texture, moderately well drained, ochric epipedon	Very fine textured tertiary alluvium /colluvium	Peneplain
LATOSOLS			
VU-Lo-3 1	Oxic Latosols, very fine texture, well drained, ochric epipedon	Very fine textured acid volcanic tuff	Peneplain volcanic cover
VU-Lc-3 1	Chromic Latosols, very fine texture, well drained, ochric epipedon		

(2) Alluvial soils (Jd)

Alluvial soils are defined as young soils developed from recent or sub-recent alluvial or/and colluvial materials. They are soils without or with a weak soil profile development (A-C profile). Stratification due to series of sedimentations is often identified. Their distribution is generally found on recent floodplains (low levees, backswamps, point bars, meander scars) and valley floors, and they are often present in association with Gley soils (Gd) and/or Organosols (H).

These soils vary in their characteristics showing a close relationship with their landscape positions. Soils on levees/point bars are well drained, deep, stratified, brown to yellowish brown colour, very poreous, loamy to sandy texture, weak crumb or granular structure, friable, medium acid (pH 5.6 - 6.3), high organic matter on the top soils, high to very high P_2O_5 and K_2O, and medium to high base saturation. The exchangeable cation is dominated by Ca^{2+}, and the CEC is more than 40 me/100 gr clay. These Alluvial soils belong to soil series AE-Jd-31.

Alluvial soils found on the recent terraces are moderately well to well drained, deep, yellowish brown to dark brown, clayey texture, massive to weak subangular blocky, friable to firm, iron mottles and manganese concretions (soft or hard) are commonly present, pH (5.0-5.5) is lower than that on the levees/point bars. P_2O_5, K_2O and nitrogen are low, base saturation is low, CEC ranges from 24 to 35 me/100 gr clay. The exchangeable cation is dominated by H^+ and Al^{3+}, and Ca^{2+} is 0.5 - 2.0 me/100 gr soils. These Alluvial soils belong to soil series AC-Jd-31 or AC-Jd-51.

The Alluvial soils found on backswamps and meander scars are generally poorly drained, deep to moderately deep, grayish colour, clayey, massive and firm or sticky (wet), mottles as well as gley colours are present throughout the profile. The soils are very poor in nitrogen, P_2O_5 and K_2O, strongly to extremely acid, very low base saturation. The exchangeable cation is dominated by Ca^{2+}, CEC is about 35 me/100 gr clay. In the area west of Kuamang village the underneath layer consists of quartz sand which have developed into Humus Podzol with pronounced Bh horizon. These Alluvial soils belong to soil series AE-Jd-81 or AU-Jd-81.

The classification of all these soil series are as follows:

AE-Jd-31
AE-Jd-51) Tropofluvents (USDA,1975), Eutric Fluvisols (FAO/UNESCO, 1974)

AE-Jd-81
AU-Jd-81) Tropic Fluvaquents (USDA, 1975), Dystric Gleysols (FAO/UNESCO, 1974)

AC-Jd-31
AC-Jd-51) Fluventic Dystropepts (USDA, 1975), Dystric Cambisols (FAO/UNESCO, 1974).

The areas are usually used as "ladang", wet ricefield, or still under secondary forests. Most of the crops grow well.

(3) Gley soils (Gd)

Gley soils are found in the poorly to very poorly drained depressions and valley floors, characterized by gley horizons due to stagnant water or high groundwater table. They associate with Acid Brown Forest Soils or Podzolic soils.

These soils have developed from alluvial/colluvial materials which are generally clayey (fine to very fine) texture. The profile development is medium to weak with an A-BG-CG or A-BtG-CG horizonation. The soils are deep to moderately deep and in some places underlain by a compact quartzite gravel layer derived from the peneplain. The soil colour is brownish gray to gray in the surface horizon and pale gray to white in the subsurface horizon or deeper, clayey (very fine) texture, weak subangular blocky structure, sticky, slow permeability, extremely to strongly acid, high to very high organic carbon and medium nitrogen in the surface horizon, but low to very low in the subsurface horizons. P_2O_5 is medium to high, K_2O is low to very low, base saturation is very low, and the exchangeable cation is dominated by H^+ and Al^{3+}. The adsorption capacity is low in the transition to Podzolic soils, and medium in the Brown Tropical Soils (subrecent river terrace) area. The increase of clay cutans were observed in some places.

Two dominant soil series were recognized i.e. series AU-Gd-71 and AU-Gd-81. Both soil series are poorly drained, but the former is better than the latter due to its rather higher position in the depressions.

These soils are classified as Gley soils (SRI) or Aeric Tropaquults (USDA, 1975) or Gleyic Acrisols (FAO/UNESCO, 1974).

(4) Brown Tropical Soils/Acid Brown Forest Soils (Bd)

These soils have developed from acid subrecent river alluvium on the subrecent river terrace of the Batang Hari, Batang Jujuhan and Batang Siat. The materials mainly consist of volcanic products from the catchment area of those rivers, their texture is very fine to fine.

The landform is level to slightly undulating subrecent river terrace. Soils on the ridges are well drained and increase in wetness to the depressions which are poorly to very poorly drained, even stagnant water commonly occurs mainly in the rainy season. Therefore the profile development is greatly influenced by rain water, and in Kotabaru, Sipangkur and Blocks F-G of the Sitiung II it is also influenced by shallow groundwater table. Due to excessive wetness the soils on the depressions are grouped into "Gley soils" (Fig. 3).

Soils on the ridges generally have a well developed B-cambic horizon (A-(B)-C), deep to very deep, homogeneous, dark brown to reddish brown, fine texture, subangular blocky to crumb structure, friable and poreous. The reddish soils are slightly high in the clay content. These soils are low in organic matter and base saturation, very strongly acid (pH 4.5-5.5), and the exchangeable cation is dominated by H^+ and Al^{3+}. The CEC is more than 24 me/100 gr clay, and the clay is dominated by kaolinite and amorphous materials. These soils are the typical Brown Tropical Soils/Acid Brown Forest Soils. They are classified as Oxic Dystropepts (USDA, 1975) or Dystric Cambisols for the series AC-Bd-31 and Chromic Cambisols for the series AU-Bd-21 (FAO/UNESCO, 1974).

Soils on level to slightly sloping area are deep to very deep, compact tending to have a Bt horizon in the subsurface horizon reflected by the clay skins/cutans (A-Btg-Cg), brown to yellowish brown colour, rich in reddish and yellowish mottles in the subsoils, fine to very fine texture, subangular blocky structure, firm, and low porosity. The iron manganese concretions scattered in the profile, the pea sized concretions often form a layer in the subsurface horizon, whereas hardpan or stone sized concretions sometimes were observed close to the depressions. Their chemical characteristics are similar. These soils are "wet association" of the Brown Tropical Soils tending to be classified as Gray Hydromorphic soils (SRI) or Aeric Tropaquults (USDA, 1975) or Gleyic Acrisols (FAO/UNESCO, 1974).

All of these series and their classification are summarized as follows:

AC-Bd-31 Oxic Dystropepts (USDA, 1975) or Dystric Cambisols (FAO/UNESCO, 1974).

AU-Bd-21 Oxic Dystropepts (USDA, 1975) or Chromic Cambisols (FAO/UNESCO, 1974).

AC-Bd-51)
AU-Bd-51) Aeric Tropaquults (USDA, 1975) or Gleyic Acrisols (FAO/UNESCO,
AU-Bd-61 1974).

These soils are used for dry field, rubber plantation, shifting cultivation, or under natural vegetations. In the transmigration field many of the A_1 horizons were removed by uncontrolled mechanical land clearing, and even more compacted horizon were observed. These conditions may cause serious damage to most food crops grown in the area, except for Cassava.

(5) Podzolic soils (Pc)

These soils occur in an undulating peneplain grading to the subrecent terrace, on the footslopes and the transition area to the valley floors. Possibly these areas were not covered intensively by the volcanic products of the Barisan Range in the early quaternary period, or the covering materials were intensively eroded. Therefore the older materials mainly consist of grayish to yellowish clay containing quartzite gravel terrace are still dominant materials forming these soils as reflected by the mineral composition of the soil samples. While the transition area is derived from alluvium or colluvium of the surrounding area.

These soils are moderately well to well drained with prominent clay cutans in the upper parts of the subsurface horizon (A-Bt-C). The solum is deep to very deep, yellowish brown to brown colour with reddish mottles scattered mainly in the lower parts of the subsoils, very fine texture (heavy clay) with relatively high quartz sand, subangular blocky structure, firm and medium to rather low porosity. In the transmigration field this layer is more compact. The organic matter is low and C/N ratio decreases rapidly with depth. The base saturation is extremely low, the exchangeable cation is dominated by H^+ and Al^{3+}, Ca^{2+} is generally less than 0.2 me/100 gr soils. The CEC is low (± 12 me/100 gr clay). The soils are very strongly acid.

These soils are classified as Chromic Podzolic soils (Yellowish Brown Podzolic soils) or Orthoxic Tropudults(USDA,1975) or Ferric Acrisols (FAO/UNESCO, 1974) and grouped into two soil series i.e. TU-Pc-51 and AU-Pc-51.

The area is used for rubber plantation, dryfield, shifting cultivation, or they are still kept under forest. The first crops in the transmigration farms looked slightly better than those in the Latosols.

(6) Latosols (L)

These soils occur very extensively on undulating to rolling areas. They have developed from acid volcanic tuffs which were deposited on the peneplain in the early quaternary period. They have advanced soil profile development characterized by oxic and weak argillic horizon, and thin to very thin surface (A_1) horizon, even under primary forest.

The soils are very deep, homogeneous and diffuse horizon differentiation, strong brown to reddish brown colour, very fine texture, crumb to weak subangular blocky, friable and poreous. Clay nodules and fine stable aggregates are typical characteristics of the B-oxic horizon. In some places clay cutans were identified mainly in the subsurface horizon. The soils are generally very strongly acid to extremely acid, low to very low nitrogen, P_2O_5 and K_2O. C/N ratio is medium and decreases to constant with depth. The base saturation is extremely low and the exchangeable cation is dominated by H^+ and Al^{3+}, while Ca^{2+} is about 0.1 me/100 gr soils. The CEC is low (± 10 me/100 gr clay).

The soils having argillic characteristics are slightly higher in the CEC (± 13 me/100 gr clay).

Based on those characteristics these Latosols are separated into Chromic Latosols (with weak argillic horizon) and Oxic Latosols (with B-ox.horizon), and based upon the US Soil Taxonomy and FAO/UNESCO systems, they are classified as Typic Haplorthox and Tropeptic Haplorthox, and Orthic Ferralsols and Xanthic Ferralsols respectively. The positions in landscape of these soils are irregular (no definite pattern).

The area is used for transmigration project, rubber plantation, shifting cultivation, and the largest area is still under primary forest. The transmigration settlements and dryfields of Blocks D and E (Sitiung II) are also located on these soils.

Two soil series were identified i.e. VU-Lc-31 and VU-Lo-31.

3.3 Mapping Unit descriptions

Mapping Unit 1: $\frac{\text{AE,AL-Jd-3,51}}{\text{IIIA}}$ Association of well and moderately well drained Alluvial soils, deep, stratified, moderately fine and medium fine texture, ochric epipedon.

This unit occurs along the main rivers of the Batang Hari, Batang Siat and Batang Jujuhan. It is located on the recent floodplains including low levees, point bars, meander splays and scars. Most areas are flat to very slightly undulating micro relieves with dominant slopes 0-3%.

The area is under riverine forest, grasses, bushes, or cultivated for arable food crops. The unit occupies a total acreage ±1,120 ha or 5.6% of the survey area.

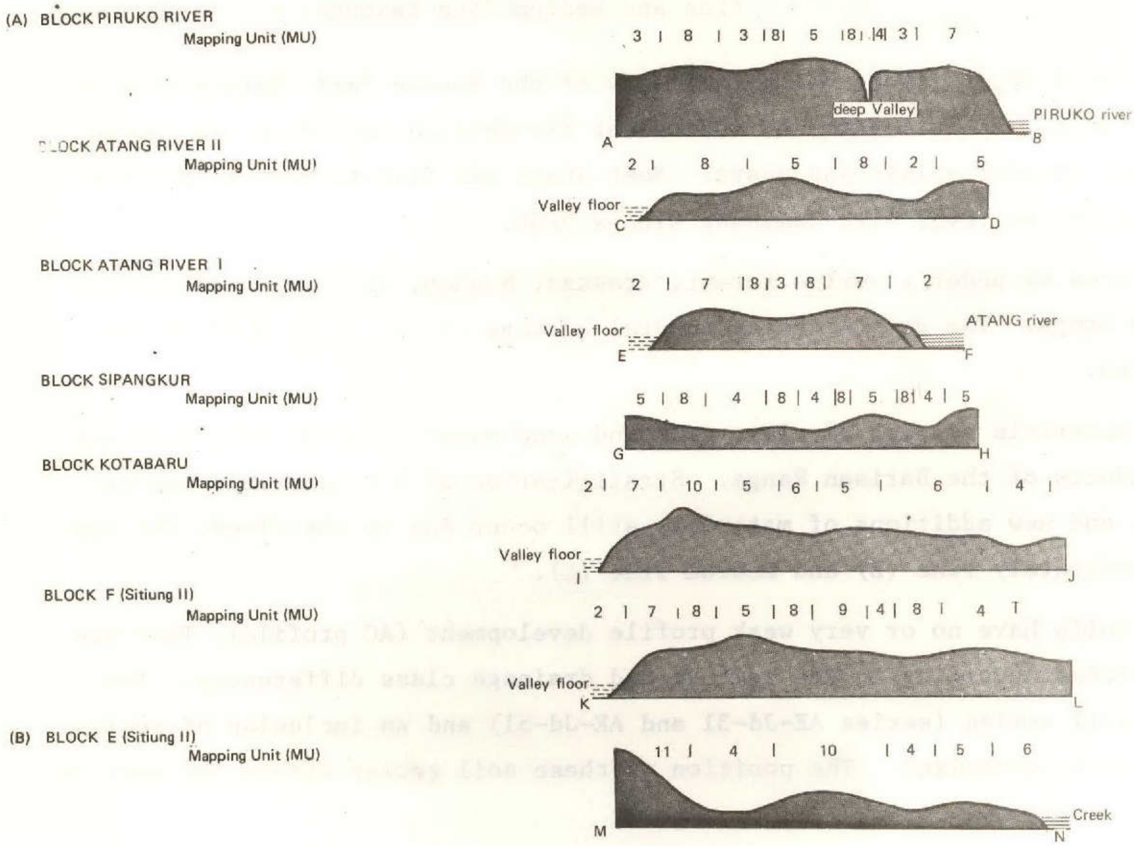
The materials consist of clay, silt and sand mainly derived from acid volcanic products of the Barisan Range. Stratification of the materials was recognized, and new additions of materials still occur due to the flood. The texture is moderately fine (E) and medium fine (L).

The soils have no or very weak profile development (AC profile). They are differentiated according to the texture and drainage class differences. Two dominant soil series (series AE-Jd-31 and AE-Jd-51) and an inclusion of series AL-Jd-31 were recognized. The position of these soil series within the unit is presented in Fig. 3.

The soil series AE-Jd-31 is deep, poreous and well drained. The topsoil is brown (10 YR 4/3), moderately fine texture, weak subangular blocky, firm (moist), non sticky and non plastic (wet). The stratified subsoils are brown (10YR 4/3) to yellowish brown (10YR 5/4-5/6), moderately fine texture and medium fine texture in the deeper layers, weak subangular blocky and massive below, firm to friable, slightly sticky and non plastic. The series is represented by Profile Ms 15 (SRI 195480/484).

The topsoil is medium acid, very high organic carbon and high nitrogen, very high total P_2O_5 as well as K_2O, high base saturation and very high adsorption capacity. The subsoils are medium to strongly acid, low organic matter, medium to high base saturation, medium to high P_2O_5, very high K_2O and medium adsorption capacity. The C/N ratio is low to very low, the Ca^{2+2} is very high in the topsoil (more than 20 me/100 gr soils) and medium (6-10 me/100 gr soils) in the subsoils. Mineral reserve is medium.

SCHEMATIC SOIL PATTERN IN SUBRECENT RIVER TERRACE (A) AND PENEPLAIN (B)



2	Complex :	Heterogeneous Alluvial Soils and Organosols, variable in depth, texture and drainage (predominantly poorly drained, marshy).
3	AU – Gd – 7 I :	Gley Soils, deep, very fine texture, poorly drained, ochric epipedon
4	AU – Gd – 8 I :	
5	AC – Bd – 3 I :	Brown Tropical Soils, very deep, fine texture, well drained ochric epipedon.
6	AC – Bd – 5 I :	Brown Tropical Soils, very deep, fine texture, moderately well drained, ochric epipedon.
7	AU – Bd – 2 I :	Brown Tropical Soils, very deep, very fine texture, well drained, ochric epipedon.
8	AU – Bd – 5 I :	Brown Tropical Soils, very deep, very fine texture, moderately well drained, ochric epipedon.
9	AU – Bd – 6 I :	Brown Tropical Soils, very deep, very fine texture, imperfectly well drained, ochric epipedon.
10.	TU – Pc – 5 I :	Chromic Podzolic Soils, deep, very fine texture, moderately well drained, ochric epipedon.
11	VU – Lo – 3 I :	Oxic Latosol, very deep, very fine texture, well drained, ochric epipedon.

Figure 3

The soil series AE-Jd-51 is deep, moderately well drained. The topsoil is dark grayish brown (10YR 4/2), moderately fine texture, massive, friable, sticky and plastic. The subsoils are brown (10YR 4/3-5/3), moderately fine texture, massive to weak subangular blocky, friable to firm, slightly sticky and plastic. Very dark gray (10YR 3/1) manganese mottles are present in the subsoils. The series is represented by Profile T 11 (SRI 195528/531).

The soils are slightly acid (pH 6.0-6.4), high organic carbon in the topsoil and low to very low in the subsoils, nitrogen is medium to low. Total P_2O_5 is very high in the topsoils and high in the subsoils, K_2O is high throughout. Base saturation is medium in the topsoil and high in the subsoils, adsorption capacity is high in the topsoil and medium in the subsoils. The C/N ratio is medium and Ca^{2+} is medium to high. Mineral reserve is low.

Irrigability class	:	This area is considered to be not suitable for wetland rice under gravity irrigation especially due to the risk of floods and the soils are mostly poreous (Subclass IVs,f).
Actual soil suitability	:	The area is moderately suited for arable crops (Subclass IIIf) and marginally suited for rubber (Subclass IVf).
Potential soil suitability	:	Since the area is difficult to improve, the potential soil suitability subclasses for arable crops and rubber are still the same with those of the actual soil suitability subclasses.

Mapping Unit 2: (Complex) - Complex of heterogeneous Alluvial soils, stratified, variable in depth, texture and drainage classes, ochric/histic epipedon.

This unit occupies narrow valley floors and stream belts, and it is scattered throughout the survey area. The areas are bordered by short steep slopes and practically all of the areas are subject to flooding during most of the year, and some parts are marshy. This unit is generally used for wetland rice, under forest or bushes. The total area is 859 ha or 4.3%.

The materials consist of very heterogeneous textured alluvium or colluvium derived from the surrounding area. Gravelly layer of quartzite gravels was observed mainly in the stream belts of the peneplain.

The soils have a heterogeneous colour, texture and drainage class, but generally they are poorly to very poorly drained. The very poorly drained soils are generally unripe and complex with Organosols. Whereas the soils on the slightly better drained area are ripe, containing gley yellowish and reddish mottles at different depth depending on the fluctuation of ground water table. Stratification can be identified. The better drained areas are usually found on the river banks. This unit was not sampled due to very scattered small and heterogeneous.

Irrigability class : This area is definitely not suitable for wetland rice under gravity irrigation (Class VI) due to the risk of the flood and the area is too narrow (small). However, this unit still can be used for traditional wetland ricefield, especially in the dry season, but the area is relatively very small.

Actual soil suitability : This unit is generally not suited for arable crops as well as rubber (Class VI).

Potential soil suitability : Since the unit is very difficult to improve, the potential soil suitability for arable crops and rubber are still considered unsuitable (Class VI).

Mapping Unit 3: $\frac{\text{AE,AU-Jd-8,91}}{\text{IIIA}}$ - Association of poorly and very poorly drained Alluvial soils, deep, moderately fine and very fine texture, ochric epipedon.

This unit occupies the depressions or backswamps which partly dried in the dry season. Oxbow lakes are typical characteristics of this unit. The area is concave with slightly undulating microrelief, and the dominant slopes are 0-3%.

The unit is under wetland ricefield (sawah), swampy brushwood or grass. The total acreage is about 118 ha or 0.5% of the survey area. The material is moderately fine to very fine textured recent river alluvium. In some places such as in the west of Kuamang village, stratification of the materials was still recognized. The coarser materials are found underneath the finer ones. These coarser materials are composed of quartz sand and have developed into Humic Podzols. The materials derived from the survey area are finer textured and less fertile than those from the main rivers. In addition, the soils in the wetter area are generally unripe with muddy structure.

Three dominant soil series were recognized i.e. series AE-Jd-81, AU-Jd-81 and AU-Jd-91. The position in landscape of these soil series is presented in Fig. 3.

Soil series AE-Jd-81 is moderately deep to deep and poorly drained. The topsoil is light gray (10YR 6/1) locally dark brown (7.5 YR 3/2), medium fine texture, sticky and plastic (wet), many distinct yellowish brown (10YR 5/8) and brown (7.5YR 5/8) mottles. The subsoil is light gray (10YR 6/1) to brownish gray (10YR 6/2) with many large distinct strong brown (7.5YR 4/6) to red (2.5YR 4/6) iron mottles, moderately fine texture, massive to weak subangular blocky structure, firm to very firm (moist), sticky and plastic (wet).

The soils are strongly acid (pH 5.0-5.5). In the topsoils the organic matter and nitrogen are low, phosphorus and potassium are medium. The organic matter decreases with depth, while phosphorus increases. The base saturation is low to medium (38-45%), the adsorption capacity (CEC of soils) is medium (14-18 me/100 gr soils) and CEC clay is high (26-35 me/100 gr clay). Ca^{2+} is low (3.9-4.5 me/100 gr soils), and mineral reserve is medium.

The soil series AU-Jd-91 is very poorly drained and submerged by water almost all the year round. This series was not sampled.

The soil series AU-Jd-81 originating from weathering products of the materials from the survey area is very fine textured, extremely acid (pH 4.5-5.0), base saturation is very low (less than 5%). The adsorption capacity is medium to high (18-44 me/100 gr soils or 17-33 me/100 gr clay). The exchangeable cation is dominated by H^{+} and Al^{3+}. The Ca^{2+} is less than 0.5 me/100 gr soils. Mineral reserve is low.

Irrigability class : This area is expected to be not suitable for wetland rice under gravity irrigation especially due to the risk of excessive wetness (stagnant water) which is difficult to drain (Subclass IVfn).

Actual soil suitability : These soils are generally not suited for arable crops as well as rubber (Class VI) having very severe limitations especially flooding and very low nutrient status.

Potential soil suitability : After certain improvements (especially fertilization and drainage measures to a certain extent) are made, the soils will be marginally suited for arable crops (Subclass IVfn), and poorly suited for rubber (Subclass Vfn).

Mapping Unit 4: $\frac{\text{AC-Jd-3,51}}{\text{IVA}}$ - Association of well and moderately well drained Alluvial soils, very deep, fine texture, ochric epipedon.

This unit is found in the northeast of Blocks F and G, west of Teluk Kayuputih, west of Kuamang village, southeast of Dusun Limau, and west of Block D. The area is flat to slightly undulating with dominant slopes 0-3%. The convex area is well drained and the flat to concave area is moderately well drained.

The unit is mostly used for arable crops such as upland rice, soybeans, corn, groundnuts and cassava, or in some places are still under alang-alang. The unit covers ± 489 ha or 2.4% of the survey area.

The material is fine textured recent river alluvium. This mapping unit is flooded during the big flood. The area is located close to the subrecent river terrace (Mapping Unit 5), therefore the upper parts of this unit are influenced by the alluvial/colluvial materials coming from that area.

The soils are grouped into Alluvial soils (SRI) or Fluventic Dystropepts (USDA) deriving two dominant soil series, i.e. Series AC-Jd-31 and series AC-Jd-51. The former series is well drained soils occupying the higher position (convex area), and the latter is moderately well drained occupying the level to rather concave areas. The position of those two soil series is illustrated in Fig. 3.

Soil series AC-Jd-31 is very deep and well drained. The topsoil is dark brown, fine texture, massive and firm. The subsoil is brown, fine texture, weak subangular blocky to massive, friable to firm, few small manganese concretions scattered in the profile (Typical profile SK 13/SRI 195282 - 286).

The soil reaction is strongly acid (pH 5.0-5.5). The organic matter and nitrogen is very low, P_2O_5 is medium, K_2O is low to very low. Base saturation is very low (less than 10%), the adsorption capacity is medium (CEC = 24-30 me/100 gr clay), and the exchangeable cation is dominated by H^+ and Al^{3+} (Al saturation ± 75%), while Ca^{2+} = 0.5-1.5 me/100 gr soils. Mineral reserve is very low.

Soil series AC-Jd-51 is very deep and moderately well drained. The topsoil is brown (10YR 4/3), moderately fine texture, massive to weak subangular blocky, friable to firm, few distinct mottles. The subsoil is yellowish brown to dark yellowish brown (10YR 5/6-4/4), moderatley fine to fine texture, massive to weak and moderate subangular blocky, firm, manganese concretions (soft) and distinct yellowish red (5YR 4/6) mottles increasing with depth (Typical profile Ms 13/SRI 195475 - 479).

The soil reaction is strongly acid (pH 5.0-5.5). The organic carbon, nitrogen, phosphorus and potassium are medium in the topsoil and low to very low in the subsoil. Base saturation is low to very low and the exchangeable cation is dominated by H^{+} and Al^{3+}, while Ca^{2+} is 0.5-2.5 me/100 gr soils. The adsorption capacity is medium (CEC of clay 26-40 me/100 gr clay). Mineral reserve is very low to low.

Irrigability class : This unit is expected to be moderately suitable for wetland rice irrigation (Subclass IIn, s) especially due to its flat landform.

Actual soil suitability : The unit is evaluated into Subclass IVn (marginally suited) for arable crops, and Subclass IIIn (moderately well suited) for rubber. The only factor considered to be slight limitation is the low nutrient status of the soils.

Potential soil suitability : After certain improvements to a certain extent especially by applying balanced fertilizers, the unit may become Subclass IIIn (moderately well suited) for arable crops and Subclass IIn (well suited) for rubber.

Mapping Unit 5 : $\frac{\text{AU-Bd-2,3,5 1}}{\text{IVA}}$ - Association of well and moderately well drained Brown Tropical Soils/Acid Brown Forest Soils, very deep, very fine texture, ochric epipedon.

This unit occupies a rather extensive area along the Batang Hari, Batang Jujuhan and Batang Siat rivers. The relief is level to slightly undulating with elongated low ridges and depressions with dominant slopes 0-3%. In some places it is dissected by some narrow deep valleys such as in Block D and near Pulau Batu.

Most of the areas have been cultivated. Rubber and coffee plantation, ladang/dry fields and brushwoods, locally wetland ricefield in the valley floors are common land use type of this unit. All local villages with small home gardens and coconuts are located in this unit. Local rules have considered this area to be specified for food crops. This unit covers a total area approximately 4,388 ha or 22.0% of the survey area.

This unit is dominated by soil series AU-Bd-21 and AU-Bd-51, with inclusions of series AC-Bd-31, AU-Bd-61 and AU-Gd-81 (see detailed soil map of Block F - Sitiung II). Soil series AC-Bd-31 and AU-Bd-21 generally occupy the ridges or convex areas, while series AU-Bd-51 and AU-Bd-61 generally occupy the level to concave areas which gradually change into depressions where soil series AU-Gd-81 exists. This general soil series pattern is illustrated in Fig. 3 . These soils have developed from subrecent river alluvium (terrace materials) dominated by acid volcanic products of the Barisan Range.

Soil series AU-Bd-21 is very deep, well drained, strong brown to yellowish red colour, fine to very fine texture, subangular blocky, friable to firm, and very small iron-manganese concretions are scattered throughout the profile. The subsoil colour is sometimes redder (Typical profile is SK 16, MD 28).

The soils are moderately slow to medium permeability, poreous with medium available water pores, medium plasticity and good aggregate stability. The topsoil is rather poor due to mechanical land clearing as compared to that of hand clearing or under natural vegetation. This soil series is generally extremely acid (pH 4.0-4.5), low to very low organic matter, nitrogen, phosphorus and potassium, and extremely low base saturation. The exchangeable cation is dominated by H^+ and Al^{3+} (Al-saturation is more than 80%), Ca^{2+} is generally less than 0.4 me/100 gr soils, the adsorption capacity is medium (20-30 me/100 gr clay). Micro elements such as manganese is high, while copper and zinc are rather low. The topsoil in general is slightly better.

Soil series AU-Bd-31 chemically is not much different from soil series AU-Bd-21, but physically and morphologically it is rather different. The depth of the soils is generally less than 150 cm and underlain by sandy/gravelly layer. The soils are well drained, dark brown to brown, fine texture, subangular blocky to crumb, friable and very small iron manganese concretions scattered throughout the profile (Typical profile MD 10/SRI 195505 - 509). This series is generally poreous and it has moderate slow permeability, medium available water pores, medium plasticity and good to very good aggregate stability. The topsoil is rather poor in the mechanically cleared area.

This series is less acid (pH 4.0-4.5), Al-saturation ranges from 70 to 80%, Ca^{2+} is more than 0.2 me/100 gr soils, and the CEC is higher (30-35 me/100 gr clay). The other characteristics are almost similar.

Soil series AU-Bd-51 is deep to very deep, moderately well drained, rather compact, brown to dark yellowish brown, fine to very fine texture, subangular blocky to massive and firm. Reddish to yellowish and strain gray mottles are scattered throughout the profile increasing with depth. The small manganese-iron concretions are also scattered in the profile, but the pea-sized concretions generally form a layer in the subsurface horizon (Typical profile SK 28/ SRI 195303-306). The topsoil is dark yellowish brown to yellowish brown (10YR 4/6-5/4), fine to very fine texture, weak subangular blocky to massive, friable to firm. The subsoil is strong brown (7.5YR 5/6) to dark yellowish brown (10YR 4/6), very fine texture, weak to moderate subangular blocky, firm to friable. Mottles and gley phenomena increase in the soil series AU-Bd-61 which is imperfectly drained soils (Typical profile Ms 27/SRI 195333-338). In the rainy season ponded water often occurs.

These soil series are moderately slow to slow permeability, low to medium available water pores, medium plasticity and medium to good aggregate stability. In the field cleared by heavy machineries, those physical properties of the topsoils are rather poor.

These series are strongly acid (pH 4.0-4.5), poor in organic matter, nitrogen, phosphorus as well as potassium, and extremely low base saturation. The exchangeable cation is dominated by H^+ and Al^{3+}, while the Ca^{2+} is generally less than 0.2 me/100 gr soils. The adsorption capacity is about 20-30 me/100 gr clay. Total manganese content is high, while Cu and Zn are rather low. The topsoil is generally rather good.

The distribution of soil series AU-Gd-81 is relatively very small and occupies small depressions. The area is generally dry in the dry season, but ponded water is always found in the rainy season. In a rather wide area this series is usually used for wetland rice. This series is poorly drained and deep to very deep.

Irrigability class : This unit is expected to be moderately suitable for wetland rice under gravity irrigation (Subclass IIn,s) with the limitations of low soil fertility and soil physical conditions.

Actual soil suitability : The dominant soils (Series AU-Bd-21 and AU-Bd-51) are marginally suited for arable crops (Subclass IVn) and moderately well suited for rubber (Subclass IIIn). The dominant limitation is especially their low soil fertility. While the localized areas (the other soil series) have poorly suited class both for arable crops and rubber (Subclass Vd) mainly due to the poor drainage condition.

Potential soil suitability : After improving the limitations to a certain extent, the dominant soils will be moderately well suited for arable crops (Subclass IIIn) and well suited for rubber (Subclass IIn). Whereas the other small areas (concave/depressions) will be moderately well suited for arable crops as well as rubber (Subclass IIId).

Mapping Unit 6 : $\frac{\text{AU-Pc,Gd-5,8 1}}{\text{IIIA-B}}$ - Association of moderately well drained Chromic Podzolic soils and poorly drained Gley soils, deep, very fine texture, ochric epipedon.

This unit occupies rather wide valley floors (stream belts) and transitional plains. The valley floors are generally flooded during the rainy season, while the transitional plains which are rather higher in their position are not flooded anymore. The relief is level and marshy in the valley floors, and slightly undulating in the transitional plains. The dominant slopes are 0-5%.

The groundwater fluctuates with season. During the rainy season most of the areas are flooded and in the dry season are dry with the groundwater table is about 80 cm below the surface. Most of the areas are still under primary forest; only small parts are used for rubber plantation, dryfields, and locally wetland ricefields. This unit covers an area approximately 1,356 ha or 6.8% of the survey area.

This unit is dominated by soil series AU-Pc-51 and AU-Gd-81. These soils have developed from alluvial and colluvial materials of the surrounding areas. In some places Organic soils are found in small areas as an inclusion. Soil series AU-Pc-51 occupies the high transitional plains, while series AU-Gd-81 occupies the valley floors (marshy areas). This pattern is illustrated in Fig. 3 .

Soil series AU-Pc-51 is deep to very deep, moderately well drained, brown to yellowish brown, the underneath horizon is pale brown, very fine texture, subangular blocky structure, friable to firm. Reddish to brownish mottles and clay cutans were observed in the upper parts of the subsoil horizon. The soils are medium permeability (Typical profile MD 16/SRI 195515-518).

This series is extremely acid (pH 4.0-4.5), low in organic matter, nitrogen, phosphorus and potassium. The base saturation is extremely low, the exchangeable cation is dominated by H^+ and Al^{3+} (Al-saturation is more than 80%), while the Ca^{2+} is 0.1 me/100 gr soils. The adsorption capacity is low (about 10 me/100 gr clay). The topsoil is slightly better.

The series AU-Gd-81 is moderately deep to deep and poorly drained. The topsoil is pale brown to dark gray, fine texture, subangular blocky to crumb, friable to firm, and high organic matter content. The subsoil is grayish brown to gray, very fine texture, subangular blcoky to massive. Discontinuous clay cutans were recognized in the subsurface horizon. Reddish and yellowish mottles increase with depth. In the lower parts of the subsoil distinct slickensides were observed.

This series is extremely acid (pH 4.0-4.5), low in nitrogen, phosphorus and potassium. The base saturation is extremely low, the exchangeable cation is dominated by H^+ and Al^{3+} (Al-saturation is more than 80%), while Ca^{2+} is 0.1 me/100 gr soils. The adsorption capacity is low (10-15 me/100 gr clay).

Irrigability class :	The valley floors (Gley soils) are expected to be not suitable for wetland rice under gravity irrigation (Subclass IVf,n) having severe limitations of flooding and very low soil fertility. Whereas the transitional plains (Podzolic soils) are marginally suitable (Subclass IIIt, n) with the limitations of undulating topography and very low soil fertility.
Actual soil suitability :	The transitional plains are marginally suited for arable crops (Subclass IVn) and moderately suited for rubber (Subclass IIIn). Whereas the valley floors are generally not suited for arable crops as well as rubber (Class VI).
Potential soil suitability :	After improvements, the transitional plains may become moderately well suited for arable crops (Subclass IIIn)

and well suited for rubber (Subclass IIn). Whilst the valley floors which are difficult to improve, potentially are not suited for arable crops (Class VI) and poorly suited for rubber (Subclass Vf,n).

Mapping Unit 7	:	$\frac{\text{TU-Pc-51}}{\text{III-IV/B-C}}$	-	Moderately well drained Chromic Podzolic soils, deep to very deep, very fine texture, ochric epipedon.

This unit is found on the undulating peneplain (dominant slopes 5-10%) west of Block E, south of Kuamang, between R. Kuamang and R. Biawak, and in the south of Block F/R. Biawak. This unit is used for rubber plantation, dryfields, or still under natural vegetation/primary forest. The total area is about 690 ha or 3.4% of the survey area.

The parent material is mainly composed of tertiary terrace deposits or mixed with quaternary volcanic deposits. The mineralogical composition of the soil samples is dominated by turbid quartz. The mineral reserve is low.

This unit is dominated by soil series TU-Pc-51 with inclusion of series AU-Gd-81 in narrow valley floors (see detailed soil map of Block E). This soil series is moderately well to well drained with deep to very deep solum. The topsoil is brown to yellowish brown, locally grayish brown, very fine texture, subangular blocky to rather massive, firm to very firm. The subsoil is yellowish brown to brownish yellow, very fine texture, subangular blocky and firm. Reddish mottles increasing with depth, pronounced clay cutans especially in the upper parts of the solum, and scattered small manganese concretions were identified.

The soils have moderately slow permeability, medium available water pores, low aeration pores, good aggregate stability, and medium plasticity. The bulk density increases with depth, and the infiltration rate is slow.

This series is extremely acid (pH 4.0-4.5), very low organic matter, nitrogen, phosphorus and potassium. The base saturation is extremely low, the exchangeable cation is dominated by H^+ and Al^{3+} (Al-saturation is more than 85%), while the Ca^{2+} is about 0.2 me/100 gr soils. The adsorption capacity is about 20 me/100 gr clay. The micro elements Mn, Cu and Zn are low. The topsoil is slightly better. Large area of the transmigration field have a thin topsoil or it has been totally removed by uncontrolled mechanical land clearing.

Irrigability class	:	This unit is expected to be not suitable for wetland rice under gravity irrigation due to unfavourable topography and very low soil fertility (Subclass IVt,n).
Actual soil suitability	:	The soils are poorly suited for arable crops (Subclass Vt,n) and marginally suited for rubber (Subclass IVs,n) having severe and moderate limitations especially unfavourable topography, very low nutrient status, and rather poor soil physical conditions.
Potential soil suitability	:	After improving those limitations to a certain extent, the soils will be moderately well suited for arable crops as well as rubber (Subclasses IIIt,n and IIIs,n respectively).

Mapping Unit 8 : $\frac{\text{VU-Lo,Lc-31}}{\text{IV B-C}}$ - Association of well drained Oxic and Chromic Latosols, very deep, very fine texture, ochric epipedon.

This unit is found on undulating to rolling peneplain volcanic cover with rounded and convex ridge crests, narrow V-shaped valleys and dendritic drainage pattern; dominant slopes are 5-15%. This unit occupies the northern (Blocks D and E) and middle parts of the survey area. The total area is about 4,010 ha or 20% of the survey area.

This unit is generally covered by rubber plantation, forest (primary and secondary) and dry field. The Block D and E areas were cleared mechanically and improperly, which caused most of the fertile topsoils were removed and unfertile subsoils exposed to the surface. Moreover, compaction, gully and sheet erosions have caused more serious problems of this area.

Two dominant soil series i.e. series VU-Lo-31 and VU-Lc-31 are found in this unit. The former series is usually found on rather level topography. Another soil series found in this unit is series TU-Pc-51 occupying the lower slopes (footslopes) is only few and small, so that it is regarded as an inclusion. The two dominant soil series have developed from quaternary acid volcanic tuff deposited on the peneplain. The mineral composition is dominated by transparent quartz sand, while the weatherable minerals are very low.

Soil series VU-Lo-31 is very deep, homogeneous, poreous and well drained. The topsoil is dark grayish brown to brown, very fine texture, weak subangular blocky to crumb and friable (Typical profile T.20/195368-372).

The soils have moderate permeability, medium available water pores, high aeration pores, good aggregate stability and high plasticity. The bulk density increases with depth and the infiltration rate is very high.

This series is extremely acid (pH 4.0-4.5). The organic matter content, nitrogen, phosphorus and potassium are low to very low. The base saturation is extremely low and the exchangeable cation is dominated by H^+ and Al^{3+} (Al - saturation is more than 80%), while the Ca^{2+} is about 0.1 me/100 gr soils. The adsorption capacity is low (± 10 me/100 gr clay). The total manganese, available copper and zinc are rather low. The topsoil is slightly better.

Soil series VU-Lc-31 is very deep, homogeneous, poreous and well drained. The difference with soil series VU-Lo-31 is mainly due to the occurence of clay cutans which mainly found in the upper horizons, and the structure is more subangular blocky. The topsoil is yellowish brown to brown, very fine texture, subangular blocky to crumb structure, and friable. The subsoil is yellowish brown to brown, very fine texture, subangular blocky, friable to firm with patchy thin clay cutans in the upper parts of the profile.

The soil permeability is moderate with medium available water pores and medium aeration pores. The bulk density increases with depth.

This soil series is extremely acid (pH 4.0-4.5), low in organic matter, nitrogen, phosphorus and potassium. The base saturation is extremely low, the exchangeable cation is dominated by H^+ and Al^{3+} (Al-saturation is more than 80%), while the Ca^{2+} is about 0.1 me/100 gr soils. The micro elements such as total manganese, available copper and zinc are low. The adsorption capacity is low (± 10 me/100 gr clay). The topsoil is slightly better.

Irrigability class	:	This unit is expected to be not suitable for wetland rice under gravity irrigation due to unfavourable topography and very low soil fertility (Subclass IVtn).
Actual soil suitability	:	The unit is poorly suited for arable crops due to unfavourable topography and very low soil fertility (Subclass Vtn), and marginally suited for rubber having moderate to severe limitations especially very low soil fer-

tility and unfavourable topography (Subclass IVtn).

Potential soil suitability : This area will be marginally suited for arable crops (Subclass IVtn) and well suited for rubber (Subclass IItn).

Mapping Unit 9 : $\frac{\text{VU-Lo/Lc-31}}{\text{IV C-D}}$ - Complex of well drained Chromic Latosols and Oxic Latosols, very deep, very fine texture, ochric epipedon.

This is the largest unit in the survey area which is found on the peneplain volcanic cover landform. The area is rolling to hillocky with small convex elongated or rounded ridge crests dissected by deep and narrow V-shaped valleys and dendritic drainage pattern. The dominant slopes range from 10 to 25%. The dissected and steep areas are generally found in the transitions to the river terrace area. The total area is about 7,006 ha or 35%.

Most of the area are still under primary forest, some are under rubber plantation and ladang (shifting cultivation). Hand-cleared ladang shows medium to well growth of crops (upland rice, maize), and mixed garden after one-year ladang seems to be the good cover to prevent erosion hazard and maintain soil fertility.

The two dominant soil series (VU-Lc-31 and VU-Lo-31) found in this unit have developed from acid volcanic tuffs. The Oxic Latosols are widely distributed in less dissected and less steep areas. The characteristics of these two dominant soil series have been described in the description of Mapping Unit 8.

In the footslopes and valley bottoms are generally found very narrow Podzolic soils and Alluvial/Peat soils as inclusions. Quartzite gravel layers generally expose on the lower footslopes.

Irrigability class : This unit is expected to be not suitable for wetland rice under gravity irrigation due to unfavourable topography and very low soil fertility (Subclass IVtn).

Actual soil suitability : This unit is poorly suited for arable crops (Subclass Vtn) and marginally suited for rubber (Subclass IVtn), both due to unfavourable topography and very low soil fertility.

Potential soil suitability	:	After improvements to a certain extent, the land are expected to be marginally suited for arable crops (Subclass IVtn) and moderately well suited for rubber (Subclass IIItn).

3.4 Soil physical properties

(1) Methods of field observations and laboratory analyses

The soil physical properties of the surveyed area were studied in the field as well as in the laboratory, in order to appraise the soil-water and soil-water-plant relationships.

Infiltration rate measurements were carried out by using the double ring infiltrometer, in 14 sites (12 sites in the river terrace and 2 sites in the peneplain/peneplain volcanic cover) covering 9 soil series. Some measurements of soil strength have also been carried out in the field by using a shear vane apparatus.

For the laboratory analyses purposes some undisturbed soil samples and undisturbed soil aggregates were collected from 17 sites. The analyses consist of the following characteristics: bulk density, total pore space, pore size distribution, water saturated permeability, aggregate stability and Atterberg values. A simple experiment had been conducted to know the amount of water required for puddling the soils.

Bulk density (BD) and total pore space (TPS) values were determined according to the formulas:

$$BD = \frac{\text{weight of soil dried at } 105^{o}C}{\text{volume of the undisturbed soil}}$$

$$TPS = \left(1 - \frac{BD}{\text{solid density}} \right) \times 100\%$$

The solid density value is considered as 2.65 g/cc.

Pore size distribution or soil moisture characteristics were determined by means of pressure plate apparatus. The samples were treated under the pressures of: 10 cm water (pF 1); 100 cm water (pF 2); 1/3 atm (pF 2.54) and 15 atm (pF 4.2), and after equilibration the soil moisture content was determined. The different pF values were chosen, to follow the grouping of pore sizes, suggested by De Boodt and de Leenheer (1959).

The grouping of the pores are as follows:

- Non useful pores, i.e. the voids of maximum 0.2 u diameter (pF 4.2) in which water is not useful for plant growth.
- Useful pores, which can hold water and air for plant growth having diameter larger than 0.2 u (micron). It can be divided into:
  - the water holding pores, having diameter between 0.2 u and 10 u corresponds for pF between 4.2 and 2.54.
  - the slow draining pores, having diamter between 10 u and 30 u or pF 2.54 - 2.
  - the quick draining pores, the diameter of which is larger than 30 u (pF 2).

The determination of soil aggregate stability was carried out following the method proposed by De Boodt and De Leenheer (1959). In this method, the initial status of soil aggregates is compared with the final status when the aggregates have been subjected to two kinds of forces, i.e. the rain drops and the forces under wet sieving. The stability is expressed as the change in mean weight diamter of the two aggregate distributions.

A constant water head permeameter was used to determine the water saturated permeability. To make the determination, the undisturbed soil samples were saturated first with water, then the measurements were made on the quantity of flow with time and per unit surface perpendicular on the flow direction at a constant water head (LPT, 1974).

Atterberg value (limits) was determined following the method described by Lambe (1956) by using a Cassagrande device.

(2) Soil physical properties

The laboratory data of some soil physical characteristics are presented in Appendices 6 and 7 . Table 7 presents the grouping of the soil series based on the criteria listed in Appendix 10. The moisture retention curves are shown in Fig. 4.

a. Bulk density, aeration pores and moisture characteristics

Soil bulk density (BD) of the surveyed area varies from 0.80 to 1.11 gr/cc for the upper layer, while for the lower layer it varies from 0.92 to 1.16 gr/cc. The lowest value is the BD of soil series VU-Lo-31 (site Wt 13/MS 12) which was taken from Block F of the Sitiung II under primary forest condition. The highest value of BD is the soil series AU-Bd-51 (site Wt 1/SK 2) taken from Block D of the Sitiung I after being cleared

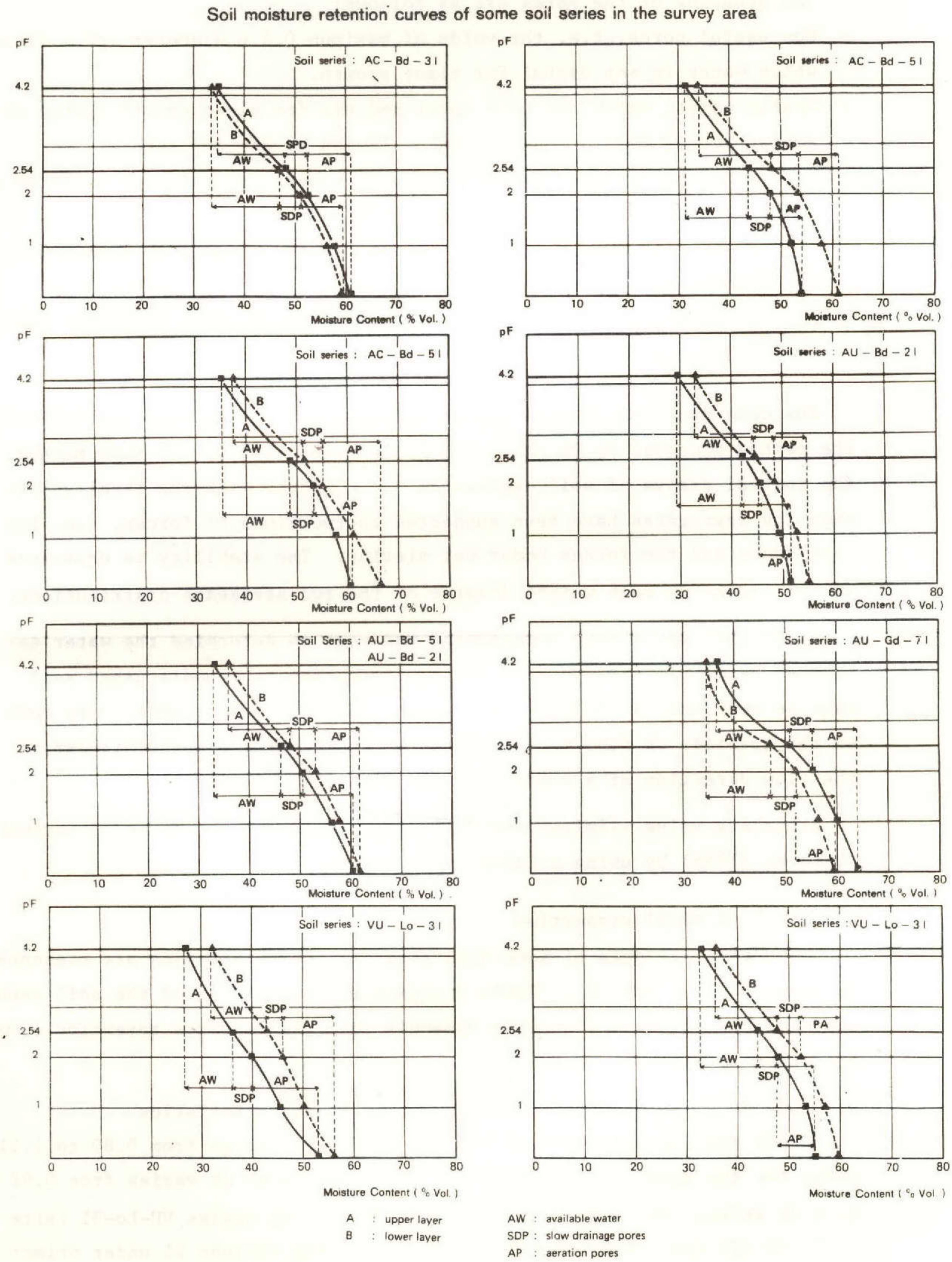

Soil moisture retention curves of some soil series in the survey area
Soil series : AC – Bd – 3 l
Soil series : AC – Bd – 5 l
Soil series : AC – Bd – 5 l
Soil series : AU – Bd – 2 l
Soil Series : AU – Bd – 5 l
AU – Bd – 2 l
Soil series : AU – Gd – 7 l
Soil series : VU – Lo – 3 l
Soil series : VU – Lo – 3 l
pF
4.2
2.54
2
1
0 10 20 30 40 50 60 70 80
Moisture Content (% Vol.)
A
B
AW
SDP
SPD
AP
PA
A : upper layer
B : lower layer
AW : available water
SDP : slow drainage pores
AP : aeration pores

Figure 4

with heavy equipments. Except Wt 13/MS 12, all of the soil samples were taken from cleared areas (hand or mechanical).

It is most likely that the difference in the BD value between the soils of cleared and those of uncleared area is the result of the land clearing, besides the original characteristics of the soils themselves. Mechanical land clearing has caused the disturbance of the topsoils, or completely removed when the tractor push the forest vegetations, so that the more compacted subsoils are exposed.

The data of aeration porosity give an idea how much the soil volume can be expected to be filled with air few hours after a heavy rainfall. Generally if the aeration porosity amounts to 10% or more, aeration is satisfactory unless there is a very shallow groundwater table (less than 50 cm).

Most of the soils of the surveyed area have low percentage of aeration pores. The highest values i.e. 29.93% for the topsoil and 19.13% for the subsoil are shown by samples Wt 13/I and Wt 13/II (soil series VU-Lo-31) of which the BD values are the lowest. Again, it is thought that the mechanical land clearing has contributed to the decrease of the percentage of aeration pores of the upper layers.

To increase the aeration porosity for better growth of upland crops, the farmers should work out the soils at proper moisture content, i.e. 70-90% of field capacity, and prevent the soils from frequent waterlogging. By working the soils at optimum moisture content, sufficient aeration porosity may be obtained, at least better than unworked soils. The optimum moisture content for working the soils in the survey area is ranging from 29.3% to 41.5% on volume basis.

All soils of the surveyed area possess sufficient available water pores ranging from 9.80% to 17.43% on volume basis. It means that the capacity of the soils to store total available water until 30 cm deep is ± 300 - 520 m^3 per hectare or 30-52 mm. If the potential evapotranspiration is 4.2 mm/day (the highest value of daily PET, listed in Table 3), then the available water will be depleted during 7-13 days. Depends on the soils, most of annual crops will suffer from drought, 7-13 days following heavy rain or heavy irrigation.

Table 7. The grouping of the soil series in relation to the physical properties

1. Aeration pores

%	Class	Soil series
< 5	very low	-
5 - 10	low	AU-Gd-71 (A+B); AC-Bd-31 (A+B); AC-Bd-51 (A+B); AU-Bd-21 (A+B); AU-Bd-51 (A+B); AU-Bd-61 (A+B); TU-Pc-51 (B).
10 - 15	medium	AC-Bd-31 (A+B); AC-Bd-51 (A+B); TU-Pc-51 (A); VU-Lo-31 (B).
> 15	high	AU-Bd-21 (A+B); AU-Bd-31 (A+B); AU-Bd-51 (A); VU-Lo-31 (A+B).

2. Available water pores

%	Class	Soil series
<5	very low	-
5 - 10	low	VU-Lo-31 (A)
10 - 15	medium	AU-Gd-71 (A+B); AC-Bd-31 (A+B); AC-Bd-51 (A+B); AU-Bd-21 (A+B); AU-Bd-31 (A+B); AU-Bd-51 (A+B); AU-Bd-61 (A+B); TU-Pc-51 (A+B); VU-Lo-31 (A+B).
15 - 20	high	AC-Bd-31 (A); AU-Bd-51 (B).
> 20	very high	-

3. Plasticity

Index	Class	Soil series
< 10	very low	-
10 - 20	low	AC-Bd-31 (A); AU-Bd-51 (A+B)
20 - 30	medium	AU-Gd-71 (A+B); AC-Bd-31 (A+B); AC-Bd-51 (A+B); AU-Bd-21 (A+B); TU-Pc-51 (A).
> 30	high	AC-Bd-51 (A+B); AU-Bd-21 (A+B); AU-Bd-31 (A+B); AU-Bd-51 (A+B); VU-Lo-31 (A+B).

4. Aggregate stability

Index	Class	Soil series
> 80	very good	AU-Gd-71 (A+B); AC-Bd-31 (A+B); AC-Bd-51 (A); AU-Bd-21 (A+B); AU-Bd-51 (A+B); TU-Pc-51 (A+B); VU-Lo-31 (A).
80 -65	good	AC-Bd-31 (A+B); AC-Bd-51 (A+B); AU-Bd-21 (A+B); VU-Lo-31 (B).
65 - 50	medium	AC-Bd-51 (A+B); AU-Bd-31 (A+B); AU-Bd-51 (B).
50 - 40	bad	AU-Bd-21 (A-B) -
< 40	very bad	-

5. Permeability

cm/hour	Class	Soil series
< 0.125	very slow	AU-Bd-51 (A)
0.125 - 0.5	slow	AU-Gd-71 (B); AC-Bd-31 (B); AU-Bd-21 (A+B); AU-Bd-31 (B); AU-Bd-61 (B).
0.5 - 2.0	moderately slow	AU-Gd-71 (A); AC-Bd-31 (A+B); AC-Bd-51 (A+B); AU-Bd-31 (A); AU-Bd-51 (B); AU-Bd-61 (A); TU-Pc-51 (A+B); VU-Lo-31 (A+B).
2.0 - 6.35	moderate	AC-Bd-31 (A); AC-Bd-51 (A+B); AU-Bd-21(A+B); VU-Lo-31 (B).
6.35 - 12.7	moderately rapid	VU-Lo-31 (A).
12.7 - 25.4	rapid	-
> 25.4	very rapid	-

Note: A = topsoil (0 - 30cm)
B = subsoil (more than 30cm).

b. Infiltration rate and saturated permeability

The data of infiltration rate are listed in Appendix 8, while the curves are shown in Fig. 5. The permeability data are presented in Appendix 6.

The data show that the infiltration rates of hand-cleared land (soil series AU-Gd-71/Wt 3 and AC-Bd-31/Wt 4) and the land under virgin condition (soil series VU-Lo-31/Wt 13) are very high i.e. 196.8 cm/hr, 32.36 cm/hr and 48.80 cm/hr for Wt 3, Wt 4 and Wt 13 respectively. Such areas will be difficult to be irrigated efficiently. According to FAO Bulletin, if the average infiltration rates after 6 hours of wetting are in excess of 12.5 cm/hr, gravity irrigation may not be practicable because of the difficulties of proper water distribution and excessive deep percolation. Fortunately most of the areas are not cultivated. Site Wt 3 (soil series AU-Gd-71) is located in a concave area covered by litter and abundant soil crackings were observed. Site Wt 4 (soil series AC-Bd-31) is located at an unplanted area mostly covered by alang-alang (Imperata cylindrica). Site Wt 13 (soil series VU-Lo-31) is located in Block F of the Sitiung II under virgin (primary) forest condition.

It is also stated in the FAO Bulletin that the optimum infiltration rates for gravity irrigation purposes are in general range from 0.7-3.5 cm/hr. When the rates are in the range of 0.1-0.2 cm/hr, surface wastes may be excessive, deep percolation for leaching is difficult to achieve.

Infiltration rate curves of the Sitiung I and Sitiung II – S. Jujuhan area.

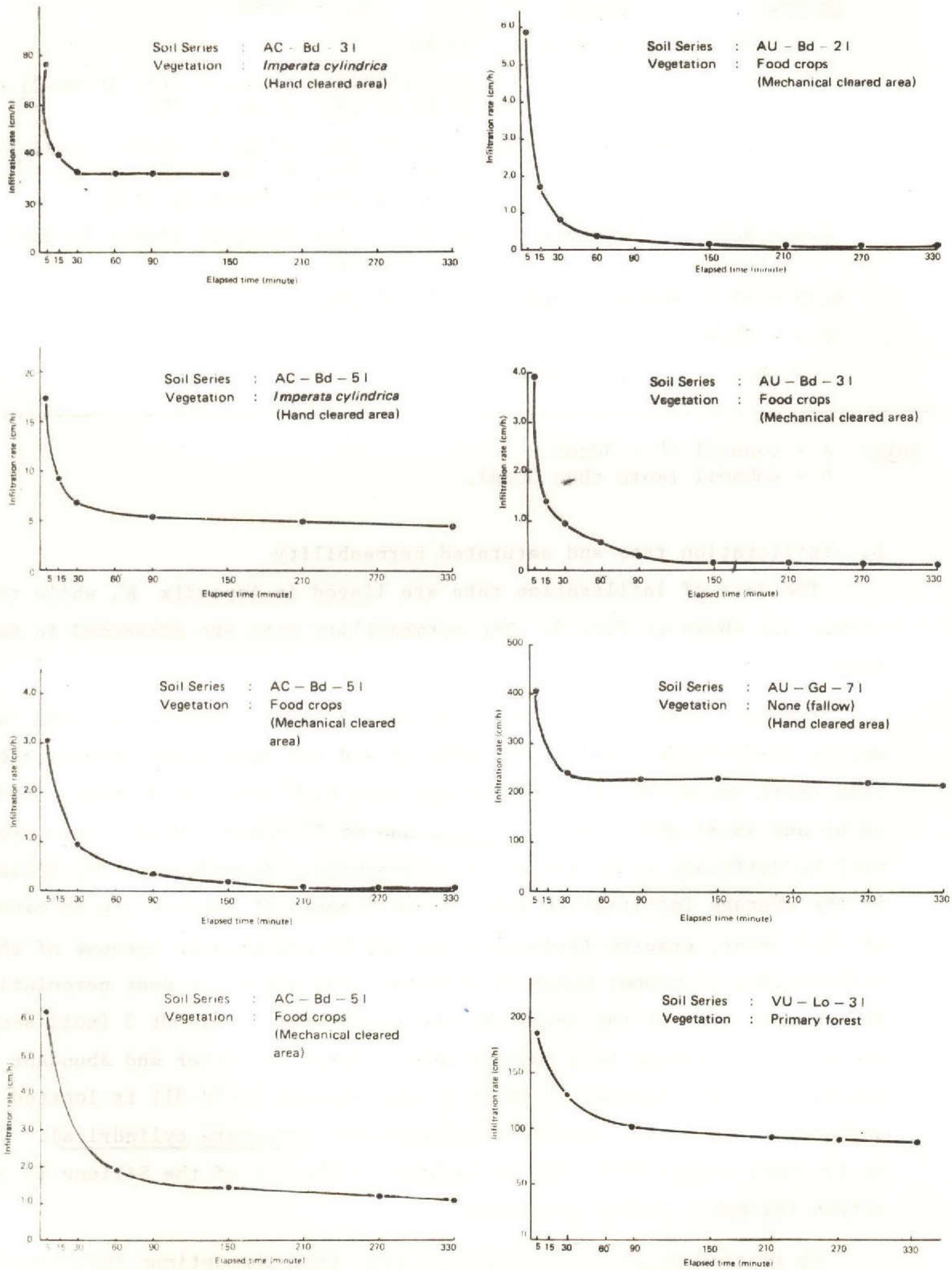


Figure 5

Crops may be damaged in hot weather by scalding action, and in some circumstances yields would be depressed by lack of aeration in the root zone due to temporary excess moisture condition. While soils with average rates less than 0.1 cm/hr are usually considered as non-arable.

Based on the above criteria, there is one site only which possess optimum infiltration capacity for gravity irrigation purposes, i.e. site Wt 11 on soil series AU-Bd-51 in Block S. Atang II. Table 8 presents the grouping of the soil series under present condition in relation to the gravity irrigation.

Table 8. The grouping of the soil series under present condition in relation to gravity irrigation

Infiltration rate (cm/hr)	Soil series	Remark
> 12.5	AU-Gd-71 (Wt 3/T 1) AC-Bd-31 (Wt 4/MS1) VU-Lo-31 (Wt 13/MS 12)	Hand-cleared - Not practicable Hand-cleared - Not practicable Virgin forest - Not practicable
3.5 - 12.5	AC-Bd-51 (Wt 5/MS 3)	Hand-cleared
0.7 - 3.5	AU-Bd-51 (Wt11/SK 9)	Mechanical-cleared - Optimum
0.2 - 0.7	AU-Bd-51 (Wt 1/SK 2)	Mechanical-cleared
0.1 - 0.2	AC-Bd-31 (Wt 7/SK 4, Wt 4/MS 1)	Mechanical-cleared -) Excessive sur- Hand-cleared) face water waste
< 0.1	AU-Bd-21 (Wt 2/SK 1, Wt10/SK12 Wt15/SK16) AU-Bd-51 (Wt 6/T 2) AC-Bd-51 (Wt 8/SK 6)	Mechanical-cleared -) Unsuitable Old rubber -) for gravity Hand-cleared -) irrigation Mechanical-cleared -) purposes Mechanical-cleared -)

Water saturated permeability rates were determined in the laboratory using undisturbed soil samples. The data show that the permeability rates vary from very slow to moderately rapid. Most of them can be classified as slow, moderately slow or moderate (see Table 7).

The permeability rate of the upper layer of site Wt 1 (soil series AU-Bd-51) is the lowest i.e. 0.03 cm/hr classified as very slow. To make the irrigation successful, the upper layer should be worked out so that the permeability rate may increase exceeding 0.1 cm/hr. According to FAO Bulletin the minimum values of hydraulic conductivity or permeability rates for successful irrigation are in the range of 0.1 - 0.2 cm/hr. It should be adequate to assure the saturated condition, whether it comes from rainfall or irrigation, or both, is likely to occur for more than 48 hours in the upper root zone. The lower layer of Wt 1 possesses better permeability, therefore shallow cultivation is sufficient to allow the excess water percolates.

It seems that there is no permeability problem for other soils, since the rate of permeability exceeds 0.1 cm/hr, meaning that the aeration pores will not be filled with water during a long period of time. But it should be noted that the permeability rate of a soil profile is regulated by the least pervious horizon. To get more valuable information, the permeability data should be combined with the infiltration data for distinguishing the land suitability classes for irrigation.

c. Stability of soil aggregates

The aggregate stability is an important characteristic of the soils, which can influence strongly the water and air economy of the soils. Depending on the stability of the aggregates, the seedbed will resist to the effect of an intensive rainfall (puddling erosion). In relation with erosion hazard, aggregate stability is also considered as an important characteristic.

Generally the soil aggregate stability in the surveyed area can be classified as good to very good. Few of them have medium or poor stability (see Table 7). The upper layer where the soil aggregate is considered as poor is Wt 10/SK 12 (soil series AU-Bd-21) in Block S. Atang II of the Sitiung I.

Relatively stable aggregates do not guarantee the soils to be free from erosion hazard. In the rolling to hilly areas, eroded upper layers were observed here and there. The low infiltration capacity of the soils due to the compacted lower layer and the high intensity of rainfall in the rainy season contributes to the high runoff causing the increase of erosion hazard.

d. Plasticity index

The plasticity of soils is measured by the 'plasticity index' which is equal to the liquid limit minus the plastic limit. Liquid limit is the soil moisture content between plastic and liquid status, while the plastic limit is the moisture content between solid and plastic status of the soils.

Most of the soils of the survey area have medium to high plasticity index. Consequently the soils will be hard to handle because they are sticky when wet and hard when dry. In the areas cleared by heavy mechanical equipments, more compacted soils will be more and more difficult to handle.

e. Soil strength

Most of the areas in the Sitiung transmigration project area were mechanically cleared, resulting in the disturbance or completely disappearance of the topsoils. Besides that, the passage of heavy equipments over the soil is thought to increase the soil compaction. In order to see how far the soil compaction hinders the growth of plant roots, some measurements of soil strength have been done using a shear vane apparatus. Table 9 presents the data of the soil strength values in the survey area.

The data show that the strength values vary greatly from 16.75 to 110.33 kilo Pascal (kPa) for the upper layers of the soils. The measurements were carried out when the soil moisture retention was higher than pF 2.54 (field capacity). Lower values of the soil strength may be expected if the measurements were carried out at the field capacity.

Experiments conducted in the laboratory at Bushland, Texas (Taylor and Burnett , 1963) demonstrated that cotton seedling tap roots could not penetrate a 1-inch thick soil layer with a strength of 400 pounds per square inch (=2,757.6 kPa). When soil strength was between 250 and 400 psi, the extent of cotton root penetration depended on the soil moisture conditions. There was no problem when soil strength at field capacity was less than 250 psi (= 1,723.5 kPa). Taylor and Burnett (1963) stated also that some experiments conducted both in the field and in the laboratory have shown that excessive soil strength reduces or stops rooting of sorghum, pigweed, cowpeas, sesame, sesbania, guar and sideoats grama. The critical soil strength values for these 7 types of plants are similar to those for cotton, but specific strength limits have not yet been established for them.

By comparing the measured strength values of the soils of the survey area with critical soil strength stated above, it is difficult to say that the soils in the Sitiung area are too hard to be penetrated by plant roots.

Table 9. Strength values of some soils of the Sitiung - S.Jujuhan area

Depth (cm)	Soil strength (k Pa)											
	AU-Bd-21		AU-Gd-71	AU-Bd-21	AC-Bd-31			AU-Bd-51			VU-Lo-31	AU-Bd-21
0-10	96.25	16.75	59.75	110.35	85.40	54.00	65.25	73.40	85.75	49.25	21.00	102.67
10-20	88.75	29.60	89.00	107.25	79.25	100.25	99.00	73.00		91.50	68.50	96.33
20-30	71.25	44.80	99.00	87.75	73.00	105.75	76.50	76.50	88.20	91.25	103.17	73.00
30-40	69.00	47.40	101.75	73.75		89.90	69.20	69.00	88.00	76.50		
40-50	67.50	59.75	94.75	62.00		87.75	59.25	65.75	75.25	75.25	91.80	61.20
50-60	63.75		83.20	53.00	56.75	79.75	60.25	63.75	74.50	75.75		
60-70								59.50	67.00			
	Block C - Sitiung I Rice field Mechanical land clearing	Block C - Sitiung I Bush Hand clearing	Block D - Sitiung I Rice field Mechanical land clearing and shallow cultivation. Topsoil ± 10 - 15 cm	Block D - Sitiung I Bush + grass Mechanical land clearing	Kotabaru, MS1 <u>Imperata cylindrica</u> Hand clearing	Block D - Sitiung I Rice field Mechanical land clearing	Block E - Sitiung I Rice field Mechanical land clearing + cultivation	Block D - Sitiung I Bush + grass Mechanical land clearing, No topsoil	Block D Sitiung I Fallow Mechanical land clearing	Block D - Sitiung I Fallow Mechanical land clearing, topsoil ± 10 cm	Block E - Sitiung II Fallow Mechanical land clearing	Block E - Sitiung II: SK 18 Bush

It is true that the critical soil strength for rice, maize, cassava, groundnuts etcetera have not been known yet, but it will not be different very much with cowpeas, for example.

Besides the effect on soil strength the increase of soil compaction may also affect on the water intake rates and soil aeration. The decrease of soil aeration seems to be an important factor affecting the bad yield of the crops.

It is obvious that the mechanical land clearing affects the strength of the soils. In Table 9 it can be seen that the strength values of soil series AU-Bd-21 which was cleared mechanically are much higher than those of soil series AU-Bd-21 without mechanical land clearing. The strength value of the upper layer of the soils with mechanical land clearing is 96.25 kPa, while for the soil without mechanical land clearing is only 16.75. Anyhow, it cannot be said that the mechanical land clearing resulting in the highly compacted soils, by which the roots cannot penetrate the soil due to the hardness of the soils. The failures of the roots to grow in the soils might be explained in relation with the low percentage of the aeration pores.

f. Water requirement for soil puddling

In order to calculate the amount of water required for 'sawah' preparation, the determination of the amount of water to puddle the soil started from field capacity was carried out in the laboratory. The result is presented in Table 10. This table shows that the amount of water required ranges from 544.33 to 1,292.22 m^3/ha per 20 cm deep. This 20 cm deep of non puddled soil can become 25 cm or more of puddled soil.

When a puddled condition has been reached, the soil normally is left unplanted for about 15 days with shallow flooding of ± 2 cm high. Since during this period some of the water losses due to evaporation and percolation, the amount of water required will increase correspondingly. The water loss due to percolation varies according to the variation of the soils, but normally decreases markedly after some years of 'sawah' cultivation. After twice planting time, percolation rates of experimental plots in Block Piruko - Sitiung I (Halcrow & Indah Karya) is about 4 mm/day. This value will be used in the calculation. The water evaporation rates vary according to the time of calculation, whether it is rainy season or dry season. To simplify the calculation, it will be assumed that the evaporation is 4 mm/day (see Table 3: Evaporation ranges from 115.7 to 130.8 mm/month, and the average is 4.2 mm/day).

Table 10. Water requirement for soil preparation of lowland rice

Soil series	No. Site	Non puddled		Puddled	Water requirement (m^3/ha)		
		B.D.*) (g/cc)	F.C.*) (% dry wgt.)	Moisture content (% dry wgt.)	Puddling (20 cm soil depth)	Col.5 15 days percolation	Col.5 2 cm flooding evaporation
AU-Gd-71	Wt_3	0.90	55.30	113.45	1,292.22	1,892.22	2,692.22
AC-Bd-31	Wt_4	1.01	51.01	107.70	1,122.77	1,722.77	2,522.77
AC-Bd-51	Wt_5	1.07	47.90	104.90	1,128.71	1,728.71	2,528.71
AU-Bd-21	Wt_{15}	1.12	42.60	78.90	648.21	1,248.21	2,048.21
AU-Bd-31	Wt_{12}	0.91	48.60	76.85	620.88	1,220.88	2,020.88
AU-Bd-51	Wt_{11}	0.97	46.60	73.00	544.33	1,144.33	1,944.33
TU-Pc-51	Wt_{14}	0.98	46.00	109.10	1,287.76	1,887.76	2,687.76
VU-Lo-31	Wt_{13}	0.83	46.80	80.20	804.82	1,404.82	2,204.82

*) B.D. : Bulk Density

F.C. : Field Capacity.

The total water requirement during 15 day preparation can be formulated as follow:

$$W = P + F + I + E$$

where:

W = total water requirement for soil preparation

P = puddling

F = flooding

I = percolation

E = evaporation

The result of the calculation of water requirement following the above equation is presented in Table 10, which ranges from 1,944.33 to 2,692.22 m^3/ha.

3.5 Soil fertility

The evaluation of soil fertility status is based on the chemical data of the top soil samples (less than 30 cm) taken from pits, and using the criteria presented in Appendix 9 .

To obtain a general view of the fertility status of soils from the survey area, the mean values of analytical data of each soil series are given in Tables 11 and 12. Complete analytical data are presented in Appendix 3 . There was no soil sample taken from Mapping unit 2 of the semi-detailed area because the unit is too small and scattered.

(1) Soil reaction (pH)

The soil pH in water is higher than in KCl solution. The pH in water of the topsoils ranges from 4.3 to 6.0, and the pH of the subsoils ranges from 4.2 to 6.4. The pH in KCl solution ranges from 3.5 to 5.0, and generally it ranges from 3.7 to 4.5. This means that most soils in the survey area are very poor in exchangeable bases. This condition is caused by a strong weathering process, leaching, and the acid parent materials. The exchangeable complex is dominated by hydrogen (H^+) and aluminum (Al^{3+}), where the aluminum saturation (Al-sat.) ranges between 70% and 99%. Except the young Alluvial soils (Jd) found mainly along the Batanghari river (especially Mapping unit 1 of the semi-detailed survey area which are less than 1%).

Table 11 . The mean values of analytical data of the top soil of each soil series in the semi - detailed survey area

Mapping Unit	Series	Texture			pH		Organic matter			Extract HCl 25 %		Exchangeable cation NH$_4$OAc pH 7.0					KCl 1N		Adsorption capacity		Base saturation (%)	Al saturation (%)	Free Fe_2O_3 (%)	Total Mn (mg)	Extract HCl 0.1 N	
		Sand (%)	Silt (%)	Clay (%)	H2O	KCl	C (%)	N (%)	C/N	P_2O_5 (mg)	K_2O (mg)	Ca (me)	Mg (me)	K (me)	Na (me)	Total cation (me)	H (me)	Al (me)	me/ 100gr soil	me/ 100 gr clay					Cu (mg)	Zn (mg)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	AE–Jd–3.I	3	63	34	6.0	5.1	4.08	0.41	9	64	108	14.9	2.2	0.9	0.1	18.1	0.4	0.1	32.3	57.5	53	< 1	0.57	92.0	0.66	3.46
	AE–Jd–5.I	2	67	31	6.1	4.7	2.86	0.25	8	59	46	8.9	1.8	0.2	0.2	11.1	0.2	0.1	23.3	57.2	49	< 1	0.64	–	–	–
2	Complex							N	o t		s a	m	p	l	e	d										
3	AE–Jd–8.I	< 1	61	38	5.3	4.3	1.31	0.12	10	28	30	4.2	1.6	0.1	0.7	6.6	2.0	1.2	16.8	34.2	39	15	0.68	–	–	–
	AU–Jd–8.I	0	31	69	4.3	3.8	3.92	0.26	18	22	26	0.1	0.1	0.1	0.1	0.4	10.9	9.4	24.9	21.2	2	96	0.84	4.7	0.45	0.43
4	AC–Jd–3.I	9	32	59	5.3	4.1	1.62	0.14	11	17	10	0.6	0.2	0.2	0.0	1.0	3.4	2.5	18.9	25.0	5	71	1.15	269.2	0.56	0.28
	AC–Jd–5.I	4	58	38	5.1	4.2	2.00	0.19	10	40	28	0.1	0.5	0.2	0.0	0.8	3.7	2.9	18.9	37.1	11	78	0.60	207.2	0.49	0.59
5	AU–Bd–2.I	3	33	64	4.6	3.8	1.60	0.16	fo	34	6	0.2	0.1	0.1	0.1	0.5	5.3	4.8	20.3	26.4	2	90	0.94	196.2	0.52	0.88
	AU–Bd–3.I	8	28	64	4.3	3.7	2.02	0.25	8	44	53	0.4	0.2	0.1	0.1	0.8	5.9	4.5	23.3	24.5	3	85	0.57	280.2	0.55	2.19
	AU–Bd–5.I	7	19	74	4.4	3.9	1.74	0.16	10	20	5	0.3	0.1	0.1	0.0	0.5	6.1	4.5	15.9	23.6	2	90	1.08	56.7	0.36	0.28
	AU–Bd–6.I	9	35	56	4.2	3.7	2.48	0.20	12	74	7	0.1	0.1	0.1	0.1	0.3	7.3	6.3	21.4	26.3	4	95	1.00	194.2	0.22	0.18
6	AU–Pc–5.I	22	17	61	4.1	3.7	2.46	0.21	11	35	5	0.1	0.1	0.1	0.1	0.4	4.6	3.5	12.3	9.1	3	90	0.38	–	–	–
	AU–Gd–8.I	28	15	57	4.3	3.4	3.41	0.26	14	10	6	0.1	0.1	0.1	0.1	0.4	5.0	4.0	19.8	16.0	2	91	0.36	1.83	0.21	0.19
7	TU–Pc–5.I	11	13	76	4.3	3.9	1.58	0.15	8	6	4	0.2	0.1	0.1	0.0	0.4	4.3	3.8	15.1	14.2	3	90	0.89	0.86	0.12	0.12
8.9	VU–Lc–3.I	10	13	77	2.8	2.6	2.46	0.06	12	11	3	0.1	0.1	0.1	0.0	0.3	3.7	2.9	15.9	12.6	3	91	1.37	0.74	0.14	0.17
9.8	VU –Lo–3.I	12	8	80	4.1	3.8	1.89	0.16	13	12	5	0.1	0.1	0.1	0.1	0.4	3.6	3.1	14.4	12.2	2	88	0.77	0.43	0.16	0.05

Table 12 . The mean values of analytical data of the top soil of each soil series in the detailed survey area

Mapping Unit	Series	Texture			pH		Organic matter			Extract HCl 25%		Exchangeable cation NH$_4$OAc pH 7.0					KCl 1N		Adsorption capacity		Base saturation (%)	Al saturation (%)	Free Fe_2O_3 (%)	Total Mn (mg)	Extract HCl 0.1 N	
		Sand (%)	Silt (%)	Clay (%)	H_2O	KCl	C (%)	N (%)	C/N	P_2O_5 (mg)	K_2O (mg)	Ca (me)	Mg (me)	K (me)	Na (me)	Total cation (me)	H (me)	Al (me)	me/ 100gr soil	me/ 100gr clay					Cu (mg)	Zn (mg)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	AO–Hf–9 h	5	29	66	4.9	3.9	20.43	1.20	17	48	17	11.6	1.6	0.3	0.3	13.8	1.45	0.46	67.4	19.6	20	–	0.91	26.7	0.72	2.09
2	Complex				N	o	t	s	a	m	p	l e	d													
3	AU–Gd–7 I	1	33	66	4.5	3.7	2.29	0.20	9	21	12	0.3	0.1	0.1	0.1	0.6	3.40	4.60	19.9	21.3	3	88	0.80	0.76	0.47	0.57
4	AU–Gd–8 I	4	31	65	4.2	3.7	3.20	0.22	4	32	4	0.2	0.2	0.1	0.1	0.6	6.60	6.20	30.0	28	2	91	1.10	40.9	0.26	0.28
5	AC–Bd–3 I	10	40	50	4.6	3.9	2.0	0.19	10	26	8	0.3	0.2	0.1	0.1	0.7	2.50	1.50	21.5	32.6	3	65	0.90	296.0	0.28	1.24
6	AC–Bd–5 I	6	36	58	4.7	3.8	1.44	0.17	10	27	8	0.3	0.2	0.1	0.1	0.7	4.60	3.10	20.6	26.6	3	86	0.90	246.4	0.39	0.43
7	AU–Bd–2 I	3	31	66	4.6	3.9	1.50	0.15	9	20	6	0.3	0.1	0.1	0.1	0.6	5.99	4.50	19.3	24	3	89	1.10	–	0.40	0.78
8	AU–Bd–5 I	7	36	57	4.5	3.8	1.79	0.18	11	22	6	0.5	0.1	0.1	0.1	0.8	5.52	4.16	14.0	26.5	3	9	0.90	164.9	0.33	0.35
9	AU–Bd–6 I	5	30	65	4.2	3.7	2.00	0.18	10	14	5	0.4	0.1	0.1	0.1	0.7	7.26	6.13	21.0	24.8	3	91	0.85	11.9	0.29	0.44
10	TU–Pc–5 I	13	18	69	4.2	3.8	2.23	0.17	12	6	3	0.1	0.1	0.1	0.0	0.3	4.70	3.73	16.1	14.9	2	92	0.92	39.7	0.10	0.44
11	VU–Lc–3 I	10	10	80	4.1	3.8	1.89	0.16	11	12	5	0.1	0.1	0.1	0.1	0.4	3.58	3.17	14.6	12.2	2	90	0.77	4.3	0.16	0.05

To reduce soil acidity and exchangeable Al, certain measures can be done, for example by flooding in the case for wetland rice, liming, and using basic fertilizers. Therefore irrigation and liming will play an important role in increasing soil productivity of the survey area.
Liming will correct soil acidity and improve cation composition such as Ca, Mg, and K. The lime requirement of dominant soil series in the survey area based on the laboratory tests is presented in Table 13.

Table 13. Average lime requirement of each soil series

M.U.	Soil series	Lime requirement (ton CaCO3/ha) to reach				Acreage	
		pH 5.0	pH 5.5	pH 6.0	pH 6.5	Ha	%
SITIUNG I / Detailed survey area:							
1.	AO-Hf-9h	-	4.75	20.00	27.50	2.5	0.5
3.	AU-Gd-71	2.00	5.25	8.75	13.50	9.5	1.8
4.	AU-Gd-81	2.50	5.50	9.25	13.50	28.8	5.3
5.	AC-Bd-31	0.25	1.25	5.75	8.50	145.5	26.6
6.	AC-Bd-51	1.00	2.00	8.50	13.00	91.5	16.7
7.	AU-Bd-21	0.25	4.75	9.00	12.50	73.5	13.4
8.	AU-Bd-51	2.75	6.25	10.25	15.25	140.0	25.6
SITIUNG II / Semi-detailed survey area:							
4.	AC-Jd-31	1.25	3.25	8.25	10.25	-	-
5.	AU-Bd-21	2.00	5.50	8.75	11.75	-	-
	AU-Bd-31	2.50	6.50	10.25	15.25	-	-
	AU-Bd-51	1.25	6.25	9.50	14.00	-	-
	AU-Bd-61	3.25	4.25	10.50	15.50	-	-
6.	AU-Gd-81′	1.50	6.50	10.25	14.50	-	-
7.	TU-Pc-51	2.00	5.50	7.50	10.75	-	-
8.	VU-Lo-31	3.25	6.75	10.25	14.50	-	-
8/9.	VU-Lc-31	2.25	5.75	9.75	11.50	-	-

(2) Organic carbon, total nitrogen and C/N ratio

The organic carbon content is generally low (less than 3%) and it decreases rapidly with depth, except in Organosols/Histosols which reaches about 20%. The total nitrogen is very low (generally less than 0.3%), except in the topsoils of some soil series, mainly in imperfectly and poorly drained soils (Hf and Gd). The C/N ratio mostly falls below 15, which means that mineralization is higher than accumulation rate, and it tends to decrease with depth. In Organosols the C/N ratio is more than 15, and it increases with depth, so that accumulation is higher than mineralization rate.

Considering those conditions, it is necessary to maintain and to add organic matter to a certain level, and addition of balanced fertilizers to obtain a sustained crop production. Proper soil and water management practices are required in order to improve the efficiency of fertilizers used.

(3) Phosphorus and potassium

Phosphorus (P) and potassium (K) extracted with 25% HCl are generally considered as reserved or potential available plant nutrients. Tables 11 and 12 and Appendix 3 show that the total phosphorus and potassium in most soil series are low to very low, i.e. less than 20 mg and less than 10 mg respectively, except in the topsoils which are generally low to medium. The high content of phosphorus and potassium is only found in the recent Alluvial soils, i.e. more than 40 mg/100 gr soils.

The availability of phosphorus is affected by many factors such as pH, the form of P-compound, exchangeable Al and Fe. Most soils in the survey area are very low in soil pH and high in exchangeable Al. As a result of this condition, it can be expected that phosphorus will be fixed by Al into insoluble forms. Heavy phosphorus fertilization is required to improve the soil productivity.

The exchangeable potassium which is considered as available K is also low to very low. Only in the topsoils potassium is slightly higher. Therefore complete and balanced fertilization is required.

(4) Exchangeable cations, base saturation and adsorption capacity

The exchangeable cation of most soil series in the survey area is dominated by hydrogen (H^+) and aluminum (Al^{3+}). Calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na) are generally low (less than 0.2 me/100 gr soils) and decrease or constant with depth; except in some Alluvial soils.

The base saturation is extremely low (less than 5%/100 gr soils). The higher values of base saturation in the topsoils might be attributed to biological recycling. Only in some soil series such as Organosols (Hf) and recent Alluvial soils (Jd) the base saturation is high. Therefore most soils in the survey area can be considered as low fertility status. Liming and balanced fertilization are required. Consequently time and methods of application must be suited with the soil condition.

The adsorption capacity or cation exchange capacity (CEC) of the soils in the survey area ranges from 8 to 25 me/100 gram soils, or CEC of clay ranges from 10 to 30 me/100 gram clay. The CEC soil of the top layer is somewhat higher than that of the subsoils. This is due to the organic matter content. Latosols and Podzolic soils have the lowest value of CEC soil i.e. less than 10 me/100 gram soils. It seems that the clay is dominated by kaolinitic type (1:1 type), whereas the other soils might be a mixture of 1:1 clay and 2:1 clay. The ranges of CEC mentioned above are considered to be favourable for obtaining satisfactory crop production under irrigation (FAO Soil Bulletin, -). To improve the nutrient holding capacity of the soils, addition of organic matter by using proper crop rotation system is necessary. According to Ramiro Guirrero (1975), with a normal and neutral amonium acetate method showed that the low effective CEC values are low in regard to high clay content as a consequence of low activity and predominance of kaolinitic clays, Fe and Al-oxides.

The result of X-ray diffraction of some soil samples from the subrecent plain shows that the clay fraction consists mainly of amorphous materials, kaoline and quartz. Small amount of magnetite, gibbsite, crystobalite and kaolinitic were also recognized (Benchmark Soils Project data).

(5) Fe, Al, Mn, Cu and Zn

Most soils in the survey area are relatively high in aluminum (more than 2 me/100 gram soils or Al-saturation ranges from 80-88%), and it is generally considered to be toxic for most crops. This high content of Al might be due to the acid and old parent materials and the soils have been intensively leached. Phosphorus applied as fertilizers will be readily fixed. In a low pH condition not only Al, but also Mn, Cu, Zn and other metals may also increase, so that their concentration in the soil solution may become toxic.

Mn is high in the moderately well drained soils, therefore it may also be toxic to crops grown in this area. Cu and Zn extracted with 0.1N HCl which are considered as available are ranging from 1 to 16 ppm and considered to be high for various crops (Vits et al, 19).

The mineralogical composition of soil sample of each typical geomorphological unit.

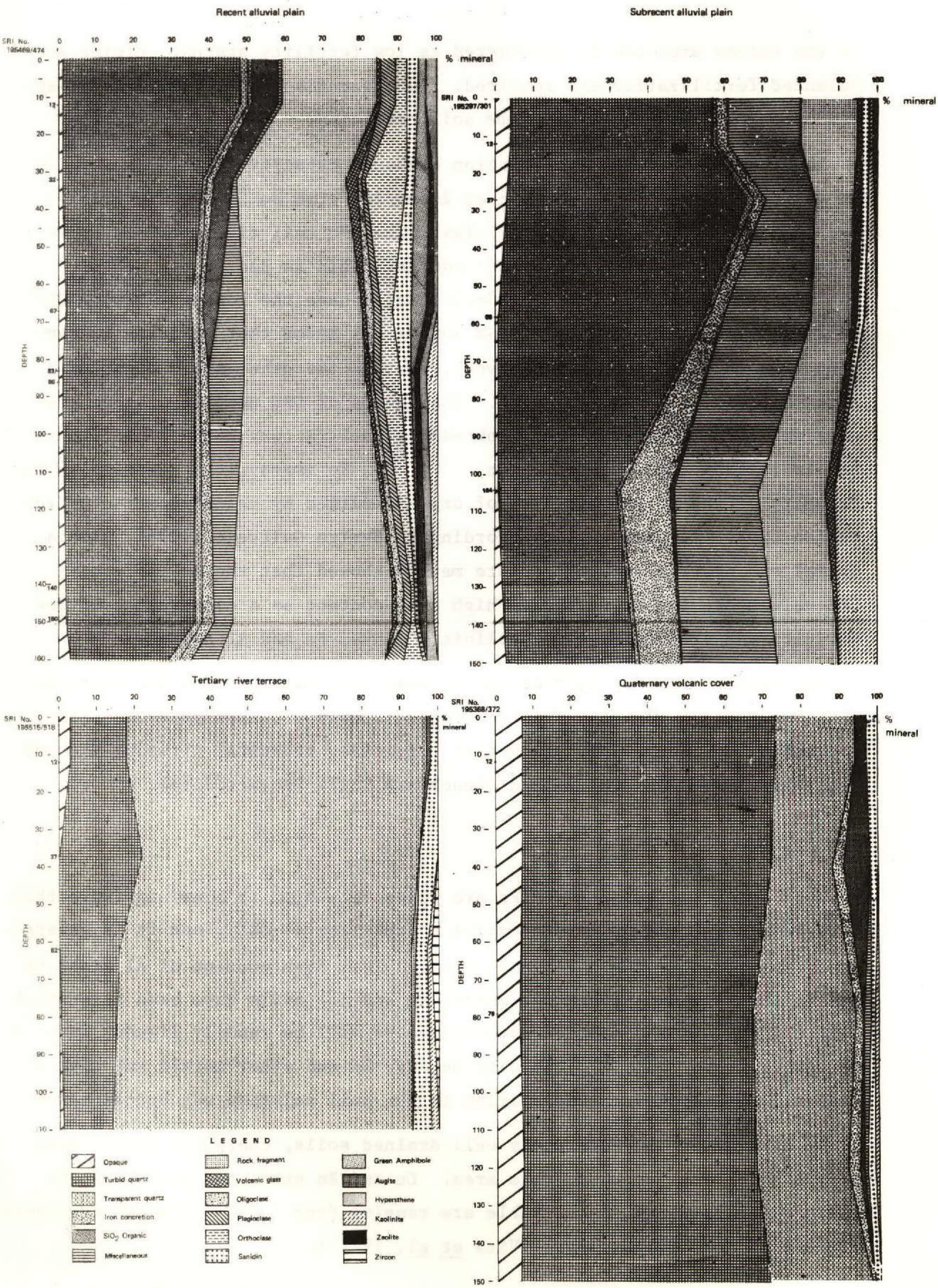


Figure 6

(6) Mineral reserve

The mineralogical composition of the sand fraction mainly consists of turbid quartz, iron concretion, weathering products and transparent quartz. The other minerals are very few (vide Diagram/Fig. 6).
Thus the mineral reserve of all soil series (except Mapping unit 1 of the semi-detailed area) is low to very low (see Appendix 4).

IV. SOIL SUITABILITY

4.1 General

The evaluation of soil suitability classes is intended for an optimum utilization of soils or land. Therefore soil maps must be interpreted in terms of their application for specific uses under a certain level of management. The interpretative systems used in this survey area are based on physical basis, which can be interpreted as to crop production potentials for ranges of conditions and practices, consisting of two methods:

1. Method proposed by Mahler (1970) with some modifications is used for interpreting the land for wetland rice under gravity irrigation.
2. Methods proposed by Riquier et al (1970) and Driessen (1975) with some modifications are used for interpreting soil/land for arable crops and rubber.

4.2 Irrigability for wetland rice in relation to present limitations

Evaluation of land for wetland rice under gravity irrigation is an attempt to predict the potentialities to a certain extent of land under the future irrigation project plan. It is assumed that the quantity of irrigation water is not limited, and the cost of project is not considered. The objective of this qualitative evaluation is to provide data for comparative study of the alternatives (Mahler, 1970).

The factors considered in this evaluation are: (1) soil limitation (soil fertility, soil depth, depth of limiting layers, topsoil texture, topsoil stoniness, subsoil stoniness, subsoil permeability, infiltration rate), (b) soil salinity/alkalinity limitation, (c) topography/erosion limitation (overall slope, maximum transversal slope, microrelief, present erosion status), and (d) drainage limitation (flooding hazard, ponding hazard, groundwater depth).

Six classes of land irrigability are recognized, i.e.:

Class I : Land which are highly suitable for wetland rice irrigation under the conditions foreseen by the project, if properly required improvement works are made.

Class II : Land which are expected to be moderately suitable for wetland rice irrigation under the conditions foreseen by the project and after the required land improvement works are made.

Class III : Land which are expected to have a marginal suitability for wetland rice irrigation foreseen by the project and after the required land improvement works are made, except by using certain irrigation techniques, such as sprinkle or trickle irrigations.

Class IV : Land which are expected to be not suitable for wetland rice irrigation under the general conditions foreseen by the project and after the required land improvement works are made.

Class V : Land which have undetermined suitability for wetland rice irrigation under the conditions foreseen by the project, and require further studies.

Class VI : Land which are definitely not suitable for wetland rice irrigation under the conditions foreseen by the project.

The limiting factors found in the survey area which are indicated by small case letters following the class are as follows:

n : very low soil fertility and high Aluminum saturation (toxicity),

s : soil physical limitation in the root zone, mainly due to unfavourable infiltration rate and permeability,

t : unfavourable topography (slope classes),

f : flooding or permanent stagnant water,

d : drainage or excessive wetness with gley phenomena.

Based on the evaluation of each mapping unit for wetland rice irrigation, the semi-detailed Sitiung II - S. Jujuhan survey area can be separated as shown in Table 14.

Table 14. Irrigability for wetland rice in the Sitiung II - S. Jujuhan survey area

Irrigability subclasses	Soil Mapping Units	Acreage	
		Ha	%
IIns	4, 5	4,877	24.4
IIItn/IVfn	6	1,356	6.8
IVtn	7, 8, 9	11,706	58.4
IVsf	1	1,120	5.6
IVfn	3	118	0.5
VI	2	859	4.3
	T O T A L	20,036	100.0

Table 14 indicates that Mapping Units 4 and 5 are generally suitable for wetland rice irrigation. However, it will be rather limited near Block D due to the dissections of the area by small incised valleys. Mapping Unit 6 is included into Subclass IIItn/IVfn due to the limited amount of available water in their upper watersheds of the correponding streams, unfavourable topography in the rather higher area, and flooding hazard in the swampy areas. However, simple (traditional) level of management is still reasonable for this unit, while the other soil mapping units fall into Class IV to Class VI. Therefore, the largest area of the Sitiung II - S. Jujuhan is not suitable for gravity irrigation.

4.3 Soil suitability for arable crops and rubber

Since the topographic conditions of the greater parts of the survey area are difficult for gravity irrigation, it is useful to evaluate this area for arable crops and rubber to give possible alternative uses according to the potential soil suitability. Arable crops and rubber are proposed for the transmigration area which is close to the nucleus rubber plantation project (Agricultural Development Plan).

In evaluating soil suitability, the present management systems (actual) and improved management to a certain extent (potential) are considered for most farmers. The future changes of management level and economic conditions will be necessary for re-evaluating the land/soils.

The parameters examined consist of soil properties and environmental factors. The soil properties consist of nutrient content, base saturation, organic matter content, parent material/mineral reserve, CEC of clay, texture/structure, and effective depth. The environmental factors include relief/slope (topography), drainage, groundwater table and/or flooding, and moisture regime. Each parameter is rated ranging from 1.0 (maximum value) to 0.01 (minimum value). By using a multiplication system, grouping into classes of suitability can be made.

Six soil suitability classes for arable crops and rubber are recognized, with increasing degree and kinds of limitations as follows:

Class I : Very well suited soils having no significant limitation,

Class II : Well suited soils having slight limitations,

Class III : Moderately well suited soils having slight to moderate limitations,

Class IV : Marginally suited soils having moderate to severe limitations,
Class V : Poorly suited soils having severe limitations,
Class VI : Generally not suited soils having very severe limitations.

Each class is divided into subclasses based on the kinds of limitations. The same limitations may be found in different classes. The limiting factors found in the survey area are the same as those used for the evaluation of irrigability for wetland rice (Subchapter 4.2).

Four classes of actual soil suitability for arable crops and rubber are evaluated in the survey area (Class III to Class VI). These four classes derive 6 subclasses for arable crops and 7 subclasses for rubber according to the dominant kinds of limitations (Table 15 and Table 16).

Potential soil suitability classes are evaluated to express the potentiality of the soils after the application of improvements of soil management practices to a certain extent. It is necessary to determine which level of management practices is required. Some improvements of the limiting factors for potential soil suitability classes are as follows:

Drainage :	requires irrigation, drainage control, flood protection, and tillage
Poor texture/: structure	requires application of organic matter, suitable cropping systems
Low nutrient : content	requires application of organic matter and improved cropping systems
Low organic : matter	requires application of fertilizers including trace elements, improved cropping systems
Acidity and : Al-toxicity	requires liming
Soil erosion :	requires bench terracing, contour planting and strip cropping systems.

Potential soil suitability in the survey area is divided into three classes (Classes III, IV and VI) deriving 6 subclasses for arable crops, and 5 classes (Classes II to VI) deriving 12 subclasses for rubber (Tables 15 and 16).

Table 15. Actual and Potential soil suitability subclasses for Arable crops and Rubber in the semi-detailed Sitiung II - S. Jujuhan area

Mapping Unit		Actual		Pontential		Acreage	
No.	Symbol	Arable	Rubber	Arable	Rubber	Ha	%
1.	AE,AL-Jd-3,5 1 / IIIA	IIIf	IVf	IIIf	IVf	1,120	5.6
2.	Complex	VI	VI	VI	VI	859	4.3
3.	AE,AU-Jd-8,9 1 / IIIA	VI	VI	IVfn	Vfn	118	0.5
4.	AC-Jd-3,5 1 / IVA	IVn	IIIn	IIIn	IIn	489	2.4
5.	AU-Bd-2,3,5 1 / IVA	IVn*) Vd	IIIn*) Vd	IIIn*) IIId	IIn*) IIId	4,388	22.0
6.	AU-Pc,Gd-5,8 1 / IIIA-B	IVn VI	IIIn VI	IIIn VI	IIn Vfn	1,356	6.8
7.	TU-Pc-5 1 / III/IVB-C	Vtn	IVsn	IIItn	IIIsn	690	3.4
8.	VU-Lo/Lc-3 1 / IVB-C	Vtn	IVtn	IVtn	IItn	4,010	20.0
9.	VU-Lc/Lo-3 1 / IVC-D	Vtn	IVtn	IVtn	IIItn	7,006	35.0
				TOTAL		20,036	100.0

*) Dominant subclass.

Table 16. Actual, Potential soil suitability subclasses for Arable crops and Rubber, and Irrigability subclasses for wetland rice in the detailed sample blocks

Mapping Unit/Soil series		Actual		Potential		Irrigability for wetland rice
No.	Symbol	Arable	Rubber	Arable	Rubber	
1.	AO-Hf-9 h	VI	VI	VI	VI	VI
2.	Complex	VI	VI	VI	VI	VI
3.	AU-Gd-7 1	VI	VI	IIIdn	IVds	IInf
4.	AU-Gd-8 1	VI	VI	IIIdn	Vds	IInf
5.	AC-Bd-3 1	IVn	IIIn	IIIn	IIn	IIsn
6.	AC-Bd-5 1	IVdn	Vdn	IIIn	IIIsn	IIn
7.	AU-Bd-2 1	IVn	IIIn	IIIn	IIn	IIsn
8.	AU-Bd-5 1	IVdn	Vdn	IIIn	IIIsn	IIn
9.	AU-Bd-6 1	IVdn	Vdn	IIIn	IIIsn	IIn
10.	TU-Pc-5 1	Vtn	IVsn	IIIn	IIIsn	IVtn
11.	VU-Lo-3 1	Vtn	IVtn	IIItn	IItn	IVts

V. DISCUSSIONS

5.1 Location and topography

The survey area is located between two important big cities i.e. Padang the capital of West Sumatera Province and Jambi the capital of Jambi Province. The area is also connected with Medan the capital of North Sumatera Province. The network of roads connecting the survey area with those three big cities is excellent, except the road between Muara Bungo in Jambi Province and Lubuklinggau in South Sumatera Province which is badly damage, however, in the near future it will be reconstructed. Therefore, the survey area which is close to the Trans-Sumatera Highway is located in a very strategic area. Moreover, the Batanghari and Batang Jujuhan rivers give more advantages to the survey area as a river transportation system.

The semi-detailed survey area of the Sitiung II - S. Jujuhan is located between 60 - 120 m above sea level and can be divided according to the main landforms, dominant slope variation, soil mapping units and proposed land utilization as presented in Table 17.

Table 17. Landforms and proposed land utilization types of the semi-detailed survey area

Landform	Dominant slope variation (%)	Soil mapping unit	Proposed land utilization	Acreage Ha	Acreage %
Recent river floodplain	0 - 3	2	Natural vegetation	859	4.3
	0 - 5	1, 3, 6	Food crops (arable and sawah); in some places occasionally flooded	2,594	12.9
Recent/subrecent river terrace	0 - 3	4)	Irrigated food crops (arable and sawah)	489	2.4
	0 - 5	5)		4,388	22.0
Peneplain	5 - 10	7	Arable crops/tree crops	690	3.4
Peneplain volcanic cover	5 - 15	8	Arable crops on the flat area and tree crops on steep slopes (more than 8%)	4,010	20.0
	10 - 25	9	Tree crops, reserved forest and firewood forest.	7,006	35.0

From the Table 17 above, irrigation will be justified only in the subrecent river terrace (Mapping unit 5) and recent (low) terrace (Mapping unit 4). The recent floodplain of Mapping unit 3 and some parts of Mapping units 2 and 6 can be used for wetland ricefield,while Mapping unit 1 is more suitable for arable food crops during the proper time when there is no flood. Mapping units 7 and 8 of the peneplain and peneplain volcanic cover are still possible for arable crops on the flatter areas (slopes less than 8%), while the steeper sloping areas are mainly for tree crops (rubber) or mixed garden. The dissected and steep peneplain volcanic cover of Mapping unit 9 are proposed for tree crops, firewood vegetation and reserved forest.

If the topographical condition is favourable, the main irrigation canal should be located on the border between the peneplain/peneplain volcanic cover and subrecent river terrace, so that large areas will be irrigated. The canals will be better placed on higher position (ridges), so that the distribution of irrigation water will be easy. The problem is that these ridges are occupied by deep to very deep poreous soils (soil series AC-Bd-31 and AU-Bd-21), where water loss will be very high during the first few years of irrigation.

The ideal plan for housing should be located along the main canals, so that the quality of irrigation water will be improved and the village condition will be more favourable.

5.2 Soils and landforms

Four main general landforms are recognized in the survey area, i.e. (1) Recent river floodplain/terrace, (2) subrecent river terrace, (3) peneplain, and (4) peneplain volcanic cover. Each unit has typical soil units which will be discussed below.

(1) Soils on the recent river floodplain/terrace

This main landform can be separated into recent floodplain and recent (low) terrace. The recent floodplain can be separated further into point bars, levees and backswamps. The recent floodplain is subject to flooding, while the recent (low) terrace is only flooded during the big flood. The deposition of materials is still going on during the flood, therefore stratification of the materials is easily recognized, especially on the point bars and levees.

The materials are composed of weathering products of various rocks from the catchment area which are predominantly acid materials. Due to the pattern of sedimentation, each of those sub-units of landform has typical soils having typical characteristics (soil series). Levelling of the river bases has caused a deposition of new/recent materials as has been observed in the west of Kuamang village where Podzols (Humic Podzols) were found developed underneath the Alluvial soils.

Soils on point bars and levees (series AE-Jd-31, AL-Jd-31) tend to be characterized by physical weathering, while the soils on backswamps (series AE-Jd-81) are influenced by stagnant water. The soils on recent (low) terrace (series AC-Jd-31, AC-Jd-51) show a well coloured/structured B horizon and leaching, therefore the soil fertility status is low (lower). This is also reflected by the growth of most crops and traditional (local) land use where people prefer the floodplain rather than the low terraces.

Wetland rice in the backswamps and arable crops on the point bars, levees and low terraces seem to be more practicable for this area. Bananas are also widely planted in this area. But the flood will always be the risk of the area.

Irrigation will be more practicable (beneficial) mainly on the low terrace, while in the backswamps drainage is more necessary.

The soils are classified as Alluvial soils (SRI) or Tropofluvents, Tropic Fluvaquents and Fluventic Dystropepts respectively for soils on point bars/levees, backswamps and low terraces.

(2) Soils on the subrecent river terraces

The soils on this main landform have more advanced profile development with a well coloured/structured B horizon (A-B-C profile), even a slight podzolization process (Bt horizon) was observed mainly in the moderately well and imperfectly drained area. While in the depressions the profile development is more influenced by ponded water, mainly during the rainy season. This might be caused by less biological activity in the moderately well and imperfectly drained area than in the well drained area.

Prominent iron-manganese concretions are usually found in the moderately well and imperfectly drained area (series AU-Bd-51 and AU-Bd-61). This might be due to the redox processes as reflected by mottles in the profile.

The pea-sized iron-manganese concretions might be due to the geogenic process, as these are not evently distributed in the area except which are formed on the concave relief. Mechanical land clearing and erosion have resulted in the exposed subsoils which are widely spread in the survey area.

Topographical conditions relating with drainage classes have performed a sequence of soils as illustrated in the detailed soil maps (Maps 5 to 11) and Fig. 3. The soils are classified as Brown Tropical Soils/Acid Brown Forest Soils including their "wet" associations and Gley soils. They are grouped into Oxic Dystropepts, Aeric Tropaquepts and Aeric Tropaquults (USDA, 1975). The soils have more advanced leaching and development. Therefore they are very low in fertility status and high in toxic elements (Al^{3+}). The chemical fertility mostly depends on the soil organic matter of topsoils. The removal of topsoils due to the improper land clearing techniques in the transmigration area has resulted serious failures of most crops.

This main unit of landform is the most potential area for irrigation and farming in the survey area. Therefore a proper soil management and taking care of the land should be seriously tackled/carried out. Irrigation is one of the measures to make these soils to be more productive.

(3) Soils on the peneplain

These soils have developed from tertiary river terrace (alluvium). In some places they mixed with colluvial materials from the volcanic cover. The soils are moderately deep to deep with yellowish brown to brown colour, very fine texture, moderate to strong subangular blocky structure, and firm consistence. In the subsoils mottled zone and prominent clay cutans were observed. These soils are less poreous than Latosols. The relief is undulating and groundwater table is rather deep (less than 4m). The soils on the lowest slopes or depressions have developed under the influence of groundwater/stagnant water.

These soils are less developed than Latosols might be due to the erosion process in the late tertiary period and/or interrupted by the covering volcanic tuff in the early quaternary period. The soils on lower slopes are generally rather shallow and they contain rounded quartzite gravels. Clay cutans were strongly identified, while clay nodules were absent. Thus they show argillic characteristics. Leaching process and decomposition have intensively taken place. The base saturation and adsorption capacity are low. Due to their lower position in landscape, available water might be better. These soils are grouped into Chromic Podzolic soils (SRI) or Orthoxic Tropudults (USDA, 1975) or Ferric Acrisols (FAO/UNESCO, 1974)

Undulating topography and rather difficult in the landscape position for gravity irrigation have caused this area to be grouped into Class IV (Land which are expected to be not suitable for wetland rice irrigation). Annual crops in the less steep slopes are still possible to be cultivated in this area, but inherent soil fertility is very low and the subsoils are rather compact. Tree crops such as rubber or perennial crops are more suitable. Intensive cultivation without any application of fertilizer or crop rotation will deteriorate these soils.

(4) Soils on the peneplain volcanic cover

These soils have developed from acid volcanic tuffs deposited on the peneplain during the early quaternary period. The soils are very deep, homogeneous, reddish brown to brown, very fine texture, weak subangular blocky to crumb, clay nodules, friable and poreous. There is no horizon differentiation except the topsoils. The soil depth generally decreases to down slopes. The soils have low bulk density and high available water pores. The relief is undulating to rolling. The groundwater table is very deep (more than 10 m).

High rainfall, warm temperature, poreous parent materials, well drained and undulating to rolling topography have brought about intensive leaching of bases, oxidation process and rapid decomposition of organic matter. The soils show latosolization and slight podzolization processes resulting an oxic B horizon and ochric epipedon. Weatherable minerals are very low. The soils have low adsorption capacity and very low base saturation.

These soils are classified as Chromic Latosols and Oxic Latosols (SRI) or Orthoxic Tropudults and Tropeptic Haplorthox (USDA, 1975) or Xanthic Ferralsols and Orthic Ferralsols (FAO/UNESCO, 1974).

The soils have good physical properties, but very poor in nutrient contents and high in aluminum saturation which may limit the growth of most crops. The chemical fertility mostly depends on the organic matter content and biological recycling which are unstable. Changing in land use/vegetation will influence the nutrient status. Furthermore improper land clearing have caused removal of topsoils and more compaction of the soils. These conditions have resulted land degradation such as in Blocks D and E (Sitiung II) which is difficult to reclaim in a short period. Proper and careful land clearing mainly in sloping area, soil conservation practice and heavy/balanced fertilizer application should be conducted. Proper land use based on the soil suitability evaluation has to be taken into consideration to obtain sustained crop yields. Adapted crop varieties to these conditions are very important. It seems that perennial crops or deep rooting annual crops are more suitable for the area.

The soils are grouped into not suitable for gravity irrigation for wetland rice due to rough topography. Special irrigation techniques for economic crops adapted to these conditions and popular to farmers might be introduced.

5.3 Climate and agriculture

Data and information on climate are very important to make better plans for crop selection, crop management and soil management, especially for upland crops dependent on rainfall. A large area of crops in the survey area will depend on rainfall, because irrigation will be limited only to the relatively flat area on the subrecent terrace. Even at present and in the next few years all crops will still depend on rainfall, as the implementation of the irrigation project has just been started. Therefore meteorological stations should be established not only in the subrecent terrace area, but also in the peneplain/peneplain volcanic cover of the Sitiung II - S.Jujuhan area. The data should be recorded continuously with general weather observation. This will help the development plan for this area and its surroundings.

Climadiagram (Fig. 2) and other climatic data (Tables 1 and 2) of this area show that the area has a udic moisture regime. The dry month (P less than 5%) ranges from 2 to 3 months (June to August), and the deficit ranges from 10 mm to 12 mm per month. Based on this study the average growing period for the area which is mainly close to the recording stations can be presented as in Table 18.

Table 18. Average crop growing periods

Growing period	J	A	S	O	N	D	J	F	M	A	M	J	J
Kotabaru													
- Two short periods					115 days			x	97 days		x		
- Reliable single period								212 days					
Teluk Kayu Putih													
- Two short periods					128 days			x	97 days		x		
- Reliable single period								225 days					
Muarabungo													
- Two short periods					106 days			x	106 days			x	
- Reliable single period								212 days					
Present planting time													
- Transmigration area													
Sitiung I					paddy			x		fallow			
Sitiung II						paddy		x		fallow			
- Local people							paddy		x		fallow		

Note: x : Harvesting time

----- : Extended growing period for crops which are less sensitive to low moisture condition.

Crops which are less sensitive to low moisture condition such as groundnuts, soybeans, maize and tobacco can be planted during the earlier growing period in the beginning of September. Due to very poor chemical soil conditions of the area where the topsoils have been removed by uncontrolled mechanical land clearing, the transmigrants planted those crops only on the ridges of accumulated topsoils or on steep slopes where the topsoils still exist. However, intensive land cultivation without using any fertilizer and soil conservation measure, the soils will be depleted seriously mainly due to the nutrients removed by crops and erosion.

The second crops such as cassava and sweet potatoes can be planted as an intercropping when rainfall or soil moisture is still sufficient (mostly in the beginning of October). It seems that local upland rice varieties (5-6 months) are adapted to the local conditions with limited soil tillage. Harvesting time will therefore take place in March/April. Then the land is left to be fallow to supply soil organic matter which is very important for the next crops. If possible it should be covered by legumes. The high yielding and short growing period of upland rice varieties (± 3½ months) seem not suited in these conditions.

Based on the climadiagram, after paddy there is still enough time for the next crops such as soyabeans, green beans, maize and sorghum, but the soil condition is not favourable especially those where the topsoils have been removed. After heavy amendments and proper management practice of soils, those groups of crops can be grown, however, these practices are beyond the capacity of most farmers in this area.

If any crop grown will receive at least a minimum requirement in terms of liming, fertilization, soil conservation, pest and disease control, and good quality of seeds are used, then the choice of types or varieties of crops for the rotation can be based according to Table 19.

Table 19. Suggested sequence of some suitable crops in various growing periods in the survey area

First growing period	Second growing period	Long period
Tobacco (tembakau)	Sorghum (sorgum)	Castas (jarak)
Sweet potatoes (ubi jalar)	Maize (jagung)	Cassava (ketela pohon)
Sunnhemp (rami)	Millets (jewawut)	Sweet potatoes (ubi jalar)
Soya beans (kacang kedele)	Soya beans (kacang kedele)	
Groundnuts (kacang tanah)	Sesame (wijen)	Rosella (rosela)
Chillies (cabe rawit)	Beans (kacang uci)	Jute (yute)
Upland rice (padi ladang)	Elephant grass (rumput gajah)	Kenaf (rami/kenaf)
Beans (kacang uci)		Pine apples (nenas)
Maize (jagung)		Sugar cane (tebu)

The duration of sunshine is shortest in January - February and the longest is in July. Therefore the good harvesting time seems to be in July. This may be the reason for local people that the harvesting time of upland rice is in April, and the yield is slightly better. For sugar cane the dry season which is too short seems to be not favourable.

In the irrigation field two crops for one year can be expected, as it has been carried out by local farmers in the Batang Mimpi irrigation area. With a limited use of fertilizers and pesticides they obtained a reasonable yield. The Batanghari river water which has a medium quality will be used for irrigation. It is expected that the first harvest (yield) will be not very good, but it will improve with time and inputs given.

The difference in planting time between the transmigration farmers and local farmers will cause difficulties to control pests. Therefore a uniform crop calendar will reduce the risks.

Perennial crops are not discussed since they do not form parts of normal rotation. Climate would favour most tropical tree crops. Low soil fertility and moderate soil physical properties will limit the choice of crops. Coffee, rubber, oil palm, coconuts, cloves, kapok, kayu manis, cashew, citrus, mango, pine apples, rambutan, dukuh, jack fruits, durian and some bananas seem to be growing well with or without some improvements.

5.4 Land use and agriculture

The present land use in the Sitiung II - S.Jujuhan area during the period of survey (1978) is presented in "Land use and Vegetation map". The boundary changes with time since the local people practise the shifting cultivation system and link with the "Adat law". Dryfield of new settlements (transmigrants) is hoped does not change because they have a limited area given by the Government i.e. 1¼ ha per family including home garden.

It was observed that permanent cultivation with food crops (annual crops) and short period of rotation with natural vegetation after "ladang" have changed the area into grassland (alang-alang), which is difficult to eradicate and it is also due to the rapid decrease of natural soil fertility after cultivation. As has been dicussed before, the natural soil fertility in this area mainly depends on the soil organic matter content of the topsoils, and the high Al-saturation (generally more than 70%) mainly in the subsurface layers which may be toxic to most crops. Uncontrolled mechanical land clearing has removed the topsoils containing organic matter, and in some places also has increased soil compaction.

These are among the reasons of the crop failures in the transmigration fields, and it will be difficult to reclaim. Dryfields derived from alang-alang in the same area and similar soil series such as in Block E (Sitiung I), Block A to C in Sitiung II show good growth and better yield of rice (upland). Only cassava grow well everywhere, except in Block E of the Sitiung II which may be caused especially by the compact subsurface soil and without topsoil. The other crops such as maize, groundnuts and soya beans were practically failed, except those were planted on the accumulated topsoil ridges, on the sloping area of subrecent soils (Mapping units 5, 6, 7 of the detailed soil map, and Mapping unit 5 of the semi-detailed soil map), and on Mapping unit 4 of the semi-detailed soil map have slightly good yield. Therefore in the transmigration fields the ridges of accumulated topsoils are generally used for leguminous plants (groundnuts, soya beans), vegetable crops and maize, while the rest of the area are planted with rice and cassava. The valley floors are usually used for wetland rice. This is a common land use pattern in the sample blocks and transmigration fields.

The present land use (1978) in the Sitiung II - S.Jujuhan area is as follows (Table 20).

Table 20. Present land use and the acreage in the semi-detailed survey area (1978)

Type of land use	Acreage Ha		%	
- Dryfield & settlement	3,651		18.2	
- Rubber	1,510		7.5	
- Alang-alang	352		1.7	
- Brushwood and shrub	445		2.2	
- Secondary forest (including riverine forest)	1,459		7.3	
- Dryland secondary forest		939		4.7
- Wetland secondary forest		520		2.6
- Secondary forest and rubber	4,623		23.1	
- Exploited primary forest	7,996		40.0	
- Dryland primary forest		6,792		34.0
- Mixed with wetland primary forest		1,204		6.0
	20,036 ha		100%	

The exploited primary forest has rapidly become smaller and smaller, because of the shifting cultivation and new settlement area (Sitiung III), especially along the Jujuhan river and in the south western part of the survey area. Reserved forests for local wood construction and firewood supply in the future must be introduced in the land use plan. It is suggested that the reserved forests may be laid out in Mapping unit 9. This reserved forests are very important for reasearch (flora and fauna) and environment.

The rough topography and very low soil fertility and acidity mainly in Mapping units 8 and 9 of the semi-detailed soil map seem that tree crops (rubber)/ cinnamon or mixed garden adapted to these conditions should be the first priority in land use. Whereas arable crops require much inputs in soil conservation practice and soil amendments (fertilizers, liming, good cropping pattern and organic matter), and they may be located in the rather flat area of Mapping unit 8. Improper land use and uncontrolled land clearing cause land degradation as observed in the field, especially in Block E of the Sitiung II.

The relatively flat area of Mapping units 5 and 4 of the semi-detailed soil map has a good possibility for irrigation purposes. The low natural soil fertility, very low pH, and high Al-saturation will be gradually improved by irrigation. Two crop rice per year has been introduced in the Batang Mimpi (Sungai Dareh) irrigation area with reasonable yield. Naturally fertilization, cropping pattern, liming, and minimum land preparation, especially for arable crops will bring them up to condition favourable for sustained cultivation. Mixed farming and rotation mainly with legumes seem to be the better way in maintaining or improving soil fertility besides irrigation. Local practice where the people use this area for food crops, and the peneplain/peneplain volcanic cover for rubber should be continued and maintained. This practice is good for soil and water conservation. The people have adapted with traditional land use of each landform condition (Table 21).

Trials of LP3 (Central Research Institute for Agriculture) are located in small areas of soil series AC-Bd-31, AU-Bd-51 and AU-Bd-21 and trials of IPB (Bogor Agriculture University) are located in soil series AE-Jd-31, AU-Bd-21 and AU-Bd-51 (in Sitiung II) and VU-Lo-31 (in Sitiung III), both for upland crops. Whereas the wetland rice experiments of the Halcrow/PT Indah Karya are located in soil series AU-Bd-51 (Block Piruko) and AU-Bd-21 (Block S. Atang I).

Table 21. Landforms (soils) and their traditional land use

Landform	Present land use
Recent floodplain	
- well drained soils	- food crops (permanent), banana, vegetables
- poorly drained soils	- wetland rice
Subrecent floodplain/terrace	
- well to moderately well drained soils	- shifting cultivation - village and home garden - rubber - coffee - brushwood
- poorly drained soils	- wetland rice
Peneplain	- shifting cultivation, rubber, secondary forest.
Peneplain volcanic cover	- shifting cultivation, rubber, secondary forest, primary forest.

Those trials should be continued and extended to the sloping areas for arable crops, and later they should be transfered to the Agricultural Extension Service as a part of the Agricultural Development Centers or networks of sub- ADC.

5.5 Soil physical properties and irrigation

a. Upland condition

In general water available pores for plant roots and aggregate stability of the soils in Sitiung area are considered as good for upland cultivation, while aeration porosity is insufficient, soil plasticity index is too high and infiltration capacity is optimum only for one site i.e. soil series AU-Bd-51 in Block S. Atang II. The mechanical penetrability seems to be reasonable/fair for most of the soils.

The low percentage of aeration porosity may become a serious problem, and it becomes worse during the rainy season since the actual air capacity may decrease. It was observed in the upland ricefield of the transmigration area, that many spots in concave surface, where the plants showed very poor growth or even died. A bad soil aeration condition is considered to be one of the reasons causing crop failures. For such soils, drainage is very important to prevent water logging in the rainy season or if the gravity irrigation applied.

The poorly growing crops were found on the compacted soils. Even cassava which generally can be considered as the most adaptable crops in the transmigration area, showed very poor growth. The roots of cassava could not spread widely. This condition was especially observed in Block E of Sitiung II in soil series VU-Lc-31 and TU-Pc-51, where the topsoils have been removed during land clearing operation or eroded,and to a certain degree soil compaction occured due to heavy machineries. According to Kohnke (1968), the depth of root penetration is determined by the nature of the plants, the mechanical penetrability of the soils, the water supply, the oxygen supply and the nutrient supply.

Lack of oxygen,possibly,is the main factor hindering the growth of roots. The soil physical data show that the aeration pores are generally low. According to Taylor and Burnett (1963) lack of aeration can become serious problems on clay or clay loam soils, for soil compaction increases the probability of oxygen deficiency. From some experiments on the silty clay loam and silt loam soils, Adams et al (1960) concluded that low percentage of pores drained at 60 cm suction on packed soils indicate that inadequate diffusion of gases during some parts of the crop growing season are perhaps a major cause of the crop failures as noted.

The soils should be worked out so that the aeration pores are sufficient for plant growth, but it may create a bad soil fertility status, since the mixture of infertile subsoils with thin topsoils may result in a relatively low fertility status, unless sufficient fertilization and liming including green manures are applied.

A problem may arise when the people work the soils due to the high value of the soil plasticity (see Table 7). The soils are very sticky when wet and hard when dry. Improperly carried out mechanical land clearing can increase the compaction of the soils and it causes the soils to be more difficult to work out in the dry condition.

From the available labour forces it is beyond the capacity of one family to cultivate their whole own land at once prior to a planting season. Each family received 1.25 ha land consist of 0.25 ha home garden which requires about 20 - 30 mandays to work, plus 1 ha farm which requires about 100 mandays (Team Pengamatan Direktorat Jenderal Transmigrasi). Some of them rented a tractor from PT Intrada in order to finish the soil preparation in a shorter time. For the future it might be valuable to provide the people with some hand tractors or draft animals for soil preparation. Draft animals will be more beneficial because their dungs will improve the soils.

It was observed in some places where the soils were very hard. It was impossible to take undisturbed soil samples when the soils were dry. The samples of soil series AC-Bd-51 from Block Kotabaru, samples AC-Bd-31 and AU-Bd-51 were taken from lower layers only, because the upper layers were too hard to sample. "Team Pengamatan Direktorat Jenderal Transmigrasi" found a site in a muddy area where the dry upper soil layer possessed high strength value as high as $4.5\ kg/cm^2$ (= 441.3 kPa) or more. This hard layer was only 5 cm thick and the moisture content was very low. The lower layers which contained higher soil moisture, possessed a lower strength value i.e. about $0.75 - 1.25\ kg/cm^2$ (=73.6 - 122.6 kPa).

The strength value of this upper layer is obviously much higher than the average value of other soils. It seems probable that the poor soil physical status was the result of the improper mechanical land clearing, which was operated during the soils in a very wet condition. It has been known that the soil moisture plays an important role in affecting the soil compaction. To minimize the formation of compacted soils and their harmful effects, the tractor operators should wait several days after a rain before driving over the soils.

The most serious effect of the improper mechanical land clearing is the disappearance of the topsoil, resulting in the exposition of the compacted and infertile subsoils. Such case was found in Blocks D and E of Sitiung II and some places in Sitiung I, which is very difficult to remedy or reclaim. Some efforts have been done, for example to distribute the gathered topsoils, but it did not help much. The application of large quantities of organic and inorganic fertilizers are required.
Unfortunately, in the present condition where the food is lacking and the land is limited, it is nearly impossible to introduce the green manure crops into the cropping pattern in the transmigration area. The best way to overcome the problem, may be to resettle the people in the more suitable area for food crop production. The seriously disturbed land should be planted with green manure crops or tree crops such as stylosanthus, centrocema, cashew, nuts and caliandra. The tree crops may be planted in plant

pits provided with sufficient fertilizers and organic matter. The reclamation of degraded land is also relevant with the improvement and maintenance of good environmental condition and ecosystem.

The mechanical penetrability, although it shows relatively high value of the compacted soils (441,3 kPa), seems not to be a limiting factor, because it is still much lower than the critical soil strength value (2,758 kPa). In addition owing to the high amount of rainfall, the roots may penetrate the wet compacted layer easier. Taylor and Burnett (1963) stated that although plant roots may not be able to penetrate a compacted layer on a certain day, rain may soften the layer sufficiently for root penetration on the following day.

b. Irrigation

The role of water is very important in helping the farmers to cultivate their land. If the water is available they can supplement some water to increase the soil moisture content, so that the optimum condition for working the soils can be achieved. The addition of water also gives a better chance for roots to penetrate the soil. During the rainy season there is plenty of water, but in the dry season, especially in June, July and August, supplement irrigation water may be necessary.

Irrigation water is very important, nevertheless it does not mean that all the problems solved. In the wet rice cultivation the soil is puddled so that there is no problem of low aeration pores or high mechanical penetrability. During the first few years, it will be very hard to change the original soil structure into puddled condition due to the high soil plasticity. A high amount of water will be required, since the percolation rate is normally high, and irrigation efficiency is generally low during the first few years. The deep cultivation of subsurface soil may cause problems of nutrient deficiency and some toxicities. The high rate of percolation will leach the toxic elements and at the same time the nutrient as well.

The low infiltration capacity of soil series AC-Bd-31 (site WT 7/SK 4), AU-Bd-21 (site Wt 2/SK 1, Wt 10/SK 12 and Wt 15/SK 16), AU-Bd-31 (site Wt 12/Md10), and soil series AU-Bd-51 (site Wt 6/T 2) may cause several problems when the rainfall is high or the land is irrigated. In the rolling area the surface run off may be very high which causes the erosion hazard.

Soil conservation measures such as terracing and soil management should be applied, and it will be desirable if an intercropping system is applied.

The infiltration rate of soil series AU-Bd-51 (site Wt 11/SK 9) is considered as the optimum for upland cultivation with supplement irrigation. The rotation system of paddy rice and upland crops will be the most beneficial practice. Most of the other soils have lower infiltration rate, which means that there is a risk of oxygen deficiency when the gravity irrigation is applied.

For the Sitiung I area, where the lowland rice cultivation is the main objective and the suitability of land to be irrigated is good, the low infiltration rate is not a limiting factor. However, for the Sitiung II area, where the topographic condition is a limiting factor, only Mapping units 4 and 5 are reasonably suitable for irrigation purposes. It must be noted that the low infiltration capacity may become a problem in the rainy season.

Soil series AU-Gd-71 (site Wt 3/T 1), AC-Bd-31 (site Wt 4/Ms 1), and soil series VU-Lo-31 (site Wt 13/Ms 12) which possess a high infiltration rate are impracticable for gravity irrigation of upland cultivation. Furthermore, if the irrigation channel is passing through the above mentioned soil series, it will be rather inefficient because the loss of water will be very high. However, considering the soil texture with approximately 50% of clay, it is still possible to reduce the permeability by compaction.

5.6 Soil fertility

Most soils in the survey area are chemically very poor and have a high content of aluminum (Al-saturation is more than 70%). In the moderately well drained soils (soil series AU-Bd-51) the manganese content is also high. The essential plant nutrients such as N, P, K, Ca and Mg are extremely low. Thus there is an imbalance of nutrients between macro and micro elements. These conditions can be detrimental to most crops grown in this area. Only soils on the recent floodplain/low terrace (soil series AE-Jd-31, AE-Jd-51, AE-Jd-7,81) have a reasonably good quality.

The natural soil fertility only depends on the organic matter of the topsoils, which is very unstable and will decrease rapidly after cultivation. Intensive and continuous cultivation without any measure of improvement/organic matter recycling and monitoring soil fertility,will deplete the soil nutrient contents, because the biological recycling is cut off.

Most of these kinds of soils can be readily improved by liming and fertilization and they will become quite productive for any climatically adapted crop. But the cost of fertilizers and lime at the farm level is high and the crop prices are low; consequently the inputs will always be too costly for the farmers. Therefore the selection of species/varieties which are better adapted to the adversed soil conditions and require a minimum to medium cost input is very important. This is a very relevant consideration because these kinds of soils are widely distributed all over Indonesia, and most of the farmers lack of capital.

According to the finding of James M. Spain et al (1975) in Columbia, many crop species are well adapted to extremely acid soil condition and are also efficient in absorbing native soil nutrients. These species are:

Tree/fruit crops	:	Mango, citrus, cashew, brazil nuts, rubber, pine apples.
Forage/legumes and grasses	:	Stylosanthus (S. Guayanensis), desmodium, kudzu, centrocema, molase grass (Melinis minutiflora), puntero (Hypharrhenia rufa), brachiaria (B. decumbens) and pastonegro (Paspalum plicatulum).
Starchy food	:	Cassava, tropical jams, certain plantain.
Legume crops	:	Cowpeas, black beans.
Cereals	:	Several adapted varieties of rice.

Liming based on the data in Subchapter 3.5 is more than 1 ton $CaCO_3$/ha and it varies with soil series and the pH value to be reached. However, it must be very careful as stated by James M. Spain et al (1975), that tropical allic soil environment (Aluminum is the dominant exchangeable cation) is extremely sensitive to over liming. It must be emphasized that the application of lime is to supply Ca and Mg as nutrients in the soils rather than to neutralize soil acidity or exchangeable aluminum, so that the lime requirement can be minimized. The Ca content in the phosphorous fertilizers might be sufficient to meet the nutrient requirements of many crops requiring less calcium. It is expected that the crop yield will be lower than if complete liming is given.

Phosphorus and potassium are also low to very low in most of the soils. Therefore basic phosphorus fertilizers seem to be the better form, especially for upland (arable) crops. Furthermore, phosphorus applied as fertilizers will be fixed by aluminum and manganese. As stated by Kamprath (1972) that Al-saturation greater than 60% will cause more plant growth to be affected by aluminum toxicity, and phosphorus applied as fertilizers will be readily fixed unless lime is applied.

Balance of iron and manganese should exist for normal plant growth. Symptoms of iron toxicity correspond to manganese deficiency, and symptoms of manganese toxicity correspond to those of iron deficiency (Somers and Shieves in Thompson, 1957). The rice varieties which are relatively resistant to Fe deficiency and Al as well as Mn toxicty, among others are IR 24, IR 127-8-1, IR 661-1-170 and IR 1008-14-1 (Ponnamperuma, 1975).

An irrigation project will certainly be beneficial to the farmers and it will promote agricultural development. Since the main purpose of the project is to provide irrigation for lowland (wetland) rice, the effects of submergence to the soils must be considered. When soils are submerged there will be several changes on chemical and physical properties of the soils.

The quality of water in the survey area is good, but very low in plant nutrients especially the river water originating from the survey area itself.

In submerged condition the soil pH will increase, which consequently will be favourable to nutrient uptake by rice. From the soil fertility point of view, the soil pH about 6.6 is generally optimum for rice growing. At this level the microbial release of N and P from soil organic matter and the availability of P are high. Furthermore the supply of Cu, Zn and Mn is adequate and the concentration of substances that interfere with the nutrient uptake such as Al, Fe, CO_2, and organic acid is below the toxic level (Ponnamperuma, 1976). Therefore the Batanghari water will be the best for irrigation than the water from the other rivers, because it contains more Ca and Mg. The water of Batang Piruko and Batang Jujuhan are slightly better than that of the Batang Biawak and Batang Kuamang. The two former river water (Batang Piruko and Batang Jujuhan) can be expected to enrich the soils mainly with those two cations, and therefore liming might be unnecessary.

Soil and water management must be carried out properly since submergence could also create some problems. A number of physiological diseases of rice are known. Many of these are associated with abnormal redox and Eh levels. One of particular interests is sulphates. Sulphates undergo reduction at low negative Eh values. The ultimate product is sulphides, an extremely toxic anion. In most soils toxicity is removed by precipitation of FeS (Tanaka and Yoshida, 1970; Ponnamperuma, 1976).

If there is not enough active iron in the soils, sulphides will accumulate which may hinder nutrient uptake by rice roots or poison the plants, and lower the availability of Cu and Zn.

Soils in the survey area are high in sulphates, low in iron, very low in cation exchange capacity, and very low in base saturation. Therefore submergence/flooding (flooded rice) have a possibility causing sulphide toxicities. Whereas toxicity due to aluminum and manganese is seldom encountered in lowland rice. It is suggested to monitor the chemical changes, especially the pH, Eh, sulphides and iron in the experimental plots of flooded rice soils currently conducted by the Halcrow and Partners in the survey area.

On the other hand according to Ponnamperuma (1975), iron (Fe) coming into solution as Fe^{2+} will increase with time, and in strongly acid Ultisols and Oxisols this Fe^{2+} formation will reach into a concentration of more than 300 ppm during a few week of submergence. Iron toxicity is recognized as one factor which limits the yield of rice on strongly acid Oxisols, Ultisols and Acid Sulphate soils in the tropics.

Based on the result of plant (rice) analyses (Table 22), iron and manganese contents show a tendency of iron and manganese toxicity and Cu deficiency in the trial plots of wetland rice in the Piruko block (soil series AU-Bd-51) and the S. Atang I block (soil series AU-Bd-21). From this table it seems that iron toxicity is less in the soil series AU-Bd-21 than in the soil series AU-Bd-51.

Table 22. Result of plant analyses of wetland (flooded) rice from the Halcrow's trial plots in the Sitiung I, analyzed by the Soil Research Institute Laboratory. (upon 100 grams of dry matter at 105° C)

Location of trial plots	Rice variety	N %	P %	K %	Ca %	Mg %	Na %	Fe ppm	Al ppm	Mn ppm	Cu ppm	Zn ppm
S. ATANG I	IR 38	1.49	0.11	0.84	0.18	0.08	0.01	385	114	5071	5	32
(Soil series	IR 38	1.58	0.14	1.25	0.42	0.11	0.01	238	29	4170	0	23
AU-Bd-21)	IR 38	1.61	0.13	1.42	0.26	0.10	0.01	211	34	4093	7	26
	IR 38	1.66	0.12	1.23	0.19	0.10	0.01	527	86	4815	5	31
PIRUKO	IR 38	1.71	0.18	1.45	0.31	0.12	0.01	551	98	2393	3	37
(Soil series	IR 38	1.46	0.15	1.09	0.38	0.08	0.01	297	54	2363	2	33
AU-Bd-51)	IR 38	1.31	0.16	1.56	0.23	0.10	0.01	292	79	3374	3	33
	IR 38	1.72	0.15	1.18	0.20	0.09	0.01	374	59	4576	2	37
	IR 34	2.28	0.15	1.69	0.15	0.09	0.01	719	66	2618	9	42
	IR 38	2.53	0.15	1.78	0.25	0.09	0.01	446	74	3359	3	35
	IR 34	1.71	0.13	2.03	0.23	0.08	0.01	672	74	3154	2	32
	IR 38	2.35	0.16	1.54	0.18	0.08	0.01	622	111	2718	0	36

According to Ishizuka (1975) the rice plants in the new reclaimed paddy field often suffer from the toxic effect of excessive iron, manganese and copper. However, after several years of continuous paddy cultivations, the elements which become soluble under reduced condition will be leached downward by the movement of irrigation water. And after a certain extent there will be deficiency of those elements in the topsoils, especially under the condition of excessive drainage. Therefore it is essential that the drainage of paddy field be maintained under optimum conditions, and the soils be intermittently aerated during the period while the crop is being cultivated. These may be the situation that have occured in the wetland (flooded) rice trials of the Halcrow and Partners in the Sitiung I area (Blocks Piruko and S. Atang I).

5.7 Soil suitability

As it has been indicated on the soil map, the result of interpretation shows that roughly 5,000 ha (25%) of the Sitiung II - S. Jujuhan area spread along the Batanghari, Batang Jujuhan and Batang Siat rivers are moderately suitable for wetland rice under gravity irrigation. Some places such as in Block D and near Kuamang village are rather dissected and isolated, therefore they will be more difficult or very costly to irrigate. On the other hand, soil series AC-Bd-31 and AU-Bd-21 located on a slightly higher position will reduce the irrigable area (see detailed soil maps), and in the first few years they will require more quantity of water due to the high porosity of the soils.

About 1,350 ha (6.8%) scattered along the streams (Mapping unit 6) are marginally suitable for gravity irrigation. Flooding hazard in the lower parts (valley floors), slightly sloping area on the higher parts (transitional plains), and a limited quantity of water for irrigation will reduce the irrigable area of this unit. It seems that a simple irrigation system (traditional) will be more practicable. However, wetland rice is also still possible in small scattered marshy areas on the valley floors and flood plains by using local water courses.

The largest part of the area will be not suitable for gravity irrigation for wetland rice, therefore interpretation for upland crops has been evaluated. Based on the result of the interpretation of the land (Tables 23 and 24), the soils are moderately well suited (Class III) to poorly suited (Class V) for arable crops, and moderately well (Class III) to marginally suited (Class IV) for rubber, with some exceptions in the valley floors and backswamps which are

Table 23. Actual and potential soil suitability for Arable crops in the semi-detailed Sitiung II - S. Jujuhan area

Description	Class	Actual			Potential		
		M.U.	Ha	%	M.U.	Ha	%
Moderately well suited	III	1	1,120	5.6	1,4,5,7	6,687	33.4
Moderately well suited & generally not suited	III, VI	-	-	-	6	1,356	6.8
Marginally suited	IV, (V) *)	4, 5	4,877	24.4	3,8,9	11,134	55.5
Marginally suited & generally not suited	IV, VI	6	1,356	6.8	-	-	-
Poorly suited	V	7, 8, 9	11,706	58.4	-	-	-
Generally not suited	VI	2, 3	977	4.8	2	859	4.3
	Total		20,036	100.0		20,036	100.0

Table 24. Actual and potential soil suitability for Rubber in the semi-detailed Sitiung II - S. Jujuhan area

Description	Class	Actual			Potential		
		M.U.	Ha	%	M.U.	Ha	%
Well suited	II, (III) *)	-	-	-	4,5,8	8,887	44.4
Well and poorly suited	II, V	-	-	-	6	1,356	6.8
Moderately well suited	III, (V) *)	4,5	4,877	24.4	7,9	7,696	38.4
Moderately well suited & generally not suited	III, VI	6	1,356	6.8	-	-	-
Marginally suited	IV	1,7,8,9	12,826	64.0	1	1,120	5.6
Poorly suited	V	-	-	-	3	118	0.5
Generally not suited	VI	2,3	977	4.8	2	859	4.3
	Total		20,036	100.0		20,036	100.0

*) Locally has poorer classes (less htan 25% of the area).

generally not suited (Class VI) for arable crops as well as rubber.

With some improvements to a certain extent, especially on soil fertility and topography condition (terraced), the soil suitability classes will be improved (potential soil suitability). Total improvements will be beyond the ability of the farmers, especially due to the lack of capital of the farmers. On the other hand, improper land clearing/land use/management will lead to the degradation of the land, as it has happened in the large parts of the transmigration area, especially in Block E of the Sitiung II. These conditions will be very difficult to reclaim, therefore at least new farms or area must be provided to substitute those presently unsuitable farms.

The area of the undulating and rolling relief is more suitable for rubber or mixed gardens. Therefore these kinds of land use should be introduced to the transmigrants/farmers or included to the project of ADP (Agricultural Development Plan) as has been developed in the north-western border of the area. This pattern of land use will require more land.

Reserve forest for wood construction and firewood must also be taken into consideration in planning which can be located in Mapping unit 9. This is very important for the future.

From the observation it seems that legume crops (soyabeans, groundnuts), maize and high yielding rice varieties are poorly suited with the current soil conditions. Therefore it is not recommended to cultivate those crops without any soil improvement. However, after several years of irrigation by using the Batanghari river water, the irrigated land will be gradually improved so that those crops can be expected to be more suitable. Furthermore, with additional soil amendments the yields are expected to increase.

VI. CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

1. The presently available contour maps (scale 1:5,000) are rather poor for base and field maps, therefore it is impossible to make reliable slope analyses. To overcome this problem, aerial photographs were used as base maps.

2. There are good networks of roads in the survey area, partly consist of all-season paved roads in the transmigration area and partly non-paved roads in the timber concessions which are very slippery in the rainy season. The area is easily reached from the Trans-Sumatera Highway mainly by passing through the feeder road.

3. The greater part of the survey area is dissected rolling to hillocky relieves with steep slopes, narrow V-shaped valley bottoms and rounded to convex ridge crests of peneplain/peneplain volcanic cover. The subrecent river terrace covering an area about 5,000 ha is slightly flat and slightly dissected by deep incised valleys. Another flat area is on the recent floodplain (1,238 ha) and recent (low) terrace (489 ha) of the Batanghari, Batang Juiuhan and Batang Siat rivers. The subrecent (high) and recent (low) terraces have a good possibility for irrigation projects. Unfortunately, there is no good large scale contour map available, therefore it is rather difficult to make any good plan for the irrigation projects in this area.

4. A long growing period and a relatively short period of water deficit (June to August) make a good possibility of twice arable crops cultivated in a year, even further if the cropping pattern is well arranged and proper soil management is practiced. The inherent low soil fertility, very acid soils and enhanced by the removal of topsoils due to improper land clearing in the transmigration fields have caused great difficulties in reclaiming those unproductive land.
   Natural biological recycling for a limited time and intensive cultivation without any additional soil amendment will decrease soil fertility seriously after few years of intensive cultivation.

5. The improper land clearing using heavy equipments without due consideration on the slope classes and soil conditions have caused degradation of the land such as the loss of topsoils, soil compaction, severe erosion and marked decrease of soil productivity.

6. Soils in the survey area are grouped according to landform units as follows: (a) Soils on recent floodplain and recent (low) terrace, (b) Soils on subrecent river terrace, (c) Soils on peneplain, and (d) Soils on peneplain volcanic cover. They consist of Alluvial soils, Humic/Low Humic Gley soils including Organosols (in the floodplains), Acid Brown Forest Soils/Brown Tropical Soils (on the subrecent river terrace), Gray Hydromorphic soils and Red-Yellow Podzolic soils (on the peneplains), and Latosols (on the peneplain volcanic covers), which may be classified in the US Soil Taxonomy as Fluvents, Typic/Histic Tropaquents including Histosols (Fibrits), Typic Dystropepts, Aeric Tropaquults, Typic Tropudults, and Tropeptic Haplorthox respectively. Soils on the recent and subrecent landforms have developed from alluvium dominated by acid volcanic materials. The soils on peneplain developed from tertiary river terrace materials or mixed with colluvial acid volcanic tuffs. Whereas the soils on peneplain volcanic cover have developed from acid volcanic tuffs. The soils on the first two main landforms are characterized by mixed clay minerals such as amorphous, kaolinitic minerals and quartz, while the soils on the two last landforms seem to be dominated by kaolinite and small amount of gibbsite, chlorite, goethite and quartz. All of these soils derive 21 dominant soil series, 11 mapping units in the detailed sample blocks, and 9 mapping units in the semi-detailed Sitiung II - S.Jujuhan area. Each soil mapping unit is a single soil series, association, or complex of soil series depend on the homogeneity-heterogeneity of the materials and other characteristics.

7. Most soils in the survey area are very acid, very low in plant nutrients, organic matter content and base saturation, on the other hand most of the soils have very high aluminum saturation. In addition, some soils are also very high in manganese content, especially in the moderately well drained Acid Brown Forest Soils. Toxicity may occur on upland (aerobic) crops due to the high aluminum and manganese contents. It seems that phosphorus fertilizers will be readily fixed by aluminum.

8. Soils on the recent floodplain and recent (low) terrace are slightly better, however, flooding is considered to be the limiting factor of this area. In the beginning of wetland rice reclamation, it seem that toxicity of iron and manganese may seriously affect rice crops. However, these iron and manganese cations will be leached after few years of irrigation practices. Therefore, intermittent irrigation will probably reduce this iron-manganese toxicity.

9. From the field observation it was identified that in some places, especially in Blocks D and E of the Sitiung II transmigration project area, improper mechanical land clearing using heavy machineries had caused the topsoil removal and the soils become more compact so that the roots of some crops can not penetrate or develop in this compact layer. In other areas soil shear strength is not limiting, but the low aeration pores may become a disadvantageous factor to the plant growth of upland crops, while the low infiltration rate will increase the run off and soil erosion hazard in rolling/hillocky areas. Successful crops cannot be expected from such soil, unless sufficient inputs are given.

10. Irrigation project will be concentrated in Mapping units 4 and 5 of the river terrace soils. Whereas the peneplain and peneplain volcanic cover are more suitable for rubber due to very low soil fertility and unfavourable topography. The recent floodplain is still possible for food crops, but sudden floods may occur especially during the rainy season. Therefore, proper periods of planting time are very improtant and must be considered.

11. The degraded farm lands of Blocks D and E of the Sitiung II should be replaced by other land, and then these land must be reclaimed and are kept under natural vegetation. The only possibility for this purpose is soil mapping unit 8 with very careful land clearing. It seems that the farmers require more land, as the priority of land use pattern of this mapping unit is tree crops (rubber) or mixed garden

6.2 RECOMMENDATIONS

1. Since the quality of base maps influences, the quality of the end results of soil survey and planning, therefore it is recommended to prepare good and accurate base maps before any physical survey or planning is conducted.

2. Climatological stations in KBS (Central Seed Garden) Sungai Dareh and in Mimpi Sugarcane Project in Kotabaru should be further developed and should record relevant data continuously. It is recommended to build up some stations in the Sitiung III supported by rainfall stations in the surrounding area, such as in Blocks B and E (Sitiung I), Blocks E and G (Sitiung II), and along the Batang Jujuhan area. These are very important for planning the agricultural program in this area and its surroundings. Based on the existing climatological data, a proposed framework of cropping pattern/rotation is suggested mainly for arable crops after land improvement.

3. The proposed main irrigation canal, if possible should be located on the boundary between the subrecent river terrace and peneplain/peneplain volcanic cover landforms. The village sites should be placed along the main canal for the efficiency of land allocation to achieve a larger proportion of the irrigated area. The topographical condition will be the limiting factor for the establishment of the irrigation network, and the main cannal must cross the Batang Siat and several deep incised valleys. There is also another possibility to make "sawah" (wet ricefield) along rather broad river alluvial plains of the Batang Biawak, Batang Kuamang and Batang Ambai rivers i.e. on the upper parts of their catchment areas (Mapping unit 6).

4. Irrigation is expected to improve water supply for crops and may also soil productivity, because the water quality of Batanghari river is reasonably good. Therefore, intensive cropping pattern/rotation of wetland rice and arable crops in planned irrigated areas can be expected to be more successful. Proper cultural practice consisting of application of balanced fertilizers, proper soil management, pest and disease control measures, and good quality of seeds should be implemented. These practices will prevent the degradation of soils from imbalanced nutrients and toxicity. The proper irrigation system in the ricefield will be beneficial for the removal of toxic elements and for the maintaining soil temperature at least in the first few years.

5. To achieve the most beneficial result of the irrigation project, an overall integrated approach of agricultural development in the project area must be carried out by respective agencies involved. Therefore, the agricultural services officers must be strengthened and properly supported by field research conducted locally.

6. Since the waterloss of the newly developed wet ricefiled through percolation is normally high, the irrigation water should be managed carefully, for example by practicing intermittent irrigation in order to cover larger irrigated area. Field investigation on this matter such as the one being conducted by Halcrow and Indah Karya will be very useful for the rapid development of the area.

7. In arable/upland crops a minimum soil tillage must be practiced in order to reduce or minimize the decomposition of soil organic matter, and aluminum as well as manganese toxicity, however, it should be sufficient to produce good aeration pores. Rotation of crops and legumes especially with mixed farming is likely to be the best system, besides improving soil fertility it is also important especially for land preparation. However, a minimum input such as the application of fertilizers and lime is required as the soil fertility is extremely low.

Limited land and lack of capital of the most farmers may constitute the limiting factor for conducting these improved methods at the present time.

8. The development of high yielding and short growing crop varieties relatively tolerance to adversed soil conditions, especially to the high aluminum content and very low pH should be carried out and be given high priority. Proper attention should also be given to plant pest and disease control to ensure successful crop production programs.

9. Soil conservaiton measures should be applied to control erosion hazard in the rolling to hillocky area. Tree crops should be introduced besides food crops, and if possible green manure crops should be included in the cropping system. Continuous crop cover or vegetative cover should be developed based on the soil syuitability classes and suitable cropping system.

10. The socio-economic aspects of the local/native people in relation to the settlements and transmigration projects must be considered seriously and be included in the planning of the projects, in order to ensure the success of any resettlement and transmigration project.

11. To prevent the degradation of physical and chemical properties of the soils, it is strongly recommended for the future transmigration projects the land clearing should be carried out properly. The main purpose of these proper land clearing techniques is not to disturb the topsoils and not to cause soil compactions. Furthermore since the possible irrigated area is very limited, the proposed settlement area should be located on the relatively unproductive land or on the area not suitable for crop production. This can be achieved if the land allocation planning is based on the relevant data and information.

12. Mechanical land clearing using heavy equipments should be carried out properly and carefully to avoid the possible degradation of land. The following land clearing activities should be practised properly:

    (i) Mechanical land clearing should be restricted to slopes of less than 8% with minimum use of heavy equipments on land allocated for crop production. The heavy equipments should be used only during drier time of the year.

    (ii) Destumping is not advocated and logs should be laid down along contours to be burned <u>in situ</u> or to be left rotting.

(iii) The remaining undergrowth and jungle flush should be cleared by hand, wind-rowed along contours and finally burned when dry.

(iv) Hand clearing is advocated for subsequent clearing by settlers aided by the provision of power saws, hand winches and draft animals.

(v) After clearing and burning of debris, the establishment of rapid cover of grasses and legumes should be carried out to minimize splash erosion.

VII. REFERENCES

Adams, E.P., G.R. Blake, W.P. Martin and D.H. Boelter, 1960. Influences of compaction on crop growth and development. 7th International Congress of Soil Science, Madison, Wisc., USA.

Boul, S.W., P.A. Sanchez, R.B. Cote Jr. and M.A. Granger. Soil fertility capability classification. In the Soil Management in Tropical America pp. 126-140. N. Carolina State University, USA.

Buurman, P. and M. Soepraptohardjo, 1978. Oxisols and associated soils on ultramafic and acid volcanic rock in Indonesia. Lokakarya I Klasifikasi Tanah, LPT Bogor.

Buurman, P., M. Soekardi, 1978. Brown Soils, Latosols or Podzolic Soils. Lokakarya I Klasifikasi Tanah, LPT Bogor.

Dit. Geologi, 1975/76. Peta Geologi. Lembar 5/VII dan 4/VIII skala 1:250.000. Bandung.

Driessen, P.M., 1971. A proposed parametric soil suitability appraisal system. First approximation. Internal memorandum of the Pedology Division. Soil Research Institute, Bogor.

Dudal, R., 1974. Soil map of the world. FAO/UNESCO, Paris.

F.A.O., (no year mentioned). Soil survey in irrigation investigations. Soils bulletin (draft).

Guerero, R.M., 1975. Soil of the Llanos Orientales of Columbia. In the Soil Management in Tropical America. pp. 61-83. N. Carolina State University, USA.

Hidayat, A., O. Sudarma and Ismunadji, 1978. Status hara tanah transmigrasi Sitiung, Seminar LP3, Bogor.

Ishizuka, Y., 1971. Nutrient deficiencies of crops. ASPAC, Taipei, Taiwan.

Kohnke, H., 1968. Soil physics. Tata Mc Graw-Hill Publish Co. LTD. Bombay-New Delhi.

Lembaga Penelitian Tanah, 1964. Pedoman pengamatan tanah di lapang. Dok. LPT Bogor.

Lembaga Penelitian Tanah, 1974. Penuntun Analisa Fisika Tanah. Publ. No. 8/1974 Bogor.

Lembaga Penelitian Tanah, 1978. Laporan survai tanah daerah Jalan Lintas Sumatera (Sei Dareh - Sumatera Barat). Dok. LPT, Bogor.

Murdoch, G., et al, 1977. Identification and reconnaissance of the study area. Project report 13, IUTP Bukittinggi.

Mahler, P.J., 1970. Manual of land classification for irrigation. Publish No. 205. Soil Institute Tehran, Iran.

Ponnamperuma, F.N., 1975. Micro nutrients limitations in tropical acid rice soils. In the Soil Management in Tropical America. pp. 330 - 345. N. Carolina State University, USA.

Ponnamperuma, F.N., 1976. Physico chemical properties of submerged soils in relation to soil fertility. In the Fertility of paddy soils and fertilizers application for rice. pp. 1-27 ASPAC, Taiwan.

Riquier, J.D., Luis Bramao and J.P. Cornet, 1970. A new system of soil appraisal in terms of actual and potential productivity (first appr.). FAO, AGL. TESR/70/6, Rome.

Schmidt, F.H., J.H.A. Ferguson, 1951. Rainfall type based on wet and dry period ratios for Indonesia with western New Guinea. Pub. No. 42. Jawatan Meteorologi dan Geofisika, Jakarta.

Sir William Halcrow and Partners, 1978. Sungai Dareh - Sitiung Irrigation Project. Inception report. Bandung.

Soepraptohardjo, M. , 1961. Sistim klasifikasi tanah di Lembaga Penelitian Tanah. Dok. LPT, Bogor.

Soekardi, M. and Darul SWP, 1977. Tanah di dataran Mimpi, KNIT II Yogyakarta.

Soil Survey Staff, 1951. Soil survey manual. USDA Handbook No. 18 Washington 25 D.C.

Soil Survey Staff, 1975. Soil Taxonomy. A basic system of soil classification for making and interpreting soil survey. Agric. Handb. No. 436. Washington D.C. USDA.

Soil Research Institute, 1979. Progress Report of Sitiung - S.Jujuhan Irrigation Project area, Bogor.

Spain, J.P., C.A. Francies, R.H. Hoovler and F. Calvo, 1975. Differential species and varietal tolerance to soil acidity. In the Soil Management in Tropical America, pp. 308-329, N. Carolina State University, USA.

Team IPB, 1976. Laporan survai kapabilitas dan agricultural plan daerah calon lokasi Rimbo Bujang - Teluk Kuali, IPB, Bogor.

Team IUTP, 1977. Evaluation of the Alai Hilir area as settlements. Project Report 21, IUTP Bukittinggi.

Trojer, H., 1976. Weather classification and plant weather relationship. SRI/ FAO Working Paper No. 11, Bogor.

Thompson, L.M., 1957. Soils and soil fertility. Mc Graw-Hill, New York.

Team Survai UNAND dan LP3 Perwakilan Sumatera Barat, 1977. Survai keadaan pertanaman transmigrasi Sitiung. Padang.

Taylor, H.M., and E. Burnett, 1963. Some effects of compacted soil pans on plant growth in the Southern Great Plains. Journal of Soil and Water Conservation, November - December 1963.

A P P E N D I C E S

Appendix 1

Soil Survey Team

of Sitiung - S. Jujuhan

A. SOIL RESEARCH INSTITUTE

1.	Dr. D. Muljadi	- Project leader/Supervisor
2.	M. Soepraptohardjo	- Deputy Project leader/Deputy Supervisor
3.	Ir. M. Soekardi	- Team leader/Coordinator
4.	Marsoedi Ds B.Sc.	- Chief of Soil survey party
5.	Moerdani	- Chief of Soil survey party
6.	M. Djaenuddin	- Member of Soil survey party
7.	Ir. Abdurachman A. M.Sc.	- Chief of Soil physics party
8.	Mochtar Shaleh	- Assistant of Soil survey
9.	Sambas	- Assistant of Soil survey
10.	A. Setiarachman	- Assistant of Soil survey
11.	Hendra Suhendra	- Assistant of Soil survey
12.	Tato Sudharto	- Assistant of Soil survey
13.	Hidayatulloh	- Logistic
14.	Budhi Sutrisno	- Logistic

B. CARTOGRAPHY/REPRODUCTION

15.	Drs. A. Suroto	- Reproduction, SRI Bogor
16.	Rosman	- Cartographer, SRI Bogor

C. RESOURCE PERSON

17.	Ir. R.A. Bustami Rosadi	- PT Indah Karya

Appendix 2 . Morphological characteristics of representative soil profiles

A. Semi-detailed Sitiung II - S. Jujuhan area

Mapping Unit : 1

Soil series : AE-Jd-31

Classification

a. SRI : Yellowish Brown Alluvial soil

b. USDA : Tropofluvent

Landform : Recent floodplain

Relief/Slope : Level

Parent material : Moderately fine to medium fine textured recent river alluvium

Drainage : Well drained

Vegetation : Glagah (Sacharum spontanum), rotan (Calamus sp), waru-waruan (Hibiscus tiliaceus), mahang (Macaranga sp)

Location : Kuamang, Sitiung II

(SRI 195480/484; MS 15)

SRI No.	Horizon	Depth (cm)	Description
195480	I	0 - 16/20	Brown (10YR 4/4); moderately fine (silty clay loam); weak fine and medium subangular blocky; firm (moist), non sticky and non plastic(wet); common fine and medium, many large tubular pores; many fine and medium, few large roots; clear wavy boundary; pH 6.0
481	II	16/20-40	Brown (10YR 4/3); moderately fine (silty clay loam); weak fine and medium subangular blocky to massive; firm (moist), slightly sticky and plastic (wet); many fine, medium and large tubular pores; many fine and few large roots; diffuse smooth boundary; pH 5.4
482	III	40 - 70/87	Yellowish brown (10YR 5/4); moderately fine (silty clay loam); massive; firm to friable (moist), slightly sticky and slightly plastic (wet); many fine, medium and large tubular pores; few fine and common medium roots; gradual smooth boundary; pH 5.7
483	IV	70/87-120	Yellowish brown (10YR 5/6); medium fine (silty loam); massive; firm (moist), slightly sticky and slightly plastic (wet); many fine, medium and large tubular pores; few fine and medium roots; clear wavy boundary; pH 5.8
484	V	120 - 140	Yellowish brown (10YR 5/4); medium fine (silty loam); structureless ; very friable (moist); many fine, medium and large tubular pores;pH6.3

Note: Biological activity throughout the profile.

Mapping Unit : 1

Soil series : AE-Jd-51

Classification

a. SRI : Brown Alluvial soil

b. USDA : Tropofluvent

Landform : Recent floodplain

Relief/Slope : Level

Parent material : Moderately fine textured recent river alluvium

Drainage : Moderately well drained

Vegetation : Harendong (Melastoma sp), rotan (Calamus sp)

Location : Kuamang, Sitiung II (SRI 195528/531; T 11)

SRI No.	Horizon	Depth (cm)	Description
195528	I	0 - 12	Dark grayish brown (10YR 4/2); moderately fine (silty clay loam); massive; fribale (moist), sticky and plastic (wet); common fine and medium, few large tubular pores; many fine and common large roots; clear smooth boundary; pH 6.0
529	II	12 - 32	Brown (10YR 4/3); moderately fine (silty clay loam); massive; friable to firm (moist), slightly sticky and plastic (wet); common fine, medium and large tubular pores; common fine and large roots; clear smooth boundary; pH 6.2
530	III	32 - 77	Brown (10YR 5/3); moderately fine (silty clay loam); weak fine subangular blocky to massive; friable to firm (moist); slightly sticky and plastic (wet); many fine, medium and large tubular pores; very dark gray (10YR 3/4) mottles; clear smooth boundary; pH 6.4
531	IV	77 - 100	Brown (10YR 5/3); moderately fine (silty clay loam); massive; friable to firm (moist), slightly sticky and plastic (wet); many medium and large tubular pores; pH 6.3

Mapping Unit : 3
Soil series : AE-Jd-81
Classification
  a. SRI : Gray Alluvial soil
  b. USDA : Tropic Fluvaquent/Typic Tropaquept
Landform : Backswamp
Relief/Slope : Level (slope <2%) with small depressions
Parent material : Fine textured recent alluvium over coarse textured subrecent alluvium
Drainage : Poorly drained
Vegetation : Rengas (Gluta rengas), bungur (Lagerstroemia speciosa)
Location : Kuamang, Sitiung II (SRI 195469/474; SK 18)

SRI No.	Horizon	Depth (cm)	Description
195469	I $C_{1.1}$	0 - 12	Light gray (10YR 6/1); moderately fine (silty clay loam); massive; sticky and plastic (wet); few fine, medium and large tubular pores; few fine and large roots; many large distinct yellowish brown (10YR 5/8) iron mottles; clear smooth boundary; pH 5.4
470	I $C_{1.2}$	12 - 32	Light gray (10YR 6/1); fine (silty clay); massive; very firm (moist), sticky and plastic (wet); few fine roots; many large distinct strong brown (7.5 YR 4/6) mottles; clear smooth boundary; pH 5.3
471	I $C_{1.3}$	32 - 67	Light gray (10YR 6/1); fine (silty clay); weak medium subangular blocky to massive; firm (moist), sticky and plastic (wet); few fine common, medium and large tubular pores; few fine roots; many large distinct red (2.5YR 4/6) mottles; abrupt wavy boundary; pH 5.3
472	I $C_{1.4}$	67 - 83/86	Gray (10YR 5/1); moderately fine (silty clay loam); massive; firm (moist), sticky and plastic (wet); common fine, medium and large tubular pores; few fine roots; few fine iron concretions; many large red (2.5YR 4/6) mottles in cracks; sand pocket; clear smooth boundary; pH 5.4
473	II A_2/ Bh	83/86 - 140/150	Brown (10YR 5/3); coarse (loamy sand); single grain to loose and massive in Bh; loose (moist), few fine roots; humus infiltration; clear smooth boundary; pH 5.5
474	II Bh/C	140/150 - 160	Brown and dark yellowish brown (10YR 5/3, 3/4); coarse (loamy sand); massive; firm (moist), and loose in C; pH 5.6

Note: Litter about 3 cm.
No land clearing.

Mapping Unit	:	3
Soil series	:	AU-Jd-81
Classification		
a. SRI	:	Yellowish Brown Alluvial soil
b. USDA	:	Tropic Fluvaquent/Aeric Tropaquept
Landform	:	Valley floor/subrecent meandering river bed
Relief/Slope	:	Level to concave (slope < 1%)
Parent material	:	Very fine textured recent river alluvium
Drainage	:	Poorly drained
Vegetation	:	Grass (<u>Gramineae sp</u>)
Location	:	Block D, Sitiung II (SRI 195524/527; T 9)

SRI No.	Horizon	Depth (cm)	Description
195524	A_1	0 - 11	Dark brown (7.5YR 3/2); fine (clay); weak fine granular; friable (moist); medium and large tubular pores; many fine, medium and large roots; many distinct strong brown (7.5YR 5/8) mottles; clear smooth boundary; pH 4.3
525	(B_1)	11 - 42	Yellowish brown (10YR 5/4); fine (clay); massive; firm (moist), slightly sticky and plastic (wet); few fine, medium and large tubular pores; few fine, medium and large roots; many distinct strong brown (7.5YR 5/8) mottles; clear smooth boundary; pH 4.3
526	(B_2)	42 - 70	Light brownish gray (10YR 6/2); fine (clay); weak fine subangular blocky; firm (moist), slightly sticky and slightly plastic (wet); few fine roots; many large distinct red (2.5 YR 4/6, 5/6) mottles; diffuse smooth boundary; pH 4.5
527	B_{3g}	70 - 120	Light brownish gray (10YR 6/2) and yellowish brown (10YR 5/6); fine (clay); massive; pH 4.9

Note: Organic matter in the first layer.
The fourth layer was sampled by augering.
Groundwater table ±40 cm.

Mapping Unit	:	4
Soil series	:	AC-Jd-31
Classification		
a. SRI	:	Brown Alluvial soil
b. USDA	:	Fluventic Dystropept
Landform	:	Low river terrace (recent)
Relief/slope	:	Undulating (slope 5-6%), on crest
Parent material	:	Fine textured recent to subrecent river alluvium
Drainage	:	Well drained
Vegetation	:	Alang-alang (Imperata cylindrica), malaka (Urophyllum corymbosum Korth)
Location	:	Block D, Sitiung II (SRI 195282/286; SK 13)

SRI No.	Horizon	Depth (cm)	Description
195282	A_1/A_3	0 - 22	Dark brown (7.5YR 4/2); fine (silty clay); massive; firm (moist), sticky and non plastic(wet); common fine, few medium and common large tubular pores, many fine and large roots; gradual smooth boundary; pH 5.1
283	B_1	22 - 43	Brown (7.5YR 4/4); fine (clay); weak medium and coarse subangular blocky; firm to friable(moist), sticky and non plastic (wet); many fine and medium, common large tubular pores; many fine roots; few small manganese concretions; diffuse smooth boundary; pH 5.3
284	(B_2)	43 - 90	Brown (7.5YR 4/4); fine (clay); weak medium and coarse subangular blocky; firm to friable(moist), sticky and non plastic (wet); many fine, medium and large tubular pores; many few small manganese concretions; diffuse smooth boundary; pH 5.3
285	B_3	90 -120	Brown (7.5YR 4/4-5/4); fine (clay); massive to weak and medium subangular blocky; friable (moist), sticky and non plastic (wet); many fine, medium and large tubular pores; common fine roots; common weathered quartz sands; diffuse smooth boundary; pH 5.3
286	BC	120 -200	Brown (7.5YR 5/4); fine (silty clay); massive to weak fine and coarse subangular blocky; friable (moist), sticky and non plastic (wet); many fine, medium and large tubular pores; few weathered quartz sands and few clay nodules; pH 5.4

Note: Biological activity in the first layer.
No mechanical land clearing.

Mapping Unit : 4
Soil series : AC-Jd-51
Classification
  a. SRI : Yellowish Brown Alluvial soil
  b. USDA : Fluventic Dystropept
Landform : Recent low river terrace
Relief/Slope : Level (<3%)
Parent material : Fine textured recent river alluvium
Drainage : Moderately well drained
Vegetation : Soybeans (<u>Glycine Max</u> MERR), corn (<u>Zea mays</u>), alang-alang (<u>Imperata cylindrica</u>)
Location : Block F, Sitiung II
(SRI 195475/479; MS 13)

SRI No.	Horizon	Depth (cm)	Description
195475	A_1	0 - 15	Brown (10YR 4/3); moderately fine (silty clay loam); massive; firm to very firm (moist), non sticky and non plastic (wet); few fine and medium, common large tubular pores; many fine and medium roots; few fine distinct mottles; clear smooth boundary; pH 5.2
476	B_1	15- 40	Yellowish brown (10YR 5/6); moderately fine (silty clay loam); massive; firm (moist), non sticky and non plastic (wet); few fine, common medium and large tubular pores; few medium and many fine roots; few fine manganese concretions; diffuse smooth boundary; pH5.3
477	(B_2)	40- 69	Light yellowish brown (10YR 6/4) to yellowish brown (10YR 5/6); fine (silty clay); weak medium subangular blocky; firm (moist), non sticky and non plastic (wet), few fine, common medium and large tubular pores; few medium roots; many coarse distinct yellowish red (5YR 4/6) mottles; gradual smooth boundary; pH 5.1
478	(B_2cn)	69-104	Yellowish brown (10YR 5/6-10YR 5/8); moderately fine (silty clay loam); weak medium subangular blocky; firm (moist), non sticky and non plastic (wet); few fine, many medium and common large tubular pores; few fine roots; many large fine manganese concretions; clear smooth boundary; pH 5.3
479	BC	104-140	Yellowish brown (10YR 5/6) to brown (10YR 4/3); fine (clay); strong medium to coarse subangular blocky; firm (moist), non sticky and non plastic (wet); few fine, medium and large tubular pores; many soft manganese concretions, pH 5.1

Mapping Unit	:	5/M.U. 7 of the detailed soil map
Soil series	:	AU-Bd-21
Classification		
a. SRI	:	Acid Brown Forest Soil
b. USDA	:	Oxic Dystropept/Fluventic Oxic Dystropept
Landform	:	Subrecent river terrace
Relief/Slope	:	Level to slightly undulating (<2%)
Parent material	:	Very fine textured subrecent alluvium
Drainage	:	Well drained
Vegetation	:	Angrung (Grewia coumnaris Sm)
Location	:	Block E, Sitiung II (close to IPB Test Farm) (SRI 195297/301; SK 16)

SRI No.	Horizon	Depth (cm)	Description
195297	A_1	0 - 12	Brown (7.5YR 4/4); very fine (heavy clay); massive; very hard (dry), sticky and plastic (wet); many fine manganese concretions; few fine, medium and large tubular pores; common fine and large roots; few clay cutans; clear smooth boundary: pH 4.6
298	B_1	12 - 27	Brown to strong brown (7.5YR 5/4-5/6); very fine (heavy clay); massive to medium and coarse subangular blocky; firm (moist), sticky and slightly plastic (wet); common fine, medium and large tubular pores; common medium roots; few fine manganese concretions; gradual smooth boundary; pH 4.7
299	$B_{2.1t}$	27 - 58	Yellowish red (5YR 5/6); very fine (heavy clay); moderate medium and coarse subangular blocky; firm (moist), sticky and non plastic (wet); many fine, common medium and large tubular pores; very fine manganese concretions; few clay cutans; few fine roots; gradual smooth boundary; pH 4.6
300	$B_{2.2}$	58 -104	Yellowish red (5YR 5/8); very fine (heavy clay); weak to moderate medium and coarse subangular blocky; friable (moist), sticky and non plastic (wet); many fine and medium, few large tubular pores; few manganese concretions; very few fine roots; clear smooth boundary; pH 5.2
301	B_3	104 -150	Yellowish red (5YR 5/8): fine (clay); moderate and medium subangular blocky: friable (moist), sticky and non plastic (wet): many fine, common medium and few large tubular pores; pH 4.7

Note: Biological activities in the first and second layers.
Mechanical land clearing.

Mapping Unit	:	5/M.U. 7 of the detailed soil map
Soil series	:	AU-Bd-21
Classification		
a. SRI	:	Acid Brown Forest Soil
b. USDA	:	Oxic Dystropept/Fluventic Oxic Dystropept
Landform	:	Subrecent river terrace
Relief/Slope	:	Level
Parent material	:	Very fine textured subrecent alluvium
Drainage	:	Well drained
Vegetation	:	Angrung (*Grewia coummaris* Sm), harendong (*Melastoma sp*), Angsana (*Pterocarpus indicus*)
Location	:	Block F, Sitiung II (SRI 195349/352; MD 28)

SRI No.	Horizon	Depth (cm)	Description
195349	A_p	0 - 15	Strong brown (7.5YR 4/6); very fine (heavy clay); weak medium subangular blocky; firm (moist), non sticky and non plastic (wet); few fine tubular pores; few fine and large roots; clear smooth boundary; pH 4.5
350	B_1	15 - 53	Strong brown (7.5YR 4/6) to yellowish red (5YR 5/6); very fine (heavy clay); moderate medium subangular blocky; firm to friable (moist), slightly sticky and slightly plastic (wet); few fine tubular pores; few fine roots; gradual smooth boundary; pH 4.2
351	$B_{2.1}$	53 - 87	Yellowish red (5YR 5/6); fine (clay); moderate fine, subangular blocky; firm to friable (moist), slightly sticky and slightly plastic (wet); few fine and medium tubular pores; few fine roots; diffuse smooth boundary; pH 4.5
352	$B_{2.2}$	87 -146	Yellowish red (5YR 5/6-5/8); fine (clay); weak fine and medium crumb; firm to friable (moist), slightly sticky and slightly plastic (wet); few medium and large tubular pores; pH 4.7

Mapping Unit	:	5
Soil series	:	AU-Bd-31
Classification		
a. SRI	:	Acid Brown Forest Soil
b. USDA	:	Oxic Dystropept/Fluventic Oxic Dystropept
Landform	:	Subrecent river terrace
Relief/Slope	:	Level (slope <2%)
Parent material	:	Very fine textured subrecent alluvium
Drainage	:	Well drained
Vegetation	:	Rubber (Hevea braziliensis), benda (Artocarpus blumei, TRECUT)
Location	:	Pulau Batu, S.Jujuhan (SRI 195500/504; MS 24)

SRI No.	Horizon	Depth (cm)	Description
195500	A_1	0 – 17	Dark brown (7.5YR 4/4); very fine (heavy clay); weak fine and medium subangular blocky; friable (moist), non sticky and non plastic (wet); many fine, medium and large tubular pores; many fine, medium and large roots; clear smooth boundary; pH 4.7
501	B_1	17 – 36	Dark brown (7.5YR 4/4); very fine (heavy clay); weak fine and medium subangular blocky; friable to firm (moist), slightly sticky and non plastic (wet); many fine, medium and large tubular pores; common fine, medium and few large roots; gradual smooth boundary; pH 4.5
502	$B_{2.1}$	36 – 77	Dark brown (7.5YR 4/4); very fine (heavy clay); moderate medium and coarse subangular blocky; firm to friable (moist), non sticky and non plastic (wet); common fine and large, few medium tubular pores; few fine roots; diffuse smooth boundary; pH 4.5
503	$B_{2.2}$	77 –133	Brown (7.5YR 5/4); very fine (heavy clay); weak fine and medium subangular blocky to crumb; friable (moist), non sticky and non plastic (wet); many fine, medium and common large tubular pores; few fine roots; patchy thin clay cutans; gradual smooth boundary; pH 4.4
504	B_3	133 –156	Strong brown (7.5YR 5/6); fine (clay); weak fine and medium subangular blocky to crumb; very friable (moist), non sticky and non plastic (wet); many fine, medium and large tubular pores; few fine roots; few manganese concretions; pH 4.4

Note: Biological activity in all of the layers.

Mapping Unit : 5

Soil series : AU-Bd-31

Classification

a. SRI : Acid Brown Forest Soil

b. USDA : Oxic Dystropept/Fluventic Oxic Dystropept

Landform : Subrecent river terrace

Relief/Slope : Level to undulating (slope 2-7%)

Parent material : Very fine textured subrecent alluvium

Drainage : Well drained

Vegetation : Upland rice (<u>Oryza sativa</u>), corn (<u>Zea mays</u>), cassava (<u>Manihot esculenta</u>)

Location : Block F, Sitiung II (SRI 195505/509; MD 10)

SRI No.	Horizon	Depth (cm)	Description
195505	Ap	0 - 14	Dark brown (2.5YR 4/4-4/2); very fine (heavy clay); weak fine subangular blocky to crumb; friable (moist); many fine, medium and large tubular pores; few fine roots; clear smooth boundary; pH 4.4
506	B_1	14 - 48	Dark brown (7.5YR 4/4); very fine (heavy clay); moderate fine subangular blocky; friable to firm (moist); many fine, medium and large tubular pores; few fine roots; diffuse smooth boundary; pH 4.0
507	$B_{2.1}$	48 - 59	Dark brown (7.5YR 4/4); very fine (heavy clay); moderate medium subangular blocky; friable to firm (moist); medium tubular pores; diffuse smooth boundary; pH 4.1
508	$B_{2.2}$	59 -122	Strong brown (7.5YR 4/6); very fine (heavy clay); moderate fine and medium subangular blocky; friable to firm (moist); medium tubular pores; diffuse smooth boundary; pH 4.2
509	B_3	122 -156	Strong brown (7.5YR 4/6); fine (clay); moderate medium subangular blocky; firm (moist); few fine tubular pores; pH 4.3

Mapping Unit : 5/M.U. 8 of the detailed soil map
Soil series : AU-Bd-51
Classification
a. SRI : Acid Brown Forest Soil
b. USDA : Oxic Dystropept
Landform : High river terrace
Relief/Slope : Level to slightly concave (slope 2%)
Parent material : Very fine textured subrecent alluvium
Drainage : Moderately well drained
Vegetation : Angrung (Grewia coumnaris Sm), simpur (Dillenia excelsa)
Location : Block E, Sitiung II
(SRI 195302/306; SK 28)

SRI No.	Horizon	Depth (cm)	Description
195302	A_1	0 - 11	Yellowish brown (10YR 5/4); very fine (heavy clay); weak fine crumb to massive; friable (moist), slightly sticky and slightly plastic (wet); common fine, medium and large tubular pores; many fine and medium roots; clear smooth boundary; pH 4.5
303	$B_{2.1}$	11 - 39	Strong brown (7.5YR 5/6); very fine (heavy clay); weak fine subangular blocky; firm (moist), slightly sticky and plastic (wet); many fine and medium, common large tubular pores; few manganese concretions and patchy thin clay cutans; many fine and medium roots; gradual smooth boundary; pH 4.7
304	$B_{2.2}$	39 - 64	Strong brown (7.5YR 5/6); very fine (heavy clay); moderate medium subangular blocky; firm (moist), slightly sticky and plastic (wet); common fine, medium and large tubular pores; few fine manganese concretions and patchy thin clay cutans; common fine roots; dark brown (7.5YR 4/4) and olive (5Y 5/4) mottles; clear smooth boundary; pH 4.6
305	B_3	64 -108	Strong brown (7.5YR 5/6); very fine (heavy clay); moderate medium subangular blocky; firm (moist), slightly sticky and slightly plastic (wet); common fine and medium, few large tubular pores; few fine manganese concretions and patchy thin clay cutans; common fine roots; clear smooth boundary; pH 4.7
306	BCg	108 -140	Red (2.5YR 5/6, 5/8); very fine (heavy clay); moderate medium subangular blocky; firm (moist), slightly sticky and slightly plastic (wet); few fine, medium and large tubular pores; light olive brown (2.5YR 5/4) mottles; pH 4.6

Mapping Unit	:	5/M.U. 8 of the detailed soil map
Soil series	:	AU-Bd-51
Classification		
a. SRI	:	Acid Brown Forest Soil
b. USDA	:	Oxic Dystropept/Aeric Tropaquult
Landform	:	Subrecent river terrace
Relief/Slope	:	Level (slope < 2%)
Parent material	:	Very fine textured subrecent alluvium
Drainage	:	Moderately well drained
Vegetation	:	Angrung (<u>Grewia coumnaris Sm</u>)
Location	:	Block F, Sitiung II (SRI 195344/348; MD 26)

SRI No.	Horizon	Depth (cm)	Description
195344	A_1	0 - 26	Dark yellowish brown (10YR 4/6); very fine (heavy clay); moderate medium subangular blocky; firm (moist), slightly sticky and slightly plastic (wet); few fine roots; clear smooth boundary; pH 4.4
345	B_1	26 - 50	Dark yellowish brown (10YR 4/6) to yellowish brown (10YR 5/6); very fine (heavy clay); weak medium subangular blocky to crumb; friable (moist), non sticky and non plastic (wet); few fine roots; gradual smooth boundary; pH 4.3
346	$B_{2.1}$	50 - 85	Dark yellowish brown (10YR 4/6) to yellowish brown (10YR 5/6); very fine (heavy clay); moderate fine subangular blocky to crumb; friable (moist), slightly sticky and slightly plastic (wet); many fine, medium and large tubular pores; few fine roots; diffuse smooth boundary; pH 4.3
347	$B_{2.2}$	85 -122	Strong brown (7.5YR 5/6) to yellowish brown (10 YR 5/6); very fine (heavy clay); moderate fine subangular blocky to crumb; friable (moist), slightly sticky and slightly plastic (wet); many fine tubular pores; few fine roots; diffuse smooth boundary; pH 4.4
348	B_3	122 -150	Yellowish brown (10YR 5/6); fine (clay); moderate fine and medium crumb; friable (moist), slightly sticky and slightly plastic (wet); many fine, few medium and large tubular pores; pH 4.6

Mapping Unit	:	5/M.U. 9 of the detailed map
Soil series	:	AU-Bd-61
Classification		
a. SRI	:	Acid Brown Forest Soil
b. USDA	:	Aeric Tropaquept
Landform	:	Subrecent river terrace
Relief/Slope	:	Slightly undulating (slope 2-3%) concave
Parent material	:	Fine to very fine textured subrecent alluvium
Drainage	:	Imperfectly drained
Vegetation	:	Angrung (Grewia coumnaris Sm), harendong (Melastoma sp) Waru (Hibiscus tiliacens L)
Location	:	Block F, Sitiung II (SRI 195333/338; MS 27)

SRI No.	Horizon	Depth (cm)	Description
195333	Ap	0 - 3	Brown (10YR 4/3); fine (clay); weak fine subangular blocky to crumb; friable (moist); many fine, medium and large tubular pores; many fine, few medium and large roots; clear smooth boundary; pH 4.5
334	B_1	3 -19	Yellowish brown (10YR 5/4); fine (clay); moderate fine and medium subangular blocky; firm (moist), slightly sticky and non plastic (wet); many fine, common medium and few large tubular pores; many fine and medium, few large roots; common medium distinct yellowish red (5YR 5/6) mottles; clear smooth boundary; pH 4.1
335	$B_{2.1}$	19 -46	Brownish yellow (10YR 6/6); very fine (heavy clay); strong coarse subangular blocky; very firm (moist), slightly sticky and non plastic (wet); common fine and medium, few large tubular pores; patchy thin clay cutans; few medium roots; many coarse distinct yellowish red (5YR 5/8) mottles; diffuse smooth boundary; pH 4.1
336	$B_{2.2}$	46 -74	Yellow (10YR 7/6); very fine (heavy clay); weak medium and coarse subangular blocky; firm (moist), slightly sticky and slightly plastic (wet); few fine, common medium and large tubular pores; patchy thin clay cutans; few medium roots; many coarse distinct yellowish red (5YR 5/8) mottles; diffuse smooth boundary; pH 4.2
337	$B_{3}g$	74-110	Yellow (10YR 7/6) and white (2.5Y 8/0); fine (clay); moderate fine and medium subangular blocky; firm (moist), slightly sticky and non plastic (wet); few fine, common medium and few large tubular pores; many coarse distinct yellowish red (5YR 5/8) mottles; clear smooth boundary; pH 4.4
338	CG	110 +	White (2.5Y 8/0); very fine (heavy clay); moderate fine and medium subangular blocky; firm (moist), slightly sticky and non plastic (wet); few fine and medium, common large tubular pores; few medium roots; many coarse distinct red (10YR 4/6) mottles; pH 4.7

Mapping Unit : 6
Soil series : AU-Gd-81
Classification
a. SRI : Gley soil
b. USDA : Typic Tropaquult
Landform : Peneplain/subrecent valley floor
Relief/Slope : Level to undulating
Parent material : Older colluvial materials from shales, sandstone and quartzite
Drainage : Poorly drained
Vegetation : Rubber (Hevea braziliensis), waru-waruan (Hibiscus sp)
Location : Kuamang, Sitiung II
(SRI 195328/332; MS 16)

SRI No.	Horizon	Depth (cm)	Description
195328	A_1	0 - 10	Very dark gray (10YR 3/1); fine (clay); weak fine crumb; very friable (moist), non sticky and non plastic (wet); many fine, medium and large tubular pores; many fine, medium and large roots; clear smooth boundary; pH 3.8
329	B_1G	10 - 32	Grayish brown (10YR 5/2); fine (clay); weak fine and medium subangular blocky; friable (moist), sticky and slightly plastic (wet); common fine, medium and large tubular pores; many fine, medium and large roots; clear smooth boundary; pH 4.6
330	$B_{2.1}G$	32 - 55	Light brownish gray (10YR 6/2); very fine (heavy clay); moderate medium subangular blocky; friable to firm (moist), sticky and slightly plastic (wet); common fine, many medium and common large tubular pores; many fine and common medium roots; patchy clay cutans; gradual smooth boundary; pH 4.6
331	$B_{2.2}G$	55 - 80	Light gray (10YR 7/1); very fine (heavy clay); moderate medium subangular blocky; firm (moist), sticky and slightly plastic (wet); few fine, common medium and large tubular pores; few fine and common medium roots; patchy clay cutans; gradual smooth boundary; pH 4.5
332	B_3G	80 -110	Light gray (5Y 7/1); very fine (heavy clay); moderate medium and coarse subangular blocky; firm (moist), sticky and slightly plastic (wet); common fine, few medium and large tubular pores; few fine roots; many coarse distinct reddish yellow (7.5YR 6/6) mottles; pH 4.4

Note: Groundwater table ± 70 cm from the surface.

Mapping Unit : 6

Soil series : AU-Pc-51

Classification

a. SRI : Yellowish Brown Podzolic soil

b. USDA : Orthoxic Tropudult

Landform : Peneplain

Relief/Slope : Level to undulating (2-4%)

Parent material : Volcanic tuff mixed with sandy material deposits (old)

Drainage : Moderately well drained

Vegetation : Meranti (Shorea sp), rotan (Calamus sp)

Location : Sitiung II - S.Jujuhan (SRI 195515/518); MD 16)

SRI No.	Horizon	Depth (cm)	Description
195515	A_1	0 - 12	Brown (10YR 5/3); fine (clay); weak fine crumb; friable (moist), slightly sticky and plastic (wet); many fine, medium and large tubular pores; many fine roots; clear smooth boundary; pH 3.8
516	B_1	12 - 37	Yellowish brown (10YR 5/4); very fine (heavy clay); moderate fine subangular blocky; friable to firm (moist), sticky and plastic (wet); many fine, few medium and common large roots; gradual smooth boundary; pH 4.3
517	$B_{2.1}$	37 - 62	Very pale brown (10YR 7/4); very fine (heavy clay); moderate medium subangular blocky; firm (moist), sticky and plastic (wet); many fine, common medium and large tubular pores; gradual smooth boundary; pH 4.5
518	$B_{2.2}$	62 -110	Very pale brown (10YR 7/4, 8/4); very fine (heavy clay); weak fine subangular blocky; firm (moist), sticky and plastic (wet), many fine, common medium and large tubular pores; pH 4.5

Note: Quartz sand in all of the layers.

Mapping Unit : 7

Soil series : TU-Pc-51

Classification

a. SRI : Yellowish Brown Podzolic soil

b. USDA : Orthoxic Tropudult

Landform : Transition plain/peneplain tongue

Relief/Slope : Undulating/middle slope

Parent material : Colluvial (mixed of weathered volcanic and deposit)

Drainage : Moderately well drained

Vegetation : Rubber (Hevea braziliensis), laban (Vitex pubescen), angrung (Grewia coumnaris Sm), medang (Decassia cassia Bl)

Location : Block D, Sitiung II (SRI 195287/290; SK 14)

SRI No.	Horizon	Depth (cm)	Description
195287	$A_{1.2}$	0 - 20	Brown (2.5YR 3/2); very fine (heavy clay); moderate medium to coarse subangular blocky to massive; very firm (moist), slightly sticky and plastic (wet); common fine, medium and few large tubular pores; many fine and common medium roots; few fine manganese concretions; clear smooth boundary; pH 4.7
288	$B_{2.1}$	20 - 60	Brownish yellow (10YR 6/6); very fine (heavy clay); moderate medium to coarse subangular blocky; firm (moist), sticky and plastic (wet); common fine, medium and few large tubular pores; few fine and large roots; continuous clay cutans; gradual smooth boundary; pH 4.5
289	$B_{2.2t}$	60 -105	Brownish yellow (10YR 6/6); very fine (heavy clay); moderate to strong medium to coarse subangular blocky; firm to friable (moist), sticky and plastic (wet); many fine, common medium and few large tubular pores; very few fine roots; continuous clay cutans; gradual smooth boundary; pH 4.6
290	B_3	105 -150	Brownish yellow (10YR 6/6-6/8); very fine (heavy clay); moderate to weak medium to coarse subangular blocky; friable (moist), sticky and non plastic (wet); common fine, medium and large tubular pores; patchy clay cutans; pH 4.6
-	BC	150 -190	Brownish yellow (10YR 6/6); fine (clay); many coarse distinct red (2.5YR 4/8) mottles

Mapping Unit : 8
Soil series : VU-Lc-31
Classification
a. SRI : Yellowish Brown Latosol (Chromic Latosol)
b. USDA : Tropeptic Haplorthox
Landform : Peneplain volcanic cover/transition plain
Relief/Slope : Undulating (slope 3-7%) with convex ridge crest
Parent material : Volcanic tuff/old shales colluvium
Drainage : Well drained
Vegetation : Meranti (Shorea sp), merawan (Hopea mengarawan), kayu ulin (Eusideroxylon zwageri), punak (Tetramerista glabra Miq), gerunggang (Cratoxylon comentum), jelutung (Dyera constulata Hook F)
Location : CV Alas, Exploited primary forest (SRI 195495/499; MS 22)

SRI No.	Horizon	Depth (cm)	Description
195495	A_3	0 - 16	Yellowish brown (10YR 5/6); fine (clay); weak fine subangular blocky to crumb; friable (moist), slightly sticky and non plastic (wet); many fine, medium and large tubular pores; many fine and large roots; clear smooth boundary; pH 3.9
496	$B_{2(t)}$	16 - 37	Yellowish brown (10YR 5/8); very fine (heavy clay); weak fine and medium subangular blocky; friable to firm (moist), sticky and non plastic (wet); few fine, many medium and common large tubular pores; many fine and common large roots; patchy clay cutans; gradual smooth boundary; pH 4.3
497	$B_{3.1}$	37 - 90	Yellowish brown (10YR 5/8); very fine (heavy clay); weak fine and medium subangular blocky; friable to firm (moist), slightly sticky and non plastic(wet); many fine, common medium and large tubular pores; many fine, medium and few large roots; diffuse smooth boundary; pH 4.3
498	$B_{3.2}$	90 -136	Yellowish brown (10YR 5/8); very fine (heavy clay); weak fine and medium subangular blocky; friable to firm (moist), slightly sticky and non plastic(wet); common fine, medium and large tubular pores; common fine and medium roots; gradual smooth boundary; pH 4.4
499	BC	136 -150	Strong brown (7.5YR 5/8); very fine (heavy clay); weak fine and medium subangular blocky; friable (moist), slightly sticky and non plastic (wet); few fine, many medium and common large tubular pores; many fine and few medium roots; pH 4.5

Mapping Unit : 8/M.U. 11 of the detailed map

Soil series : VU-Lo-31

Classification

a. SRI : Brown Latosol

b. USDA : Tropeptic Haplorthox

Landform : Peneplain volcanic cover

Relief/slope : Rolling with slope 10 - 11%

Parent material : Volcanic tuff

Drainage : Well drained

Vegetation : Upland rice (Oryza sativa), cassava (Manihot esculenta), angrung (Grewia coumnaris Sm)

Location : Block E, Sitiung II (on ridge crest) (SRI 195368/372; T 20)

SRI No.	Horizon	Depth (cm)	Description
195368	Ap	0 - 12	Dark yellowish brown (10YR 4/2); very fine (heavy clay); weak fine crumb; friable (moist), non sticky and non plastic (wet); many fine, medium and large tubular pores; many fine and medium roots; clear smooth boundary; pH 4.5
369	B_1	12 - 40	Dark brown (7.5YR 4/4); very fine (heavy clay); weak fine crumb; friable (moist), non sticky and non plastic (wet); many fine, medium and large tubular pores; patchy thin clay cutans; diffuse smooth boundary; pH 4.0
370	$B_{2.1}$	40 - 79	Strong brown (7.5YR 5/6); very fine (heavy clay); weak fine crumb to subangular blocky; friable (moist), non sticky and non plastic (wet); common fine, medium and large tubular pores; diffuse smooth boundary; pH 4.1.
371	$B_{2.2}$	79 -120	Strong brown (7.5YR 5/6); very fine (heavy clay); moderate fine subangular blocky; friable (moist), non sticky and non plastic (wet); common fine, medium and large tubular pores; diffuse smooth boundary; pH 4.2
372	BC	120 -150	Strong brown (7.5YR 5/6); very fine (heavy clay); moderate fine subangular blocky to crumb; friable (moist), slightly sticky and slightly plastic (wet); few fine, medium and large tubular pores; pH 4.3.
	C	150+	Red (2.5YR 5/8); massive; firm

Mapping Unit : 9
Soil series : VU-Lc-31
Classification
a. SRI : Brown Latosol (Chromic Latosol)
b. USDA : Typic Haplorthox
Landform : Peneplain volcanic cover
Relief/Slope : Rolling with convex ridges (slope ± 24%) on ridge crest
Parent material : Volcanic tuff
Drainage : Well drained
Vegetation : Meranti (Shorea sp), kayu ulin (Eusideroxylon zwageri)
Location : Km 11.5 CV Alas, Exploited primary forest
(SRI 195490/494; MS 18)

SRI No.	Horizon	Depth (cm)	Description
-	Ao	0 - 5	Dusky red (2.5YR 3/2); litter; gradual smooth boundary
195490	A_1	5 - 15	Dark brown (7.5YR 4/4); very fine (heavy clay); weak fine and medium crumb; very friable(moist); slightly sticky and slightly plastic (wet); many fine, medium and large tubular pores; many fine, medium and large roots; gradual smooth boundary; pH 4.3
491	A_3	15 - 46	Strong brown (7.5YR 5/6); very fine (heavy clay); weak fine and medium subangular blocky to crumb; very friable (moist), slightly sticky and non plastic (wet); many fine, medium and common large tubular pores; common medium, large and many fine roots; gradual smooth boundary; pH 4.5
492	$B_{1.1}$	46 - 88	Strong brown (7.5YR 5/6); very fine (heavy clay); weak fine and medium subangular blocky to crumb; friable (moist), slightly sticky and non plastic (wet); many fine, medium and common large tubular pores; patchy clay cutans, many fine, common medium and few large roots; diffuse smooth boundary; pH 4.6
493	$B_{1.2}$	88 -130	Strong brown (7.5YR 5/6); very fine (heavy clay); weak fine and medium subangular blocky; friable (moist), slightly sticky and non plastic (wet); common fine, many medium and common large tubular pores; patchy thin clay cutans; many fine, medium and large roots; diffuse smooth boundary; pH 4.8
494	B_3	130 -150	Strong brown (7.5YR 5/6); very fine (heavy clay); weak fine and medium subangular blocky to crumb; very friable (moist), slightly sticky and non plastic (wet); common fine, medium and large tubular pores; few fine and large roots; pH 4.5

Mapping Unit	:	9
Soil series	:	VU-Lo-31
Classification		
a. SRI	:	Yellowish Brown Latosol (Oxic Latosol)
b. USDA	:	Tropeptic Haplorthox
Landform	:	Peneplain volcanic cover
Relief/slope	:	Undulating to rolling (slope 12-20%) with convex ridge crest
Parent material	:	Volcanic tuff
Drainage	:	Well drained
Vegetation	:	Meranti (Shorea sp), rotan (Calamus sp), terentang (Buchanania auricullata Bl), punak (Tetramerista glabra Miq)
Location	:	Block F, Sitiung II (SRI 195318/322; MS 12)

SRI No.	Horizon	Depth (cm)	Description
195318	A_1	0 - 8	Dark yellowish brown (10YR 3/4); very fine (heavy clay); weak fine and medium subangular blocky; friable (moist), sticky and plastic (wet); many fine, medium and large tubular pores; many fine and common large roots; gradual smooth boundary; pH 3.6
319	B_1	8 - 40	Dark yellowish brown (10YR 4/6); very fine (heavy clay); weak fine and medium subangular blocky; friable (moist), sticky and plastic (wet); many fine, medium and large tubular pores; many fine, medium and few large roots; diffuse smooth boundary; pH 4.1
320	B_{ox1}	40 - 78	Dark yellowish brown (10YR 4/6); very fine (heavy clay); weak fine and medium subangular blocky to crumb; friable (moist), sticky and plastic (wet); many fine, medium and large tubular pores; many fine, medium and few large roots; diffuse smooth boundary; pH 4.3
321	B_{ox2}	78 -120	Strong brown (7.5YR 5/6); very fine (heavy clay); weak fine and medium subangular blocky to crumb; friable (moist), sticky and plastic (wet); many fine, medium and large tubular pores; common fine, many medium and few large roots; diffuse smooth boundary; pH 4.4
322	BC	120 +	Strong brown (7.5YR 5/6) to yellowish brown (10 YR 5/6); very fine (heavy clay); weak fine and medium angular blocky to crumb; friable (moist), sticky and plastic (wet); many fine, medium and large tubular pores; few fine and common medium roots; pH 4.7

Note: No land clearing.

B. Detailed Sitiung I area

Mapping Unit : 1

Soil series : AO-Hf-9h

Classification

a. SRI : Mesotrophic Organosol

b. USDA : Tropofibrist/Sapric Ferric Tropofibrist

Landform : Valley floor

Relief/Slope : Concave

Parent material : Organic deposit and fine textured alluvium/colluvium

Drainage : Very poorly drained

Vegetation : Grass (Gramineae), kalamento (Spodiopogon Byronis Trin)
(SRI 195359/362; T4)

SRI No.	Horizon	Depth (cm)	Description
195359	I	0 - 30	Dark reddish brown (5YR 3/2); fibric; clear smooth boundary; pH 4.8
360	II	30 - 50	Dark reddish brown (5YR 3/2, 3/3); fibric; clear smooth boundary; pH 5.0
361	III	50 -100	Gray (5YR 5/1); sapric; clear smooth boundary; pH 4.8
362	IV	100 -125	Gray (5YR 5/1) to very dark gray (10YR 3/1); moderate fine (silty clay loam); pH 4.9

Mapping Unit	:	3
Soil series	:	AU-Gd-71
Classification		
a. SRI	:	Low Humic Gley soil
b. USDA	:	Dystric Tropaquept
Landform	:	Subrecent river terrace
Relief/Slope	:	Level to concave/depression
Parent material	:	Very fine textured subrecent alluvium
Drainage	:	Poorly drained
Vegetation	:	Grass (Gramineae sp), purun (Fimbristylis diphylla Vohl)
Location	:	Block S. Piruko, Sitiung I (SRI 195264/269; SK 5)

SRI No.	Horizon	Depth (cm)	Description
195264	A_1	0 - 12	Grayish brown (10YR 5/2); very fine (heavy clay); massive to weak fine and medium angular blocky; friable to firm (moist), sticky and plastic(wet); few fine, common medium and many large tubular pores; few manganese concretions; many medium distinct yellowish red (5YR 4/6) iron mottles; few fine roots; gradual smooth boundary; pH4.5
265	B_1g	12 - 26	Grayish brown (10YR 5/2) to light brownish gray (10YR 6/2); very fine (heavy clay); massive to moderate medium and coarse angular blocky; firm (moist), sticky and slightly plastic (wet); few fine, medium and large tubular pores; few clay coatings; common large distinct yellowish red (5YR 4/6,4/8)iron mottles on peds; common fine roots; clear smooth boundary; pH 4.6
266	B_2g/B_3	26 - 36	Light brownish gray (10YR 6/2); very fine(heavy clay); moderate to weak medium subangular blocky; firm (moist), sticky and slightly plastic (wet); few fine and medium, many large tubular pores; many coarse distinct yellowish red (5YR 4/6)iron mottles along the poros; few large roots; abrupt smooth boundary; pH 4.6
267	C_1G	36 - 88	Pale brown (10YR 6/3); moderately fine (silty clay loam); massive; very firm (moist), sticky and slightly plastic (wet); few fine, medium and large tubular pores; many coarse distinct brownish yellow (10YR 6/8) and red (2.5YR 4/6) mottles; gradual smooth boundary; pH 4.8
268	C_2G	88 - 107	Light gray (10YR 7/2); moderate fine (silty clay loam); massive; very firm (moist), sticky and slightly plastic (wet); few fine, medium and large tubular pores; many coarse distinct brownish yellow (10YR 6/8) and red (2.5YR 4/8) mottles; gradual smooth boundary; pH 5.1
269	C_3G	107 - 140	Light gray (10YR 7/2); medium fine (silt loam); massive; very firm(moist), sticky and plastic (wet); common fine and medium, few large tubular pores; many coarse distinct olive yellow (2.5YR 6/8) and red (2.5YR 4/8) mottles; pH 5.2

Mapping Unit : 4
Soil series : AU-Gd-81
Classification
 a. SRI : Low Humic Gley soil
 b. USDA : Aeric Tropaquult
Landform : Depression on the subrecent river terrace
Relief/Slope : Level to undulating (concave)
Parent material : Very fine textured subrecent alluvium
Drainage : Poorly drained
Vegetation : Cassava (<u>Manihot esculenta</u>), alang-alang (<u>Imperata cylindrica</u>), harendong (<u>Melastoma sp</u>)
Location : Block Sipangkur, Sitiung I
 (SRI 195323/327; MS 8)

SRI No.	Horizon	Depth (cm)	Description
195323	A_1	0 - 6	Dark brown (7.5YR 3/2); very fine (heavy clay); weak fine and medium subangular blocky; friable (moist), non sticky and non plastic (wet); common fine, many medium and large tubular pores; many fine and few medium roots; clear smooth boundary; pH 4.1
324	B_1	6 -12/18	Dark yellowish brown (10YR 4/2); very fine(heavy clay); moderate medium subangular blocky to massive; firm (moist), slightly sticky and slightly plastic (wet); few fine, common medium and few large tubular pores; common fine roots; clear smooth boundary; pH 4.3
325	B_2g	12/18-35	Light yellowish brown (2.5YR 6/4); very fine (heavy clay); moderate fine and medium subangular blocky; firm (moist), sticky and non plastic (wet); few fine, common medium and large tubular pores; few fine roots; patchy clay coating; many coarse distinct red (2.5YR 4/8) mottles; clear smooth boundary; pH 4.3
326	B_3G	35 - 75	Light gray (5Y 7/1); very fine (heavy clay); moderate medium subangular blocky; firm to friable (moist), sticky to slightly sticky and plastic (wet); few fine, medium and large tubular pores; few medium roots; many coarse distinct red (2.5YR 5/8) mottles (plinthite); gradual smooth boundary; pH 4.4
327	CG	75 -100	Light gray (5Y 7/1); fine (silty clay); strong coarse subangular blocky and angular blocky; sticky and non plastic (wet); few fine, medium and large tubular pores; many coarse distinct red (2.5YR 4/8) mottles (plinthite); pH 4.7

Mapping Unit : 5
Soil series : AC-Bd-31
Classification
  a. SRI : Acid Brown Forest Soil
  b. USDA : Oxic Dystropept/Fluventic Oxic Dystropept
Landform : Subrecent river terrace
Relief/Slope : Level to undulating
Parent material : Fine textured subrecent alluvium
Drainage : Well drained
Vegetation : Cassava (Manihot esculenta), papaya (Carica papaya), upland rice (Oryza sativa)
Location : Block Piruko, Sitiung I (SRI 195258/263; SK 4)

SRI No.	Horizon	Depth (cm)	Description
195258	A_1/Ap	0 - 13	Dark brown (7.5YR 3/2); fine (silty clay); weak fine and medium subangular blocky; very friable (moist), slightly sticky and slightly plastic (wet); many fine, medium and large tubular pores; many fine and large roots; clear smooth boundary; pH 4.4
259	A_3	13 - 30	Brown (7.5YR 4/4); fine (clay); moderate medium and fine subangular blocky; friable (moist), sticky and non plastic (wet); many fine, common medium and large tubular pores; few manganese concretions; many fine and large roots; clear smooth boundary; pH 4.5
260	$B_{2.1}$	30 - 70	Brown (7.5YR 5/4); fine (silty clay); weak medium and coarse subangular blocky; friable (moist), sticky and non plastic (wet); many fine, common medium and large tubular pores; few fine manganese concretions; few gravels; many fine, few medium and many large roots; gradual smooth boundary; pH 4.8
261	B_2/B_3	70 -102	Brown (7.5YR 5/4); fine (clay); massive to weak medium and fine subangular blocky; firm (moist), sticky and non plastic (wet); many fine, medium and few large tubular pores; common fine manganese concretions; diffuse smooth boundary; pH 5.1
262	BC	102-130/140	Brown (7.5YR 5/4); moderate fine (clay loam); weak fine subangular blocky to crumb; friable (moist), non sticky and non plastic (wet); many fine, medium and large tubular pores; many weathered terrace gravels and fragments; abrupt wavy boundary; pH 5.0
263	C	130/140-150	Brownish yellow (10YR 6/8); coarse (gravelly sand); spongy structure; firm (moist)

Note: Gravels mainly consist of pumice and a small amount of basaltic and older rock fragments (granite, diorite).
Mechanical land clearing.

Mapping Unit : 5

Soil series : AC-Bd-31

Classification

a. SRI : Acid Brown Forest Soil

b. USDA : Oxic Dystropept/Fluventic Oxic Dystropept

Landform : Subrecent river terrace

Relief/Slope : Level (slope<2%) on elongated low ridge

Parent material : Fine textured subrecent alluvium

Drainage : Well drained

Vegetation : Alang-alang (Imperata cylindrica), harendong (Melastoma sp)

Location : Kotabaru, Sitiung I

(SRI 195307/311; MS 1)

SRI No.	Horizon	Depth (cm)	Description
195307	A_1	0 - 8	Dark yellowish brown (10YR 3/4); fine (clay); weak fine and medium subangular blocky; friable (moist), non sticky and non plastic (wet); few fine, many medium and large tubular pores; many medium and many fine roots; clear smooth boundary; pH 4.9
308	$B_{1.1}$	8 - 20	Dark brown (7.5YR 4/4); fine (clay); weak coarse subangular blocky to massive; firm (moist), slightly sticky and non plastic (wet); few fine, medium and large tubular pores; common medium and few fine roots; diffuse smooth boundary; pH 5.0
309	$B_{1.2}$	20 - 60	Dark brown (7.5YR 4/4): fine (clay); weak medium and coarse subangular blocky; firm (moist), slightly sticky and non plastic (wet); common fine, medium and large tubular pores; few fine roots; diffuse smooth boundary; pH 5.1
310	$B_{3.1}$	60 - 90	Dark brown (7.5YR 4/4): very fine (heavy clay); weak fine and medium subangular blocky; firm (moist), slightly sticky and non plastic (wet): common fine, medium and large tubular pores; few fine roots; diffuse smooth boundary; pH 5.2
311	$B_{3.2}$	90 -140	Dark brown to brown (7.5YR 4/4-5/4): fine(clay); moderate fine and medium subangular blocky; firm (moist), slightly sticky and non plastic (wet); common fine and large, many medium tubular pores; pH 5.1

Mapping Unit	:	6
Soil series	:	AC-Bd-51
Classification		
a. SRI	:	Acid Brown Forest Soil
b. USDA	:	Oxic Dystropept/Fluventic Oxic Dystropept
Landform	:	Subrecent river terrace
Relief/Slope	:	Flat to slightly undulating
Parent material	:	Fine textured subrecent alluvium
Drainage	:	Moderately well drained
Vegetation	:	Randu (*Ceiba pentandra*), cassava (*Manihot esculenta*), labu (*Lagenaria vulgaris*), cabe (*Capsicum minimum*)
Location	:	Block Piruko, Sitiung I (SRI 195270/275; SK 6)

SRI No.	Horizon	Depth (cm)	Description
195270	Ap	0 - 13	Brown (10YR 4/3); fine (silty clay); weak medium and fine subangular blocky; friable (moist), sticky and slightly plastic (wet); many fine, medium and large tubular pores; few rounded manganese concretions; many fine and large roots; clear smooth boundary; pH 4.5
271	B_1cn	13 - 26	Dark brown (7.5YR 4/4); fine (clay); massive; very firm (moist), sticky and slightly plastic (wet): common fine, few medium and large tubular pores; many manganese concretions (gravel size); few fine and medium roots; clear smooth boundary; pH 4.8
272	B_2cn	26 - 46	Yellowish brown (10YR 5/6): fine (silty clay); medium and fine subangular blocky; firm (moist), sticky and non plastic (wet); common fine and medium, few large tubular pores; many manganese concretions (rounded gravel size); patchy thin clay coatings; common fine roots; few medium faint yellowish red (5YR 4/8) mottles; clear smooth boundary; pH 4.7
273	$B_{2.2}$	46 - 83	Yellowish brown (10YR 5/6); fine (clay); moderate to weak medium and coarse subangular blocky; firm to friable (moist), sticky and non plastic (wet); few fine, common medium and large tubular pores; few manganese iron concretions; patchy clay coatings; few fine roots; common large distinct yellowish red (5YR 4/8) mottles; clear smooth boundary; pH 4.0
274	B_3	83 -132	Light brownish gray (10YR 6/2); fine (silty clay); massive; weak to moderate medium and coarse subangular blocky; firm (moist), slightly sticky and non plastic (wet); few fine, common medium and large tubular pores; few iron nodules and iron concretions; many coarse distinct red (2.5YR 4/8) mottles; gradual smooth boundary; pH 5.0
275	C	132 -145	Light brownish gray (10YR 6/2); moderate fine (silty clay loam); massive to weak fine and medium subangular blocky; firm to friable (moist), slightly sticky and non plastic (wet); many fine, medium and large tubular pores; many weathered minerals; many coarse yellowish brown (10YR 6/8) mottles; pH 4.6

Mapping Unit : 6
Soil series : AC-Bd-51
Classification
a. SRI : Acid Brown Forest Soil
b. USDA : Typic Dystropept
Landform : Subrecent river terrace
Relief/Slope : Level to undulating (slope >2%)
Parent material : Fine textured subrecent alluvium
Drainage : Moderately well drained
Vegetation : Alang-alang (Imperata cylindrica)
Location : Block Kotabaru, Sitiung I
(SRI 195312/317; MS 3)

SRI No.	Horizon	Depth (cm)	Description
195312	A_1	0 - 10	Dark brown (10YR 3/3); fine (clay); weak medium and coarse subangular blocky; firm to friable (moist), slightly sticky and non plastic (wet); common fine, large and many medium tubular pores; many fine and medium roots; abrupt smooth boundary; pH 5.0
313	B_1	10 - 40	Strong brown (7.5YR 5/6); fine (clay); weak medium and coarse subangular blocky to massive; friable to firm (moist), slightly sticky and non plastic (wet); few fine and medium, common large tubular pores;many fine and medium roots; gradual smooth boundary;pH4.8
314	B_2	40 - 66	Reddish yellow (7.5YR 6/6); fine (clay); weak fine and medium subangular blocky; friable(moist), slightly sticky and non plastic (wet); common fine and medium, few large tubular pores; few fine and medium roots; diffuse smooth boundary; pH 4.9
315	B_3	66 -105	Reddish yellow (7.5YR 6/6); fine (clay); weak fine and medium subangular blocky; firm (moist), slightly sticky and non plastic (wet); few fine, many medium and large tubular pores; few fine and medium roots; common coarse yellowish red (5YR 5/6) mottles; gradual smooth boundary; pH 4.8
316	B_3cn	105 -135	Reddish yellow (7.5YR 6/6); fine (silty clay); moderate fine and medium subangular blocky; firm (moist), slightly sticky and non plastic (wet); few fine, many medium and common large tubular pores; few fine manganese concretions; common coarse brown (7.5YR 5/4) mottles; clear smooth boundary; pH 4.9
317	IC	135 - 140	White (2.5Y 8/2); moderate fine (silty clay loam);weak fine and medium subangular blocky; firm (moist), non sticky and non plastic (wet); many large manganese concretions; many distinct coarse strong brown (7.5YR 5/6) mottles; pH 4.6
	IIC	140 +	Weathered tuff

Mapping Unit : 7
Soil series : AU-Bd-21
Classification :
a. SRI : Acid Brown Forest Soil
b. USDA : Oxic Dystropept/Fluventic Oxic Dystropept
Landform : Subrecent river terrace
Relief/Slope : Level (slope <2%)
Parent material : Very fine textured subrecent alluvium
Drainage : Well drained
Vegetation : Alang-alang (Imperata cylindrica), harendong (Melastoma sp)
Location : Block S.Atang I, Sitiung I (SRI 195247/251; SK 1)

SRI No.	Horizon	Depth (cm)	Description
195247	A_1	0 - 7	Brown (7.5YR 4/4); very fine(heavy clay); weak medium and fine subangular blocky to crumb;friable(moist),slightly sticky to sticky and slightly plastic (wet);many fine,medium and large tubular pores; many organic matter; many fine and common large roots;abrupt smooth boundary;pH 4.7
248	B_1	7 - 25	Strong brown (7.5YR 5/4);very fine (heavy clay); massive breaking into medium and coarse subangular blocky; very firm (moist), sticky and non plastic (wet);few fine, medium and large tubular pores; few fine manganese concretions; few fine roots; abrupt smooth boundary; pH 5.0
249	$B_{2.1}$	25 - 70	Yellowish red (5YR 4/6);very fine (heavy clay); moderate to coarse medium subangular blocky;friable (moist),sticky and non plastic (wet);common fine and medium, few large tubular pores; common fine manganese concretions;patchy clay coatings; few fine and large roots; diffuse smooth boundary; pH 5.2
250	$B_{2.2}$	70 - 102	Yellowish red (5YR 4/6, 5/6); fine(clay); moderate medium subangular blocky; friable (moist), sticky and non plastic (wet); many fine,common medium and few large tubular pores;common rounded manganese concretions; few fine medium roots; spotted organic matter; gradual smooth boundary; pH 5.0
251	B_3/BC	102 - 150	Yellowish red (5YR 5/8); fine (silty clay); moderate medium and coarse subangular blocky; friable (moist), sticky and non plastic(wet); many fine, medium and large tubular pores; pH 5.0

Mapping Unit : 8
Soil series : AU-Bd-51
Classification
a. SRI : Acid Browr Forest Soil
b. USDA : Aeric Tropaquult
Landform : Subrecent river terrace
Relief/Slope : Level to slightly undulating transition to concave area
Parent material : Very fine textured subrecent alluvium
Drainage : Moderately well drained
Vegetation : Upland rice (Oryza sativa), maize (Zea mays), cassava (Manihot esculenta)
Location : Block S.Atang I, Sitiung I (SRI 195252/257; SK 2)

SRI No.	Horizon	Depth (cm)	Description
195252	A_1	0 - 4	Dark brown(7.5YR 3/2);very fine(heavy clay);weak fine and medium subangular blocky;firm(moist), slightly sticky and slightly plastic(wet); many fine,medium and large tubular pores;many organic matter;many fine and medium roots;abrupt smooth boundary; pH 4.3
253	$B_{2.1}$	4 - 22	Yellowish brown(10YR 5/8);very fine(heavy clay); massive breaking into medium to coarse subangular blocky;very firm(moist),sticky and slightly plastic(wet);few fine,medium and large tubular pores;many fine manganese concretions;continuous clay coatings; few fine roots; clear smooth boundary; pH 4.7
254	$B_{2.2}$	22 - 45	Yellowish brown(10YR 5/6-5/8);very fine (heavy clay);moderate medium and coarse subangular blocky; firm(moist),sticky and non plastic(wet); common fine and medium,few large tubular pores; many fine rounded manganese concretions;continuous clay coatings;clear smooth boundary; pH 4.9
255	B_3	45 - 82	Yellowish brown to brownish yellow(10YR 5/8-6/8); very fine(heavy clay);moderate medium and coarse subangular blocky breaking into fine subangular blocky;firm(moist),sticky and non plastic (wet); few fine,common medium and large tubular pores; few large manganese concretions;patchy thin clay cutans; few coarse distinct yellowish red (5YR 4/6)mottles;gradual smooth boundary; pH 4.9
256	BC	82 - 117	Yellowish brown(10YR 6/8);medium fine(silt loam); weak fine medium and coarse subangular blocky;firm (moist),sticky and non plastic(wet);common fine and medium,few large tubular pores;spotted organic matter;few weathered gravels;many coarse distinct red(2.5YR 4/8) mottles;abrupt smooth boundary; pH 4.9
257	IIC	117 - 200	Yellowish brown(10YR 5/4);medium fine(silt loam); weak fine subangular blocky;firm(moist),sticky and non plastic(wet);many coarse distinct red (2.5YR 4/8) mottles; many weathered gravels; pH 5.0

Mapping Unit : 8
Soil series : AU-Bd-51
Classification
a. SRI : Acid Brown Forest Soil
b. USDA : Aquic Dystropept/Orthoxic Tropudult
Landform : Subrecent river terrace (depression)
Relief/Slope : Level (concave)
Parent material : Very fine textured subrecent alluvium
Drainage : Moderately well drained
Vegetation : Randu (Ceiba pentandra), nangka/jack fruit (Artocarpus integra), maize (Zea mays)
Location : Block S.Atang II, Sitiung I (SRI 195276/281; SK 9)

SRI No.	Horizon	Depth (cm)	Description
195276	Ap	0 - 8	Brown (10YR 4/3); fine(clay); loose;friable (moist), sticky and non plastic(wet); many fine,medium and large tubular pores;many fine roots;many organic matter;abrupt smooth boundary; pH 4.5
277	$B_{2.1}$	8 - 22	Dark yellowish brown(10YR 4/6); fine(clay); massive to moderate medium and coarse subangular blocky;firm to very firm(moist), sticky and plastic(wet); few fine,common medium and few large tubular pores; patchy thin clay coatings; many coarse distinct yellow(10 YR 7/8) mottles; few fine roots;micro organism pores; clear smooth boundary; pH 4.4
278	$B_{2.2}$	22 - 49	Brownish yellow(10YR 6/6-6/8); very fine (heavy clay);moderate medium and fine subangular blocky; friable to firm(moist), sticky and non plastic (wet);common fine, many medium and few large tubular pores;many coarse distinct yellowish red (5 YR 4/6) iron mottles;few very fine roots; gradual smooth boundary; pH 4.5
279	$B_{2.3}$	49 - 74	Brownish yellow(10YR 6/8);very fine(heavy clay); moderate medium and coarse subangular blocky;friable to firm(moist), sticky and non plastic(wet); common fine,many medium and few large tubular pores; few shining slickensides;few very fine roots; many coarse distinct red (2.5YR 4/8)mottles;clear smooth boundary; pH 4.4
280	BC/C_1	74 - 105	Brownish yellow(10YR 6/6); very fine(heavy clay); massive;very firm(moist), sticky and non plastic (wet); many fine, common medium and few large tubular pores; few shining slickensides;many coarse distinct red (2.5YR 4/8) mottles; clear smooth boundary; pH 4.4
281	C_2	105 - 150	Light brownish gray(10YR 6/2) and brownish yellow (10YR 6/6);fine(clay);massive;hard(dry),slightly sticky and plastic(wet);few fine,medium and few large tubular pores;many coarse distinct red(2.5 YR 4/8) mottles; pH 4.5

Mapping Unit : 10
Soil series : TU-Pc-51
Classification
a. SRI : Yellowish Brown Podzolic soil
b. USDA : Orthoxic Tropudult
Landform : Transition plain/peneplain tongue
Relief/Slope : Undulating
Parent material : Colluvial (mixed of weathered volcanic and deposit)
Drainage : Moderately well drained
Vegetation : Angrung (Grewia coumnaris Sm)
Location : Block E Sitiung II
(SRI 195291/296; SK 15)

SRI No.	Horizon	Depth (cm)	Description
195291	A_1	0 - 2	Dark brown(7.5YR 3/4); very fine(heavy clay);massive;firm(moist), slightly sticky and non plastic (wet); few fine,medium and large tubular pores; many organic matter;few large roots; abrupt smooth boundary; pH 3.9
292	B_1	2 - 17	Brownish yellow(10YR 6/6);very fine(heavy clay); massive; very firm(moist),sticky and slightly plastic(wet);common fine and medium,few large tubular pores;few fine manganese concretions and quartz sand,few fine and medium decomposed organic matter along root channels and pores; clear smooth boundary; pH 4.3
293	$B_{2.1}$	17 - 56	Brownish yellow(10YR 6/6);very fine(heavy clay); moderate medium and coarse subangular blocky;friable(moist); sticky and plastic(wet); many fine medium and large tubular pores;few fine manganese concretions and quartz sand; patchy thin clay cutans; few large roots; gradual smooth boundary; pH 4.2
294	$B_{2.2}$	56 - 94	Brownish yellow(10YR 6/8);fine(gravelly clay);moderate fine medium subangular blocky;friable(moist), sticky and plastic(wet);many fine,medium and large tubular pores;few fine manganese concretions;patchy thin clay cutans;few fine and large roots;abrupt smooth boundary; pH 4.4
295	BC	94 - 130	Brownish yellow(10YR 6/8);fine(gravelly clay);moderate fine and coarse subangular blocky; friable to firm(moist),sticky and slightly plastic(wet); many fine, medium and large tubular pores;few fine manganese concretions;many distinct yellowish red (5YR 4/6) mottles;gradual smooth boundary; pH 4.5
296	C	130 +	Brownish yellow(10YR 6/8);fine(gravelly clay);weak fine and medium subangular blocky to massive; friable(moist),sticky and slightly plastic(wet); common fine,and medium, many large tubular pores; many iron concretions with rounded size; gravels mainly consist of quartzite terrace gravels (rounded); pH 4.5

Note: Mechanical land clearing

Appendix 3A : Chemical data of soil series in the semi – detailed survey area (over dry basis per 100 gr fine soil)

Soil sample		Depth (cm)	Texture			pH		Organic matter			Extract HCl 25 %		Exchangeable cation NH_4OAc 1N pH 7.0					KCl 1N		Adsorption capacity		Base saturation (%)	Al saturation (%)	Free Fe_2O_3 (%)	Total Mn (mg)	Extract HCl 0.1 N	
SRI No.	Horizon		Sand (%)	Silt (%)	Clay (%)	H_2O	KCl	C (gr)	N (gr)	C/N	P_2O_5 (mg)	K_2O (mg)	Ca (me)	Mg (me)	K (me)	Na (me)	Total cation (me)	H (me)	Al (me)	(me)	me / 100 gr clay					Cu (mg)	Zn (mg)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Mapping Unit (MU)		1																									
AE–Jd–3 I																											
195480	I	0 – 16/20	3	67	30	6.0	5.7	6.73	0.64	11	91	115	23.0	3.1	1.2	0.1	27.3	0.16	0.00	43.2	84.8	63	–	0.39	80.9	0.49	3.46
481	II	16/20 – 40	2	59	39	5.4	4.5	1.43	0.19	8	38	102	6.9	1.8	0.7	0.1	9.5	0.54	0.26	21.5	30.2	44	3	0.75	103.2	0.83	0.40
482	III	40 – 70	1	67	33	5.7	4.7	1.03	0.13	8	62	87	9.0	2.2	0.7	0.1	12.0	0.17	0.07	22.5	60.0	53	1	0.76	–	–	–
483	IV	70 – 80/120	2	77	21	5.8	4.6	0.41	0.07	6	48	58	5.6	2.3	0.2	0.3	11.4	0.36	0.18	18.3	82.0	62	2	0.84	–	–	–
484	V	80/120–140	21	66	13	6.3	4.9	0.20	0.03	7	69	45	5.7	1.5	0.2	0.3	7.7	0.06	0.03	11.0	80.6	70	1	0.81	–	–	–
AE–Jd–5 I																											
195528	I	0 – 12	1	69	30	6.0	4.8	3.39	0.38	9	78	47	11.6	2.1	0.3	0.2	14.2	0.28	0.07	30.2	70.9	47	1	0.58	–	–	–
529	II	12 – 33	2	67	31	6.2	4.6	1.33	0.17	8	49	45	7.9	1.7	0.1	0.2	9.9	0.10	0.04	19.3	49.3	51	1	0.67	–	–	–
530	III	33 – 77	1	64	36	6.4	4.5	0.76	0.10	8	20	53	10.0	2.1	0.1	0.3	12.5	0.17	0.04	18.6	47.4	67	1	0.78	–	–	–
531	IV	77 – 100	2	61	37	6.3	4.4	0.58	0.07	8	56	66	9.2	2.2	0.1	0.3	11.8	0.21	0.06	17.4	42.9	68	1	0.88	–	–	–
Mapping Unit (MU) :		2							N	o	t		s	a m	p		l	e	d								
Mapping Unit (MU) :		3																									
AE–Jd–8 I																											
195469	C1.1	0 – 12	1	62	38	5.4	4.3	1.77	0.16	11	36	29	4.0	1.4	0.1	1.1	6.6	2.32	1.36	17.6	34.0	38	17	0.40	–	–	–
470	C1.2	12 – 32	1	60	40	5.3	4.3	1.02	0.10	10	48	30	4.4	1.7	0.1	0.4	6.6	1.86	1.11	16.4	34.3	40	14	0.84	–	–	–
471	C1.3	32 – 67	1	58	41	5.3	4.4	0.89	0.10	9	51	32	4.9	2.2	0.1	0.2	7.4	1.09	0.54	16.8	35.3	44	7	0.87	–	–	–
472	C1.4	67 – 83/86	19	45	36	5.4	4.5	0.54	0.07	8	84	27	3.9	1.8	0.1	0.2	6.0	0.72	0.37	13.7	26.8	44	6	1.11	–	–	–
473	A2/Bh	83/86-140/150	82	9	9	5.5	4.6	0.20	0.03	7	61	24	1.7	0.6	0.1	0.2	2.6	0.32	0.19	6.9	70.9	38	7	0.40	–	–	–
474	Bh/C	140/150-160	89	8	3	5.6	4.8	0.20	0.02	10	57	21	1.0	0.3	0.1	0.1	1.6	0.12	0.07	5.4	–	38	4	0.70	–	–	–
AU–Jd–9 I																											
195524	A1	0 – 11	0	32	68	4.3	4.0	12.42	0.69	18	59	74	0.3	0.3	0.2	0.1	0.9	10.92	9.19	44.2	16.7	2	91	0.43	2.8	0.30	0.56
525	B1	11 – 42	0	31	69	4.3	3.5	0.91	0.11	8	9	9	0.1	0.1	0.1	0.1	0.3	10.93	9.58	18.1	22.7	2	100	0.98	5.4	0.50	0.38
526	B2	42 – 70	0	39	61	4.5	3.5	0.44	0.07	6	7	12	0.1	0.3	0.1	0.1	0.6	12.95	12.75	21.7	33.1	3	99	0.81	–	–	–
527	B3g	70 – 120	0	36	64	4.9	3.6	0.28	0.05	6	18	15	0.4	0.7	0.1	0.1	1.3	10.19	9.35	18.4	27.6	7	88	0.69	–	–	–
Mapping Unit (MU) :		4																									
AC–Jd–3 I																											
195282	A1/A3	0 – 4	10	41	49	5.1	4.2	2.89	0.21	14	21	15	1.5	0.3	0.3	0.1	2.1	2.31	1.44	22.4	29.5	9	87	0.88	323.7	0.49	1.21
283	B1	4 – 22	9	30	61	5.3	4.1	1.34	0.13	10	16	9	0.4	0.2	0.1	0.0	0.7	3.68	2.79	18.1	24.0	4	97	0.21	257.1	0.58	2.27
284	B2	22 – 43	10	28	62	5.3	4.0	0.51	0.06	9	28	6	0.5	0.3	0.1	0.1	0.9	4.11	3.88	17.6	26.0	5	98	1.35	141.0	0.44	3.21
285	B3	43 – 90	6	38	56	5.3	4.1	0.29	0.03	10	28	7	1.2	0.5	0.1	0.1	1.8	5.00	4.15	19.0	32.4	9	70	1.46	–	–	–
286	BC	90 – 120	4	48	48	5.4	4.0	0.14	0.03	5	18	6	1.4	0.1	0.1	0.1	1.6	5.19	4.49	28.0	57.9	9	74	1.42	–	–	–
AC–Jd–5 I																											
195475	A1	0 – 15	7	56	37	5.2	4.4	2.53	0.24	11	31	36	1.2	0.7	0.2	0.1	2.1	3.77	2.68	22.1	41.8	10	56	0.73	237.3	0.72	0.74
476	B1	15 – 40	5	58	37	5.3	4.4	0.75	0.09	8	19	24	0.4	0.3	0.1	0.0	0.8	3.92	3.16	12.7	29.0	6	80	0.64	165.1	0.39	0.52
477	B2	40 – 69	6	41	53	5.1	4.4	0.48	0.07	7	19	26	1.4	0.9	0.1	0.1	2.4	2.96	2.27	13.8	23.6	17	49	0.78	–	–	–
478	B2cn	69–104	4	56	40	5.3	4.4	0.34	0.05	7	22	28	2.3	1.5	0.1	0.1	4.0	2.56	1.97	17.5	39.0	24	33	0.78	–	–	–
479	BC	104–140	10	38	52	5.1	4.3	0.24	0.04	6	59	28	2.1	1.6	0.1	0.2	4.0	2.73	2.05	19.9	36.9	20	34	0.80	–	–	–
195510	A1	0 – 16	2	62	36	5.0	4.0	3.16	0.29	11	47	32	1.8	1.0	0.3	0.0	3.1	2.09	1.22	23.6	42.9	22	28	0.47	240.1	0.52	0.62
511	AB	16 – 28	1	56	43	4.9	4.0	1.17	0.14	8	31	25	0.6	0.3	0.1	0.0	1.0	5.57	5.23	19.1	31.0	5	84	0.58	196.4	0.40	0.54
512	B2t	28 – 57	1	43	57	5.3	3.9	0.59	0.09	7	33	20	0.5	0.1	0.1	0.1	0.8	6.08	4.55	16.4	26.0	5	85	0.86	–	–	–
513	B2.1	57 – 105	1	55	45	5.3	3.9	0.35	0.07	5	45	25	0.5	0.3	0.1	0.1	1.0	6.91	5.68	17.3	36.4	6	85	0.98	–	–	–
514	B2.2	105 – 125	2	44	54	5.3	3.8	0.14	0.06	2	87	32	0.6	0.7	0.2	0.1	1.5	8.08	0.66	18.8	34.6	8	31	0.98	–	–	–

Appendix 3A (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Mapping Unit (MU) :	5																										
AU–Bd–2 I																											
195297	A1	0 – 12	4	21	75	4.6	3.9	2.04	0.18	11	23	7	0.1	0.1	0.1	0.1	0.3	6.27	5.02	20.2	19.7	1	94	0.01	203.6	0.45	0.79
298	B1	12 – 27	3	30	67	4.7	4.0	0.96	0.12	8	16	4	0.2	0.1	0.1	0.0	0.4	5.22	4.31	19.8	25.8	2	91	0.94	218.1	0.49	1.21
299	B2.1t	27 – 58	3	20	77	4.6	3.9	0.58	0.08	7	12	4	0.2	0.1	0.1	0.0	0.4	5.94	4.92	16.9	20.0	2	92	1.83	138.8	0.49	1.92
300	B2.2	58 – 104	3	29	68	5.2	3.9	0.35	0.07	5	18	3	0.1	0.1	0.1	0.1	0.4	5.25	4.35	16.2	22.5	2	91	1.79	–	–	–
301	B3	104 – 150	3	46	51	4.7	3.7	0.22	0.06	4	22	3	0.2	0.1	0.1	0.1	0.4	5.97	5.10	17.2	32.5	2	93	1.87	–	–	–
195349	Ap	0 – 15	5	34	61	4.5	3.7	2.66	0.22	12	26	13	0.8	0.4	0.2	0.1	1.4	5.90	4.98	21.2	23.2	7	78	1.12	38.3	0.32	1.13
350	B1	15 – 53	4	29	67	4.2	3.8	0.98	0.11	9	21	5	0.4	0.2	0.1	0.1	0.7	5.44	4.37	16.4	20.6	4	86	1.21	12.4	0.21	0.34
351	B2.1	53 – 87	nd	nd	nd	4.5	3.7	0.54	0.09	6	12	5	0.3	0.1	0.1	0.1	0.3	4.31	3.51	14.2	–	2	92	0.74			–
352	B2.2	87 – 146	nd	nd	nd	4.7	3.8	0.34	0.07	5	7	5	0.2	0.1	0.1	0.1	0.2	3.90	3.08	13.0	–	2	93	0.95	–	–	
195532	Ap	0 – 18	1	24	75	4.9	3.8	3.14	0.28	11	69	8	0.1	0.2	0.1	0.1	0.5	5.57	4.57	25.4	22.8	2	90	0.62	414.7	0.78	0.60
533	B1	18 – 59	2	48	50	4.9	3.9	1.37	0.15	9	57	5	0.1	0.1	0.1	0.1	0.2	4.28	3.63	22.3	37.4	1	95	0.70	332.1	0.78	1.11
534	B2.1	59 – 82	1	39	60	4.8	3.7	0.42	0.08	5	103	4	0.1	0.1	0.1	0.1	0.3	5.06	4.28	17.4	27.2	2	93	0.78	–	–	–
535	B2.2	82 – 140	2	20	78	4.7	3.7	0.29	0.07	4	81	4	0.1	0.1	0.1	0.1	0.3	6.72	5.21	18.4	22.6	2	95	0.88	–		–
AU–Bd–3 I																											
195500	A1	0 – 17	11	24	66	4.7	4.0	3.77	0.39	10	75	14	0.6	0.3	0.4	0.1	1.4	3.48	2.49	29.1	29.0	5	86	0.50	538.3	0.68	5.51
501	B1	17 – 36	10	22	67	4.5	3.9	1.39	0.17	8	59	6	0.4	0.1	0.1	0.1	0.6	4.31	3.34	21.7	27.0	3	85	0.61	377.0	0.58	2.39
502	B2.1	36 – 77	10	14	76	4.5	3.9	0.75	0.11	7	49	5	0.7	0.2	0.1	0.0	1.0	3.80	3.24	20.6	24.0	5	76	0.59		–	–
503	B2.2	77 – 133	6	20	75	4.4	3.9	0.37	0.08	5	64	4	0.2	0.2	0.1	0.0	0.5	4.66	3.89	19.7	25.0	3	89	0.75	–	–	–
504	B3	133 – 156	15	25	60	4.4	3.8	0.28	0.06	5	115	5	0.2	0.2	0.1	0.0	0.4	3.80	3.17	17.8	28.4	2	89	0.80	–	–	
195505	Ap	0 – 14	6	33	61	4.4	3.8	3.35	0.31	11	35	14	0.6	0.4	0.2	0.0	1.2	7.60	5.44	23.4	23.9	5	82	0.52	142.2	0.53	0.53
506	B1	14 – 48	6	32	62	4.0	3.6	1.30	0.20	7	19	6	0.2	0.2	0.1	0.0	0.5	8.08	6.34	20.7	20.7	2	93	0.64	92.9	0.45	0.53
507	B2.1	48 – 59	5	29	66	4.1	3.6	0.62	0.10	6	16	5	0.1	0.1	0.1	0.0	0.3	0.66	5.13	19.1	26.5	2	94	0.65	–	–	–
508	B2.2	59 – 122	5	32	63	4.2	3.7	0.48	0.08	6	15	4	0.1	0.1	0.1	0.0	0.3	7.03	5.25	17.5	25.8	2	95	0.72	–	–	–
509	B 3	122 – 156	5	39	56	4.3	3.8	0.35	0.06	6	15	5	0.1	0.1	0.1	0.1	0.5	8.68	7.05	19.7	33.5	2	96	0.74	–	–	–
AU–Bd–5 I																											
195302	A1	0 – 11	4	33	63	4.5	3.8	2.68	0.23	12	21	5	0.2	0.2	0.1	0.0	0.3	6.75	5.54	22.6	24.5	1	94	1.14	113.1	0.42	0.30
303	B2.1	11 – 39	4	35	61	4.7	3.9	1.12	0.14	8	13	3	0.1	0.1	0.1	0.0	0.3	6.42	5.46	18.9	26.1	2	94	1.38	113.6	0.36	0.30
304	B2.2	39 – 64	6	33	61	4.6	3.8	0.76	0.10	8	8	3	0.1	0.1	0.1	0.0	0.3	4.52	5.17	19.0	27.8	2	94	1.46	113.0	–	–
305	B3	64 – 108	3	32	65	4.9	3.9	0.45	0.08	6	9	3	0.1	0.1	0.1	0.0	0.3	6.18	5.45	18.2	28.1	2	95	1.53	–	–	–
306	BgC	108 – 140	3	34	63	4.6	3.7	0.29	0.06	5	8	2	0.1	0.1	0.1	0.1	0.3	9.08	8.05	20.3	30.8	1	96	1.66	–	–	–
195344	A1	0 – 26	11	25	62	4.4	3.9	2.90	0.24	12	32	10	0.8	0.2	0.2	0.0	1.2	7.22	3.85	23.8	21.6	3	76	0.57	0.0	0.45	0.34
345	B1	26 – 50	10	22	68	4.3	3.9	0.89	0.10	9	18	4	0.4	0.1	0.1	0.1	0.6	4.14	3.43	17.5	21.7	3	85	1.16	0.0	0.25	0.20
346	B2.1	50 – 85	11	21	69	4.3	3.8	0.54	0.08	7	22	4	0.5	0.1	0.1	0.1	0.8	4.11	3.59	17.5	22.5	2	81	0.91	0.0	0.21	0.26
347	B2.2	85 – 122	16	26	63	4.4	3.9	0.37	0.07	5	22	4	0.3	0.2	0.1	0.1	0.6	3.93	3.45	17.1	25.1	2	85	1.30	–	–	–
348	B3	122 – 150	4	37	47	4.6	3.9	0.27	0.05	6	39	4	0.4	0.2	0.1	0.1	0.7	3.71	3.28	16.1	33.1	4	82	1.41	–	–	–
AU–Bd–6 I																											
195333	Ap	0 – 3	9	33	58	4.5	3.7	3.28	0.27	12	23	15	1.9	0.5	0.4	0.2	3.0	6.23	5.35	21.4	21.9	14	64	0.88	12.3	0.25	0.18
334	B1	3 – 19	9	36	56	4.1	3.7	2.33	0.19	12	9	6	0.5	0.1	0.1	0.1	0.7	7.56	6.47	21.4	27.1	3	90	1.02	0.0	0.21	0.18
335	B2.1	19 – 46	6	32	62	4.1	3.7	1.06	0.11	10	6	6	0.4	0.1	0.1	0.1	0.6	8.04	6.79	19.8	27.4	3	91	0.97	0.0	0.21	0.11
336	B2.2	46 – 74	5	26	69	4.2	3.7	0.70	0.09	8	3	5	0.3	0.1	0.1	0.0	0.4	9.33	8.58	19.5	25.7	2	95	1.10	–	–	–
337	B3g	74 – 110	3	41	56	4.4	3.7	0.41	0.06	7	4	7	0.4	0.1	0.1	0.1	0.6	10.14	9.21	19.1	32.1	3	93	1.23	–	–	–
338	C	110 +	1	37	62	4.7	3.7	0.25	0.05	5	2	3	1.0	0.3	0.1	0.1	1.5	10.63	10.65	20.4	31.7	7	87	1.13	–	–	–
Mapping Unit (MU) :	6																										
AU–Pc–5 I																											
195515	A1	0 – 12	36	10	54	3.8	3.5	4.43	0.37	12	16	9	0.2	0.2	0.2	0.1	0.7	5.26	4.16	16.9	9.6	4	86	0.35	–	–	–
516	B1.1t	12 – 37	27	8	65	4.3	3.8	1.52	0.14	11	44	3	0.1	0.1	0.1	0.1	0.3	4.27	3.23	10.0	8.9	3	81	0.40	–	–	–
517	B1.2t	37 – 62	26	12	62	4.5	3.8	0.84	0.07	12	3	3	0.1	0.1	0.1	0.1	0.2	3.75	2.66	8.1	9.5	2	93	0.33	–	–	–
518	B2.t	62 – 110	25	12	73	4.5	3.9	0.44	0.08	6	0	2	0.1	0.1	0.1	0.1	0.2	3.66	3.07	7.7	8.6	3	94	^0.33	–	–	–
195519	Ap	0 – 15	38	16	46	4.2	3.6	4.06	0.29	14	24	8	0.3	0.1	0.2	0.1	0.6	4.87	3.66	16.4	12.4	4	86	0.35	5.3	0.23	0.24
520	AB	15 – 40	28	11	61	4.6	4.0	1.02	0.11	9	3	4	0.1	0.1	0.1	0.1	0.3	3.22	2.49	9.9	12.8	3	89	0.45	2.7	0.21	0.31
521	B1	40 – 80	28	8	64	4.5	4.0	0.68	0.07	10	0	4	0.1	0.1	0.1	0.1	0.4	2.96	2.31	8.7	11.0	5	85	0.33	–	–	–
522	B2	80 – 98	28	8	64	4.6	3.9	0.54	0.07	8	2	3	0.1	0.1	0.1	0.1	0.4	3.46	2.54	7.6	9.0	5	86	0.14	–	–	–
523	BC	98 – 120	23	16	61	4.5	4.0	0.43	0.06	7	1	4	0.1	0.1	0.1	0.1	0.4	3.01	2.27	7.8	11.0	5	85	0.35	–	–	–
AU–Gd–8 I																											
195328	A1	0 – 10	27	16	57	3.8	3.5	12.41	0.63	20	39	16	0.1	0.1	0.3	0.1	0.6	10.07	8.27	47.9	26.4	1	93	0.27	0.0	0.21	0.20
329	B1	10 – 32	25	15	60	4.6	4.0	2.97	0.23	13	7	4	0.1	0.1	0.1	0.0	0.3	4.37	3.61	18.1	17.1	2	92	0.34	0.0	0.21	0.06
330	B2.1g	32 – 55	22	14	64	4.6	4.0	0.99	0.10	10	3	2	0.1	0.1	0.1	0.1	0.1	4.21	3.55	12.7	15.7	1	97	0.30	–	–	–
331	B2.2g	55 – 80	26	10	64	4.5	3.9	0.54	0.08	7	3	2	0.1	0.1	0.1	0.0	0.2	4.07	3.20	10.7	14.4	2	94	0.22	–	–	–
332	B3g	80 – 110	28	13	59	1	3.9	0.37	0.05	7	2	1	0.1	0.1	0.1	0.0	0.2	3.59	3.09	8.0	11.8	3	93	0.11			

Appendix 3A (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Mapping Unit (MU) : 7																											
TU - Pc - 5l																											
195287	A1	0 – 3	15	13	71	4.7	3.9	3.05	0.23	13	14	3	0.2	0.1	0.1	0.0	0.4	4.76	3.78	22.1	19.7	2	90	0.82	4.6	0.23	0.16
288	B1.1t	3 – 20	11	6	83	4.5	3.9	1.06	0.10	11	5	1	0.2	0.1	0.1	0.0	0.3	3.53	2.64	13.7	13.1	2	89	1.14	4.6	0.10	0.03
289	B2.1t	20 – 60	10	11	79	4.6	4.0	0.66	0.08	8	3	1	0.2	0.1	0.1	0.0	0.3	3.59	3.07	10.7	11.4	3	91	1.07	0.0	0.05	0.14
290	B2.2t	60 – 105	9	5	86	4.6	3.9	0.57	0.07	8	6	1	0.1	0.1	0.1	0.0	0.2	3.48	2.84	11.8	11.9	2	93	1.16	–	–	–
195291	A1	0 – 2	23	8	69	3.9	3.6	5.35	0.32	17	17	6	0.3	0.1	0.1	0.0	0.5	7.00	5.57	23.2	13.2	2	91	0.78	0.0	0.13	0.07
292	B1	2 – 17	12	19	69	4.3	4.0	1.81	0.15	12	5	3	0.1	0.1	0.1	0.0	0.3	4.39	3.49	15.2	15.1	2	92	0.94	4.5	0.10	0.20
293	B2.1	17 – 56	19	8	73	4.2	4.0	0.95	0.10	10	3	2	0.2	0.1	0.1	0.0	0.4	3.09	2.34	10.8	11.2	4	85	1.48	0.6	0.05	0.01
294	B2.2	56 – 94	19	6	75	4.4	4.0	0.61	0.07	9	2	1	0.1	0.1	0.1	0.0	0.2	3.08	2.33	9.6	10.7	2	92	0.83	–	–	–
295	BC	94 – 130	23	10	67	4.5	4.0	0.40	0.04	10	6	1	0.3	0.2	0.1	0.1	0.5	2.01	2.04	8.8	8.6	6	80	0.89	–	–	–
296	C	130 +	28	24	48	4.5	3.9	3.24	0.03	8	2	1	0.2	0.1	0.1	0.0	0.3	3.21	2.70	8.0	15.4	4	90	0.77	–	–	–
195485	B1	0 – 20	10	11	79	4.0	3.8	1.17	0.19	6	12	7	0.4	0.2	0.1	0.0	0.7	5.02	4.12	14.7	14.7	5	15	0.63	2.7	0.12	0.15
486	B2.1	20 – 46	10	9	81	4.0	3.7	1.15	0.12	10	4	4	0.2	0.1	0.1	0.0	0.4	4.28	3.22	13.3	12.5	3	89	0.68	0.0	0.18	0.11
487	B2.2	46 – 90	9	10	81	4.2	3.8	0.82	0.09	9	17	3	0.2	0.1	0.1	0.0	0.4	3.25	2.43	11.5	11.7	3	86	0.66	–	–	–
488	B2.3	90 – 125	8	8	84	4.2	3.7	0.62	0.07	9	12	3	0.2	0.1	0.1	0.0	0.3	3.39	2.62	9.6	9.5	3	90	0.67	–	–	–
489	B3	125 – 155	9	10	81	4.2	3.7	0.54	0.06	9	9	1	0.2	0.1	0.1	0.0	0.4	2.99	2.36	11.5	12.4	3	85	0.75	–	–	–
Mapping Unit (MU) : 8																											
VU–Lc–3 I																											
195495	A1	0 – 16	24	14	62	3.9	3.6	3.94	0.31	13	17	6	0.1	0.1	0.1	0.1	0.4	5.66	4.46	20.2	15.5	2	92	0.58	8.0	0.21	0.21
496	B1	16 – 37	20	6	74	4.3	3.9	1.50	1.41	11	11	3	0.1	0.1	0.1	0.0	0.1	3.61	2.68	13.7	13.2	1	46	0.62	5.3	0.18	0.11
497	B2.1	37 – 90	19	12	69	4.3	3.9	0.85	0.09	9	6	2	0.2	0.1	0.1	0.0	0.2	3.17	2.46	11.2	13.0	2	92	0.56	–	–	–
498	B2.2	90 – 136	20	7	73	4.4	3.9	0.68	0.07	10	5	1	0.1	0.1	0.0	0.0	0.1	2.95	2.29	10.6	12.1	1	96	0.66	–	–	–
499	B2.3	136 +	17	11	72	4.5	4.0	0.54	0.06	9	5	1	0.1	0.1	0.0	0.1	0.3	2.68	2.04	8.7	10.1	3	87	0.50	–	–	–
VU–Lo 3 I																											
195368	Ap	0 – 12	13	13	74	4.5	3.8	3.25	0.24	14	17	6	0.1	0.2	0.1	0.1	0.4	4.62	3.67	19.3	14.5	2	90	0.66	29.4	0.16	0.08
369	B1	12 – 40	9	8	83	4.0	3.8	1.31	0.13	10	11	4	0.1	0.1	0.1	0.0	0.3	3.13	2.96	12.6	11.2	2	90	0.81	4.9	0.16	0.03
370	B2.1	40 – 79	9	8	83	4.1	3.8	0.85	0.09	9	10	3	0.1	0.1	0.1	0.1	0.2	3.00	2.32	9.9	9.3	2	92	0.86	–	–	–
371	B2.2	79 – 120	10	9	82	4.2	3.8	0.65	0.08	8	9	3	0.1	0.1	0.1	0.0	0.2	2.67	2.24	9.2	9.2	2	91	0.81	–	–	–
372	BC	120 – 150	8	7	84	4.3	3.8	0.51	0.09	6	7	3	0.1	0.1	0.1	0.1	0.2	2.64	2.30	9.0	9.1	2	92	0.95	–	–	–
Mapping Unit (MU) : 9																											
VU–Lc–3 I																											
195490	A1	0 – 15	4	30	66	4.3	3.9	4.26	0.32	13	14	5	0.1	0.1	0.0	0.1	0.2	4.63	3.55	22.1	16.4	1	95	0.46	5.5	0.14	0.21
491	A3	15 – 46	4	8	88	4.5	4.0	1.50	0.13	12	5	2	0.2	0.1	0.1	0.0	0.4	3.30	2.41	13.7	11.0	3	86	0.53	2.7	0.12	0.24
492	B1.1	46 – 88	3	9	88	4.6	3.9	0.89	0.09	10	17	2	0.2	0.1	0.1	0.0	0.3	2.24	1.99	11.6	10.5	3	87	0.53	–	–	–
493	B1.2	88 – 130	3	8	89	4.8	4.0	0.61	0.07	9	15	3	0.2	0.1	0.0	0.0	0.3	2.68	2.18	11.7	12.6	3	88	0.63	–	–	–
494	B3	130–150	3	8	89	4.8	3.9	0.55	0.06	9	11	3	0.1	0.1	0.1	0.1	0.4	2.05	1.37	11.5	11.3	3	82	0.64	–	–	–
VU–Lo–3 I																											
195318	A1	0 – 8	9	14	77	3.6	3.9	5.44	0.41	13	22	6	0.1	0.3	0.2	0.1	0.7	4.68	3.57	23.8	11.5	3	83	0.97	12.3	0.10	0.52
319	B1	8 – 40	6	9	85	4.1	3.9	1.66	0.14	12	12	2	0.1	0.1	0.1	0.1	0.3	2.66	2.10	12.6	9.7	2	87	1.35	12.2	0.10	0.03
320	Box1	40 – 78	4	13	83	4.3	4.0	0.94	0.09	10	11	1	0.1	0.1	0.1	0.0	0.2	2.11	1.75	11.1	10.4	2	89	1.22	–	–	–
321	Box2	78 – 120	5	8	87	4.4	4.0	0.80	0.07	11	9	1	0.1	0.1	0.1	0.1	0.3	2.03	1.55	11.0	10.2	3	83	1.43	–	–	–
322	BC	120 +	5	6	89	4.7	4.0	0.67	0.07	10	9	1	0.1	0.2	0.1	0.1	0.3	1.59	1.22	10.2	9.5	3	80	1.39	–	–	–

Appendix 3 B : Chemical data of Soil series in the detailed survey area (over dry basis per 100 gram fine soil)

Mapping Unit	Soil sample: SRI No.	Soil sample: Horizon	Depth (cm)	Texture: Sand (%)	Texture: Silt (%)	Texture: Clay (%)	pH: H_2O	pH: KCl	Organic matter: C (%)	Organic matter: N (%)	Organic matter: C/N	Extract HCl 25%: P_2O_5 (mg)	Extract HCl 25%: K_2O (mg)	Exchangeable cation, NH_4OAc 1N pH 7.0: Ca (me)	Mg (me)	K (me)	Na (me)	Total cation me)	Exchangeable cation, KCl 1N: H (me)	Al (me)	Adsorption capacity: (me)	Adsorption capacity: me/ 100gr clay	Base saturation (%)	Al saturation (%)	Free Fe_2O_3 (%)	Total Mn (mg)	Extract HCl 0,1 N: Cu (mg)	Extract HCl 0,1 N: Zn (mg)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1	AO – Hf – 9.h																											
	195359	I	0 – 30	5	29	66	4.8	3.9	20.43	1.20	17	48	17	11.6	1.6	0.3	0.3	13.8	1.45	0.46	6.74	19.6	20	3	0.91	26.7	0.72	2.09
	360	II	30 – 50	9	39	52	5.0	4.5	23.35	1.27	19	30	10						0.94	0.26					0.82	21.3	0.67	1.09
	361	III	50 – 100	18	44	38	4.8	3.7	6.73	0.21	32	40	22	8.3	1.9	0.5	0.4	11.1	1.83	1.00	39.1	37.2	28	8	0.85	–	–	
	362	IV	100 – 125	17	53	30	4.9	4.1	2.06	0.10	21	39	53	12.4	3.7	1.3	0.5	17.9	0.46	0.13	30.1	–	60	1	0.60			
2	Complex									Not Sampled																		
3	AU – Gd – 7.I																											
	195264	A1	0 – 12	1	32	67	4.5	3.7	3.25	0.35	9	46	15	0.5	0.2	0.3	<0.1	1.0	6.35	4.43	21.5	19.3	5	82	0.45	18.9	0.76	0.77
	265	B1g	12 – 26	2	31	67	4.6	3.7	1.12	0.14	8	34	7	0.1	0.1	0.1	<0.1	1.2	7.40	5.17	18.4	26.2	1	96	1.16	11.6	0.49	0.98
	266	B2g/B3	26 – 36	4	36	60	4.6	3.7	1.02	0.13	8	49	7	0.1	0.1	0.1	<0.1	0.3	8.14	5.76	18.3	26.1	2	95	1.78	5.1	0.55	1.36
	267	C1.1	36 – 88	5	57	38	4.8	3.7	0.14	0.03	5	33	19	0.5	0.4	0.3	<0.1	1.2	7.75	5.14	14.0	35.7	9	81	1.62	–	–	–
	268	C1.2	88 – 117	4	67	29	5.1	3.8	0.15	0.03	5	45	25	0.4	0.3	0.9	<0.1	1.6	6.19	4.49	14.6	49.1	11	73	1.51	–	–	–
	269	C1.3	117 – 140	7	67	29	5.2	3.8	0.08	0.02	4	38	27	0.5	0.3	1.2	0.1	2.1	4.71	2.67	13.1	50.6	16	56	1.13	–	–	–
	195339	A1	0 – 8	3	33	64	4.5	3.9	3.81	0.34	11	50	19	0.3	0.2	0.2	0.0	1.2	5.56	4.38	23.8	21.6	3	85	0.57	0.0	0.45	0.34
	340	B1	8 – 20	2	31	67	4.6	3.8	1.36	0.14	10	18	9	0.3	0.1	<0.1	0.1	0.6	5.47	4.40	17.5	20.7	3	88	1.16	0.0	0.25	0.20
	341	B2.1	20 – 40	2	30	68	4.6	3.9	0.84	0.11	8	27	8	0.3	0.1	0.1	0.1	0.8	5.24	4.47	17.5	22.5	2	92	0.91	0.0	0.21	0.26
	342	B2.2	40 – 68/75	2	33	65	5.1	3.8	0.31	0.06	5	55	7	0.2	0.2	<0.1	0.1	0.6	5.70	4.99	17.1	25.1	2	91	0.30	–	–	–
	343	B3	68/75 – 120	3	48	49	4.7	3.8	0.14	0.04	4	21	7	0.4	0.2	<0.1	0.1	8.7	7.24	5.39	16.6	33.1	4	95	1.41	–	–	–
4	AU – Gd – 8.I																											
	195323	A1	0 6	3	31	66	4.1	3.8	6.69	0.43	16	57	9	0.4	0.4	0.2	0.1	1.1	5.47	4.93	33.1	23.5	3	82	0.69	49.6	0.25	0.34
	324	B1	6 – 12/28	4	31	65	4.3	3.7	2.30	0.16	14	25	3	0.1	0.2	0.1	0.1	0.5	6.93	6.55	25.0	29.2	2	93	1.21	38.5	0.26	0.27
	325	B2G	12/28 – 75	4	24	72	4.3	3.5	0.95	0.11	9	12	2	0.1	0.2	0.1	<0.1	0.4	6.67	6.31	19.0	22.9	2	94	1.21	12.3	0.25	0.08
	326	B3G	75 – 100	2	31	67	4.4	3.4	0.48	0.05	10	7	3	0.2	0.3	0.1	0.1	0.7	9.47	9.14	21.1	29.6	3	93	1.20	–	–	–
	327	CG	100 +	1	40	59	4.7	3.5	0.19	0.04	5	9	3	0.4	0.5	0.1	0.1	1.1	9.73	9.23	20.3	33.7	5	90	1.12	–	–	–
5	AC – Bd – 3.I																											
	195258	A1/Ap	0 – 13	11	49	40	4.4	3.8	2.75	0.23	12	35	12	0.3	0.1	0.1	0.1	0.5	3.89	2.14	20.6	33.2	2	81	0.80	310.8	0.33	0.79
	259	A3	13 – 30	13	38	48	4.5	3.9	1.48	0.14	11	17	9	0.4	0.1	0.1	0.1	0.5	2.83	1.65	19.6	32.4	2	79	0.79	256.5	0.33	1.23
	260	B2.1	30 – 70	10	40	50	4.8	4.0	0.68	0.09	8	20	5	0.2	0.1	0.1	0.1	0.5	5.13	1.74	18.6	33.7	3	78	1.05	–	–	–
	261	B2/B3	70 – 102	11	38	51	5.1	4.0	0.37	0.05	7	28	14	0.1	0.1	0.1	0.1	0.5	1.58	1.78	18.6	34.8	3	78	1.21	–	–	–
	262	BC	102–139/140	21	48	31	5.0	3.8	0.22	0.03	7	57	12	0.1	0.1	0.1	0.1	0.3	5.00	2.81	18.3	56.5	2	90	1.29	–	–	–
	263	C	139/140–150							Not Sampled																		
	195307	A1	0 – 8	10	38	52	4.9	4.2	3.71	0.32	12	37	21	1.3	1.4	0.5	0.1	3.3	1.31	0.40	27.7	34.4	12	12	1.17	343.9	0.31	1.04
	308	B1.1	8 – 20	10	39	51	5.0	4.1	2.86	0.24	12	30	6	0.5	0.4	0.1	0.1	1.0	2.30	1.47	23.2	30.6	4	60	1.24	343.9	0.31	0.71
	309	B1.2	20 – 60	7	35	58	5.1	4.2	1.17	0.13	9	24	3	0.2	0.2	0.1	0.1	0.5	1.59	1.22	22.1	32.8	2	71	1.21	296.2	0.21	2.36
	310	B3.1	60 – 90	6	31	63	5.2	4.2	0.62	0.07	9	28	3	0.2	0.2	0.1	0.1	0.6	1.89	1.18	20.5	30.1	3	66	1.00	–	–	–
	311	B3.2	90–140	7	38	55	5.1	4.1	0.35	0.06	6	41	3	0.2	0.2	0.1	0.1	0.6	2.81	2.11	21.7	37.8	3	78	1.12	–	–	–
6	AC – Bd – 5.I																											
	195270	Ap	0 – 13	4	42	54	4.5	3.8	3.18	0.26	12	38	15	0.3	0.1	0.1	0.1	0.5	5.60	2.88	22.1	25.4	2	85	0.64	294.3	0.41	0.72
	271	B1cn	13 – 25	2	40	58	4.8	3.9	1.23	0.15	8	17	9	0.4	<0.1	<0.1	0.0	0.4	4.90	2.84	19.3	26.0	2	88	0.80	330.7	0.33	0.95
	272	B2cn	25 – 46	2	41	57	4.7	3.9	0.74	0.11	7	10	7	0.3	<0.1	<0.1	0.0	0.3	5.49	3.96	16.4	25.3	2	93	1.06	78.4	0.42	1.37
	273	B2.2	46 – 83	1	36	63	4.9	3.9	0.37	0.06	6	11	3	0.1	0.1	<0.1	<0.1	0.2	5.37	4.60	16.1	25.4	1	96	0.96	–	–	–
	274	B3	83 – 132	4	49	47	5.0	3.9	0.21	0.03	7	18	3	0.2	0.1	0.1	<0.1	0.4	6.64	5.73	15.9	32.3	3	93	1.29	–	–	–
	275	C	132 – 145	8	56	36	4.6	3.7	0.15	0.03	5	46	1	0.2	0.1	0.1	<0.1	0.4	7.78	5.67	15.8	42.8	3	93	1.28	–	–	–
	195312	A1	0 – 10	10	31	59	5.0	4.1	3.22	0.28	12	49	9	1.3	0.4	0.2	0.1	2.0	2.68	2.02	24.1	26.4	8	50	1.05	212.6	0.53	0.41
	313	B1	10 – 40	9	31	60	4.8	3.9	0.95	0.10	10	20	3	0.1	0.2	0.1	<0.1	0.4	4.37	3.75	19.3	28.0	2	90	0.98	170.6	0.37	0.46
	314	(B2)	40 – 66	7	31	62	4.9	3.9	0.62	0.07	9	26	3	0.1	0.1	0.1	0.1	0.4	4.69	4.35	19.1	27.1	2	92	1.05	–	–	–
	315	B3	66 – 105	4	36	60	4.8	3.9	0.41	0.05	8	43	3	0.1	0.1	0.1	0.1	0.4	6.38	5.45	19.6	30.8	2	93	1.08	–	–	–
	316	B3g	105 – 135	13	44	43	4.9	3.9	0.23	0.04	6	74	3	0.1	0.1	0.1	0.1	0.4	5.06	4.47	16.6	36.7	2	92	1.37		–	–
	317	C	135 – 140	13	51	37	4.6	3.8	0.18	0.03	6	51	4	0.1	0.2	0.1	<0.1	0.4	6.68	5.68	20.3	53.7	2	93	1.20		–	–

Appendix 3B (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
7	AU – Bd – 2.1																											
	195247	A1	0 – 7	2	28	70	4.7	3.8	2.40	0.25	10	25	11	0.3	<0.1	0.1	0.1	0.6	6.38	4.08	21.9	32.2	3	87	0.93	356.7	0.46	0.55
	248	B1	7 – 25	2	38	60	5.0	3.9	1.27	0.13	10	18	6	0.1	<0.1	0.1	<0.1	0.2	6.99	2.61	19.3	26.5	1	93	1.39	324.3	0.40	0.74
	249	B2.1	25 – 70	3	32	65	5.2	4.1	0.57	0.10	6	20	6	0.1	<0.1	<0.1	0.1	0.2	6.50	2.62	17.4	24.5	1	93	1.43	302.0	0.50	1.38
	250	B2.2	70 – 109	4	36	60	5.0	3.9	0.38	0.07	5	24	6	0.1	<0.1	<0.1	0.1	0.2	8.14	4.43	18.2	28.8	1	96	1.76	–	–	–
	251	B3/BC	109 – 150	3	50	47	5.0	3.8	0.29	0.05	6	31	4	0.1	<0.1	<0.1	0.2	0.3	10.20	6.39	18.1	36.7	2	84	1.81	–	–	–
	195297	A1	0 – 12	4	21	75	4.6	3.9	2.04	0.18	11	23	7	0.1	0.1	0.1	0.1	0.3	6.27	5.02	20.2	19.7	1	94	1.01	203.6	0.45	0.79
	298	B1	12 – 27	3	30	67	4.7	4.0	0.96	0.12	8	16	4	0.2	0.1	0.1	0.0	0.4	5.22	4.31	19.8	25.8	2	92	0.94	218.1	0.49	1.21
	299	B2.1t	27 – 58	3	20	77	4.6	3.9	0.58	0.08	7	12	4	0.2	0.1	0.1	0.0	0.4	5.94	4.92	16.9	20.0	2	92	1.83	138.8	0.49	1.92
	300	B2.2	58 – 104	3	29	68	5.2	3.9	0.35	0.07	5	18	3	0.1	0.1	0.1	0.1	0.4	5.25	4.35	16.2	22.5	2	92	1.79	–	–	–
	301	B3	104–150	3	46	51	4.7	3.7	0.22	0.06	4	22	3	0.2	0.1	0.1	0.1	0.4	5.97	5.10	17.2	32.5	2	93	1.87	–	–	–
	195349	Ap	0 – 15	5	34	61	4.5	3.7	2.66	0.22	12	26	13	0.8	0.4	0.2	0.1	1.4	5.90	4.98	21.2	23.2	7	78	1.12	38.8	0.32	1.13
	350	B1.1	15 – 53	4	29	67	4.2	3.8	0.98	0.11	9	21	5	0.4	0.2	0.1	0.1	0.7	5.44	4.37	16.4	20.6	4	86	1.21	12.4	0.21	0.34
	351	B1.2	53 – 87				4.5	3.7	0.54	0.09	6	12	5	0.3	0.1	0.1	0.1	0.3	4.31	3.51	14.2	–	2	92	0.74	–	–	–
	352	B2.1	87 – 140				4.7	3.8	0.34	0.07	5	7	5	0.2	0.1	0.1	0.1	0.2	3.90	3.08	13.0	–	2	94	0.95	–	–	–
8	AU – Bd – 5.I																											
	195252	A1	0 – 4	3	33	64	4.3	3.6	3.13	0.24	13	41	10	0.2	0.1	0.1	0.1	0.3	10.08	6.26	26.4	28.3	1	95	0.81	219.5	0.50	0.46
	253	B2.1	4 – 22	3	33	64	4.7	3.7	1.55	0.16	10	15	6	0.2	0.1	0.1	0.1	0.3	9.36	6.31	22.3	28.4	1	95	1.09	176.0	0.42	0.84
	254	B2.2	22 – 45	2	31	67	4.9	3.8	0.86	0.12	7	10	4	0.1	0.1	0.1	0.1	0.1	8.34	5.49	20.0	26.4	1	98	1.13	71.6	0.41	0.75
	255	B3g	45 – 82	1	30	69	4.9	3.9	0.55	0.08	7	6	4	0.1	0.1	0.1	0.1	0.1	10.91	8.35	20.2	27.1	1	99	1.28	–	–	–
	256	BC	82 – 117	1	81	18	4.9	3.8	0.34	0.06	6	10	3	0.1	0.1	0.1	0.1	0.1	12.30	9.05	25.0	33.9	1	99	1.61	–	–	–
	257	C	117 – 300	24	66	70	5.0	3.7	0.22	0.03	7	89	12	0.2	0.1	0.2	0.1	0.5	6.74	4.85	23.4	22.8	2	91	0.95	–	–	–
	195276	Ap	0 – 8	12	33	56	4.5	3.9	3.53	0.31	11	56	24	1.0	0.4	0.5	0.0	1.9	4.80	3.81	20.9	20.8	9	67	0.62	23.6	0.23	0.53
	277	B2.1	8 – 22	19	24	57	4.4	3.9	1.15	0.14	8	10	9	0.1	0.1	0.2	0.0	0.4	5.38	4.60	16.9	24.5	2	92	0.88	11.6	0.23	0.49
	278	B2.2	22 – 49	7	22	65	4.5	3.8	0.76	0.10	8	5	7	0.1	0.1	0.1	0.0	0.3	6.37	5.65	17.3	24.9	2	95	0.95	7.2	0.32	0.84
	279	B2.3	49 – 74	10	22	68	4.4	3.8	0.43	0.08	5	14	7	0.1	0.1	0.1	0.0	0.3	6.46	5.66	15.5	21.2	2	95	0.82	–	–	–
	280	BC/C1	74 – 105	12	22	66	4.4	3.8	0.28	0.05	6	21	4	0.1	0.1	0.1	0.0	0.3	6.36	5.49	14.5	20.9	2	95	0.97	–	–	–
	281	C2	105 – 150	18	22	60	4.5	3.9	0.18	0.03	6	43	2	0.1	0.1	0.1	0.0	0.3	4.76	4.14	11.4	18.3	3	93	1.40	–	–	–
	195302	A1	0 – 11	4	33	63	4.5	3.8	2.68	0.23	12	21	5	0.2	0.2	0.1	0.0	0.3	6.75	5.54	22.6	24.6	1	95	1.14	113.1	0.42	0.30
	303	B2.1	11 – 39	4	35	61	4.7	3.9	1.12	0.14	8	13	3	0.1	0.1	0.1	0.0	0.3	6.42	5.46	18.9	26.1	2	95	1.38	113.6	0.36	0.30
	304	B 2.2	39 – 64	6	33	61	4.6	3.8	0.76	0.10	8	8	3	0.1	0.1	0.1	0.0	0.3	4.52	5.17	19.0	27.8	2	95	1.46	–	–	–
	305	B3	64 – 108	3	32	65	4.9	3.9	0.45	0.08	6	9	3	0.1	0.1	0.1	0.0	0.3	6.18	5.45	18.2	26.1	2	95	1.53	–	–	–
	306	BgC	108 – 140	3	34	63	4.6	3.7	0.29	0.06	5	8	2	0.1	0.1	0.1	0.1	0.3	9.08	8.05	20.3	30.8	1	96	1.66	–	–	–
	195344	A1	0 – 26	15	25	62	4.4	3.9	2.90	0.24	12	32	10	0.8	0.2	0.2	0.0	1.2	7.22	3.85	23.8	21.6	3	85	0.57	0.0	0.45	0.34
	345	B1	26 – 50	10	22	68	3.3	3.9	0.89	0.10	9	18	4	0.1	0.1	0.1	0.6	4.1	4.14	3.41	17.5	21.7	3	88	1.16	0.0	0.25	0.20
	346	B2.1	50 – 85	10	21	69	4.3	3.8	0.54	0.08	7	22	4	0.5	0.1	0.1	0.1	0.8	4.11	3.59	17.5	22.5	2	92	0.91	0.0	0.21	0.26
	347	B2.2	85 – 122	11	26	63	4.4	3.9	0.37	0.07	5	22	4	0.3	0.2	0.1	0.1	0.6	3.45	3.45	17.1	25.1	2	91	1.30	–	–	–
	348	B3	122 – 150	16	37	47	4.6	3.9	0.27	0.05	6	39	4	0.4	0.2	0.1	0.1	0.7	3.71	3.28	16.6	33.1	4	95	1.41	–	–	–
	195363	B1	0 – 14	3	26	71	4.6	3.7	1.03	0.14	7	10	8	0.3	0.2	0.1	0.1	0.3	6.39	5.66	18.3	21.8	2	95	0.60	220.1	0.31	0.41
	364	BCn	14 – 41	5	38	57	4.5	3.8	0.54	0.11	5	12	9	0.1	0.2	0.1	0.1	0.3	5.27	4.50	19.1	31.2	2	94	0.60	1828.2	0.31	0.32
	365	B3	41 – 78	2	29	69	4.4	3.6	0.34	0.08	4	3	6	0.1	0.2	0.1	0.1	0.5	8.44	7.52	18.3	25.4	3	94	0.53	–	–	–
	366	BC	78 – 100	2	36	62	4.4	3.7	0.25	0.06	4	3	5	0.1	<0.1	0.1	<0.1	0.2	8.86	7.73	17.7	27.3	1	97	0.53	–	–	–
	367	C	100 – 160	5	39	56	4.6	3.7	0.16	0.04	4	5	4	0.2	0.1	0.1	0.1	0.5	7.49	5.56	16.8	29.1	3	92	0.53	–	–	–

Appendix 3B (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
9	AU – Bd – 6.I																											
	195333	Ap	0 – 3	9	33	58	4.5	3.7	3.28	0.27	12	23	15	1.9	0.5	0.4	0.2	3.0	6.23	5.35	21.4	21.9	14	64	0.88	12.3	0.25	0.18
	334	B1	3 – 19	9	36	56	4.1	3.7	2.33	0.19	12	9	6	0.5	0.1	0.1	0.1	0.7	7.56	6.47	21.4	27.1	3	90	1.02	0.0	0.21	0.18
	335	B2.1	19 – 46	6	32	62	4.1	3.7	1.06	0.11	10	6	6	0.3	0.1	0.1	0.1	0.4	8.04	6.70	19.8	27.4	3	89	0.97	0.0	0.21	0.11
	336	B2.2	46 – 74	5	26	69	4.2	3.7	0.70	0.09	8	3	5	0.3	0.1	<0.1	0.0	0.4	9.33	8.58	19.5	25.7	2	96	1.10	–	–	–
	337	B3g	74 – 110	3	41	56	4.4	3.7	0.41	0.06	7	4	7	0.4	0.1	0.1	0.1	0.6	10.14	9.21	19.1	32.1	3	94	1.23	–	–	–
	338	C	110 +	1	37	62	4.7	3.7	0.25	0.05	5	2	13	1.0	0.3	0.1	0.1	1.5	10.63	10.65	20.4	31.7	7	88	1.13	–	–	–
	195353	AB	0 – 14	3	32	65	4.0	3.7	2.24	0.21	11	23	6	0.1	0.1	0.1	0.1	0.3	8.34	6.86	23.0	26.3	1	96	0.70	24.9	0.42	0.61
	354	B1.1	14 – 33	2	21	77	4.5	3.8	0.95	0.13	7	12	5	0.1	0.1	0.1	0.1	0.1	6.33	5.32	18.7	21.0	1	98	0.71	19.7	0.31	0.77
	355	B1.2	33 – 60	2	25	73	4.5	3.8	0.68	0.12	6	7	6	0.1	0.1	0.1	0.1	0.1	6.49	5.46	17.6	21.6	2	98	0.64	–	–	–
	356	B2.2	60 – 89	1	30	69	4.5	3.7	0.48	0.09	5	9	6	0.1	0.1	0.1	0.1	0.3	8.02	7.30	18.5	24.9	2	96	0.67	–	–	–
	357	BC	89 – 132	2	30	68	4.5	3.7	0.41	0.08	5	16	6	0.1	0.1	0.1	0.1	0.3	6.81	5.69	20.0	27.5	2	95	0.67	–	–	–
	358	C	132 – 150	3	57	40	4.5	3.8	0.21	0.07	3	12	14	0.1	0.1	0.3	0.1	0.6	10.79	-5.71	18.7	45.2	3	90	0.92	–	–	–
10	TU – Pc – 5.I																											
	195291	A1	0 – 2	23	8	69	3.9	3.6	5.35	0.32	17	17	6	0.3	0.1	0.1	0.0	0.5	7.00	5.57	23.2	13.2	2	90	0.78	0.0	0.13	0.07
	292	B1	2 – 17	12	19	69	4.3	4.0	1.81	0.15	12	5	3	0.1	0.1	0.1	0.0	0.3	4.39	3.49	15.2	15.1	2	92	0.14	4.5	0.10	0.20
	293	B2.1	17 – 56	19	8	73	4.2	4.0	0.95	0.10	10	3	2	0.2	0.1	0.1	0.0	0.4	3.09	2.34	10.8	11.2	4	95	1.48	0.6	0.05	0.01
	294	B2.2	56 – 94	19	6	75	4.4	4.0	0.61	0.07	9	2	1	0.1	0.1	0.1	0.0	0.2	3.08	2.33	9.6	10.7	2	92	0.83	–	–	–
	295	BC	94 – 130	23	10	67	4.5	4.0	0.40	0.04	10	6	1	0.3	0.2	<0.1	<0.1	0.5	2.01	2.04	8.8	8.6	6	80	0.89	–	–	–
	296	C	130 +	28	24	48	4.5	3.9	0.24	0.03	8	2	1	0.2	0.1	<0.1	0.0	0.3	3.21	2.70	8.0	15.4	4	90	0.77	–	–	–
11	VU – Lo – 3.I																											
	195368	Ap	0 – 12	13	13	74	4.5	3.8	3.25	0.24	14	17	6	0.1	0.2	0.1	<0.1	0.4	4.62	3.67	19.3	14.5	2	87	0.66	29.4	0.16	0.08
	369	B1	12 – 40	9	8	83	4.0	3.8	1.31	0.13	10	11	4	0.1	0.1	0.1	0.0	0.3	3.13	2.96	12.6	11.2	2	91	0.81	4.9	0.16	0.03
	370	B2.1	40 – 79	9	8	83	4.1	3.8	0.85	0.09	9	10	3	0.1	0.1	0.1	<0.1	0.2	3.00	2.32	9.9	9.3	2	92	0.86	–	–	–
	371	B2.2	79 – 120	10	9	81	4.2	3.8	0.65	0.08	8	9	3	0.1	0.1	<0.1	0.0	0.2	2 67	2.24	9.2	9.2	2	92	0.81	–	–	–
	372	BC	120 – 150	8	7	85	4.3	3.9	0.51	0.09	6	7	3	0.1	0.1	<0.1	<0.1	0.2	2.64	2.30	9.0	9.1	2	92	0.95	–	–	–

Appendix 4A : Mineral composition of the sand fraction of the semi – detailed survey area.

SRI. SRI	Fraction	Opaque	Zircon	Turbid quartz	Transparent quartz	Iron concretion	SiO_2 Organic	Zeolite	Hydrargillite	Weathered mineral	Rock Fragment	Volcanic glass	Oligoclase	Int. Plagioclase	Basic Plagioclase	Orthoclase	Sanidine	Muscovite	Biotite	Green amphibole	Brown amphibole	Augite	Hypersthene	Basaltine	Zelosite	Epidote	Tourmaline	Andalusite	Orthite	Kaolinite	Garnet
Mapping Unit 1																															
AE – Jd – 3.I																															
195480	IV	–	–	37	–	2	sp	–	–	3	34	7	–	3	–	4	6	sp	1	2	–	–	1	–	–	sp	–	–	–	–	–
481	IV	1	–	34	–	4	–	–	–	6	31	2	–	5	–	11	1	sp	2	1	–	1	1	–	–	–	–	–	–	–	–
482	IV	–	–	25	2	3	2	–	–	13	39	8	–	1	–	2	1	–	–	2	–	–	1	–	–	1	–	–	–	–	–
483	IV	–	–	29	3	–	1	sp	–	4	39	1	–	6	–	4	4	sp	4	4	–	–	1	–	–	–	–	–	–	–	–
484	IV	3	–	13	1	4	–	–	–	5	52	6	–	6	–	1	2	–	2	2	–	sp	3	–	–	–	–	–	–	–	–
AE – Jd – 5.I																															
195528	IV	1	sp	38	–	10	3	–	–	4	29	5	–	1	–	1	6	1	sp	sp	–	–	1	–	–	–	–	–	–	–	–
529	IV	–	–	20	1	24	–	–	–	1	35	6	–	1	–	2	8	–	–	1	–	–	sp	–	–	–	–	–	–	1	–
530	IV	–	–	35	–	15	–	sp	sp	12	22	2	1	1	1	1	3	1	–	4	–	–	–	–	–	sp	–	–	–	2	–
531	IV	1	–	37	1	2	–	–	1	10	29	3	–	1	–	4	6	–	2	3	–	–	sp	–	–	–	–	–	–	sp	–
Mapping Unit 2								N o t s a m p l e d																							
Mapping Unit 3																															
AE – Jd – 8.I																															
195469	IV	1	–	47	2	1	7	–	–	1	25	1	–	4	–	3	3	–	–	2	–	–	3	–	–	–	–	–	–	–	–
470	IV	1	–	37	1	2	5	–	–	1	29	3	1	1	–	11	2	–	–	4	–	1	1	–	–	sp	–	–	–	–	–
471	IV	2	–	33	2	1	4	–	–	7	31	1	2	2	–	3	5	–	–	4	–	2	1	–	–	–	–	–	–	–	–
472	IV	1	–	35	1	2	–	–	–	10	32	1	1	2	–	5	3	–	–	1	–	1	2	–	–	sp	sp	–	–	3	sp
473	IV	2	–	34	2	3	–	–	–	5	42	1	2	2	–	1	1	–	–	–	–	2	2	–	–	–	–	–	–	1	–
474	IV	3	–	26	3	3	–	–	–	7	44	–	–	5	–	5	1	–	–	sp	–	sp	3	–	–	sp	–	–	–	–	sp
AU – Jd – 9.1																															
195524	IV	1	–	29	20	7	13	1	–	7	8	3	–	3	–	–	2	–	2	sp	–	3	–	–	–	–	–	–	–	1	–
525	IV	2	–	40	13	11	9	sp	–	–	10	sp	1	sp	–	–	3	–	10	sp	–	1	–	–	–	–	sp	–	–	sp	–
526	IV	–	sp	40	20	20	3	–	–	8	1	1	–	–	–	–	3	–	2	sp	–	1	–	–	–	–	–	–	–	1	–
527	IV	1	–	18	–	54	1	sp	–	14	5	1	1	–	sp	–	3	–	sp	–	–	–	–	–	–	–	–	–	–	1	–
Mapping Unit 4																															
AC – Jd – 3.I																															
195282	IV	7	–	58	–	5	1	sp	–	11	5	2	sp	sp	–	–	7	–	–	1	1	–	sp	–	–	sp	sp	–	–	2	–
283	IV	12	–	54	3	4	sp	sp	–	14	4	sp	1	–	–	–	7	–	–	–	sp	–	–	–	–	sp	sp	–	–	1	–
284	IV	7	–	45	–	4	–	1	–	18	13	–	–	–	–	–	5	–	–	sp	1	–	–	–	–	–	–	–	–	6	–
285	IV	5	–	38	1	7	–	–	–	28	13	–	–	–	–	–	4	–	–	sp	1	sp	–	–	–	–	sp	–	–	3	–
286	IV	2	–	32	3	4	–	1	1	25	13	–	–	–	–	–	7	–	–	–	1	–	–	–	–	–	sp	–	–	11	–
AC – Jd – 5.I																															
195475	IV	sp	–	65	–	4	sp	–	–	4	13	1	–	–	–	5	7	–	–	1	–	–	sp	–	–	–	–	–	–	–	–
476	IV	1	–	63	–	4	1	–	–	8	15	1	–	–	–	2	4	1	–	–	–	–	sp	–	–	–	–	–	–	–	–
477	IV	1	–	49	2	4	–	–	–	15	12	1	1	–	–	6	8	–	–	sp	–	–	–	–	–	–	–	–	–	1	–
478	IV	1	–	48	1	7	–	–	–	12	17	–	1	–	–	3	7	–	2	–	–	–	–	–	–	–	–	–	–	1	–
479	IV	7	–	23	–	8	1	sp	–	16	18	1	sp	–	–	2	12	–	3	1	1	–	sp	–	–	–	–	–	–	1	–
195510	IV	2	–	57	2	7	2	–	1	9	8	–	sp	sp	–	2	5	–	–	sp	–	–	2	–	–	–	–	sp	–	3	–
511	IV	3	–	30	1	35	sp	sp	–	17	5	2	–	–	–	–	3	sp	–	–	–	–	–	–	–	–	–	–	–	4	–
512	IV	4	–	51	2	19	–	sp	–	8	11	1	–	–	–	–	4	–	–	–	sp	sp	–	–	–	–	–	–	–	–	–
513	IV	–	–	40	–	15	–	–	–	6	14	–	1	–	–	1	10	1	–	–	–	–	sp	–	–	–	–	–	–	12	–
514	IV	–	–	19	–	35	–	–	–	20	14	–	–	–	–	–	5	1	–	1	–	–	–	–	–	–	sp	–	–	5	–

Appendix 4A (continued)

SRI No.	Fraction	Opaque	Zircon	Turbid quartz	Transparent quartz	Iron concretion	SiO_2 Organic	Zeolite	Hydrargilite	Weathered mineral	Rock Fragment	Volcanic glass	Oligoclase	Int. Plagioclase	Basic Plagioclase	Orthoclase	Sanidine	Muscovite	Biotite	Green amphibole	Brown amphibole	Augite	Hypersthene	Basaltine	Zelosite	Epidote	Tourmaline	Andalusite	Orthite	Kaolinite	Garnet
Mapping Unit 5																															
AU – Bd – 2.I																															
195297	IV	4	–	53	1	3	sp	1	–	19	15	1	–	–	–	–	2	–	–	–	–	–	sp	–	–	–	–	–	–	1	–
298	IV	4	–	61	3	3	sp	1	–	13	10	2	–	–	–	–	1	–	–	–	–	sp	–	–	sp	–	–	–	–	2	–
299	IV	1	–	54	1	4	–	sp	–	23	11	1	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	3	–
300	IV	1	–	31	1	13	1	–	–	22	18	2	–	–	–	–	sp	–	–	–	–	–	–	–	–	–	sp	–	–	11	–
301	IV	3	sp	34	1	11	–	–	–	25	16	–	–	–	–	–	sp	–	–	–	–	–	–	–	–	–	–	–	–	10	–
195349	IV	2	–	78	2	9	sp	sp	–	5	2	–	–	–	–	–	1	–	–	–	sp	–	–	–	–	–	–	sp	–	1	–
350	IV	2	–	66	1	17	sp	–	–	2	8	–	–	–	–	–	2	–	–	–	sp	–	–	–	–	–	–	–	–	2	–
351	IV	–	–	63	1	23	1	–	–	5	6	–	–	–	–	–	sp	–	–	sp	sp	–	–	–	–	–	–	sp	–	1	–
352	IV	1	–	53	1	23	1	sp	sp	2	16	–	–	–	–	–	1	–	–	–	–	–	sp	–	–	–	–	–	–	2	–
195532	IV	2	–	45	14	6	6	–	–	20	1	2	sp	–	–	–	2	–	–	sp	–	sp	sp	–	–	–	sp	–	–	2	–
533	IV	1	–	46	17	4	6	1	–	18	3	1	–	–	–	–	2	–	–	–	–	–	sp	–	–	–	–	–	–	1	–
534	IV	4	–	40	18	2	3	–	–	28	2	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	1	–
535	IV	4	–	30	13	2	sp	–	–	47	2	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–
AU – Bd – 3.I																															
195500	IV	7	sp	24	4	26	4	–	sp	26	4	sp	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	3	–
501	IV	11	sp	30	7	14	3	–	1	30	2	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–
502	IV	3	–	21	7	30	5	–	sp	27	5	sp	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–
503	IV	9	–	25	6	25	3	–	–	23	5	–	sp	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	1	–
504	IV	–	–	7	2	74	–	–	sp	11	3	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	1	–
195505	IV	4	–	66	5	2	5	–	1	5	10	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–
506	IV	3	–	66	3	2	–	–	sp	13	11	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–
507	IV	9	–	60	2	4	sp	–	sp	17	3	–	sp	–	–	–	3	–	–	–	–	–	–	–	–	–	sp	–	–	2	–
508	IV	4	–	55	5	7	1	1	–	16	7	–	–	–	–	–	sp	–	–	–	–	–	–	1	–	–	–	–	–	3	–
509	IV	2	–	36	1	13	sp	–	–	37	7	–	–	–	–	–	1	–	–	–	–	–	–	1	–	–	–	sp	–	2	–
AU – Bd – 5.I																															
195302	IV	1	–	59	4	7	1	–	–	13	9	4	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–
303	IV	–	–	61	4	5	sp	sp	–	20	7	–	–	–	–	–	1	–	–	sp	–	–	–	–	–	–	–	–	–	2	–
304	IV	1	–	53	1	6	1	sp	–	15	9	1	–	–	–	–	3	–	–	–	–	–	sp	–	–	–	–	sp	–	10	–
305	IV	1	–	47	6	8	sp	sp	–	21	11	sp	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	5	–
306	IV	–	–	46	6	9	–	–	–	23	11	–	–	–	–	–	sp	–	–	–	–	–	–	–	–	–	–	–	–	5	–
195344	IV	8	–	41	6	11	sp	–	2	20	7	sp	–	–	–	–	2	–	–	sp	sp	–	–	–	–	–	–	sp	–	3	–
345	IV	1	–	40	3	18	1	1	–	25	5	–	–	–	–	–	2	–	–	–	–	–	sp	–	–	–	–	–	–	3	–
346	IV	2	–	42	2	8	sp	–	–	23	13	–	–	–	–	–	4	–	–	4	1	–	–	–	–	–	–	–	–	5	–
347	IV	–	–	33	1	21	1	–	sp	32	9	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–
348	IV	3	–	15	2	40	–	sp	2	27	7	–	–	–	–	–	sp	–	–	–	sp	–	–	–	–	–	–	–	–	4	–
AU – Bd – 6.1																															
195333	IV	sp	–	74	2	7	sp	1	–	7	7	sp	–	–	–	–	2	–	–	–	–	–	–	–	–	sp	–	–	–	sp	–
334	IV	–	–	80	2	2	1	–	–	2	6	–	sp	–	–	–	4	–	–	–	–	–	sp	–	–	sp	–	–	–	3	–
335	IV	–	–	73	3	4	–	sp	sp	1	14	1	–	–	–	–	2	–	–	–	–	–	sp	–	–	–	sp	sp	–	2	–
336	IV	–	–	68	4	7	1	–	sp	2	10	1	–	–	–	–	1	–	–	–	–	–	sp	–	–	–	–	–	–	6	–
337	IV	–	–	40	–	31	–	–	–	–	10	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	17	–
338	IV	–	–	18	5	60	–	1	–	2	5	1	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	5	–
Mapping Unit 6																															
AU – Pc – 5.I																															
195515	IV	3	sp	15	79	sp	1	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	sp	–	–	–	–	–	–		
516	IV	–	sp	22	73	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	–	–	–	–	–	–	sp	–	–	
517	IV	–	2	16	77	–	–	–	–	–	1	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	1	–
518	IV	1	sp	13	79	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	–	–	–	–	–	–	–	–	2	–
195519	IV	sp	sp	19	76	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
520	IV	–	1	21	71	–	–	–	–	–	1	–	–	–	–	–	6	–	–	–	–	–	–	–	–	–	–	sp	–	–	–
521	IV	2	sp	17	76	–	–	–	–	1	–	–	–	–	–	–	4	–	–	–	–	–	–	–	–	–	–	sp	–	–	–
522	IV	1	sp	25	70	sp	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
523	IV	3	–	10	58	22	–	–	–	2	3	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–

Appendix 4A (continued)

SRI No.	Fraction	Opaque	Zircon	Turbid quartz	Transparent quartz	Iron concretion	SiO_2 Organic	Zelosite	Hydrargilite	Weathered mineral	Rock Fragment	Volcanic glass	Oligoclase	Int. Plagioclase	Basic plagioclass	Orthoclase	Sanidine	Muscovite	Biotite	Green amphibole	Brown amphibole	Augite	Hypersthene	Basaltine	Zelosite	Epidote	Tourmaline	Andalusite	Orthite	Kaolinite	Garnet
AU – Gd – 8.I																															
195328	IV	6	sp	66	24	—	sp	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	sp	—	—	—	—	1	—
329	IV	2	sp	62	35	—	sp	—	—	—	sp	sp	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	sp	—	sp	—
330	IV	4	sp	54	35	—	sp	—	—	—	2	1	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
331	IV	4	1	65	28	—	sp	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	sp	—
332	IV	4	sp	58	37	sp	—	—	—	—	1	—	—	—	—	—	sp	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mapping Unit 7																															
TU – Pc – 5.I																															
195287	IV	6	sp	72	18	1	1	—	—	—	—	—	—	—	—	—	2	—	—	sp	—	—	sp	—	—	—	—	—	—	—	—
288	IV	6	sp	63	18	4	2	—	—	—	3	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
289	IV	3	—	67	23	4	1	1	—	sp	—	—	—	—	—	—	1	—	—	—	—	—	—	—	sp	—	—	—	—	—	—
290	IV	5	sp	65	23	3	1	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	1	—	sp	—	—	—	—
195291	IV	1	sp	75	19	1	1	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	sp	—	sp	—	sp	1	—
292	IV	1	sp	80	16	sp	1	—	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	sp	—	—	—	—	—	—
293	IV	4	sp	69	26	1	sp	—	—	—	—	—	—	—	—	—	sp	—	—	—	—	—	—	—	sp	—	—	—	—	sp	—
294	IV	4	sp	61	30	1	1	—	—	—	sp	—	—	—	—	—	2	—	—	—	—	sp	—	—	—	—	sp	—	—	1	—
295	IV	3	sp	78	9	5	1	—	—	1	1	—	—	—	—	—	sp	—	—	—	—	—	—	—	sp	—	1	sp	—	1	—
296	IV	3	sp	85	1	9	—	—	—	1	—	—	—	—	—	—	sp	—	—	—	—	—	—	—	sp	—	—	—	—	1	—
195485	IV	2	sp	65	24	2	5	—	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	sp	—	—	—	—	—	—	—
486	IV	3	sp	70	22	1	sp	—	sp	1	—	—	—	—	—	—	3	—	—	—	—	—	sp	—	—	—	—	—	—	—	—
487	IV	2	—	72	22	1	—	sp	sp	—	2	—	—	—	—	—	1	—	—	sp	—	—	—	—	—	—	—	—	—	—	—
488	IV	1	sp	64	25	5	1	—	—	—	2	—	—	—	—	—	2	—	—	—	—	—	—	sp	—	—	—	sp	—	—	—
489	IV	1	sp	76	17	4	sp	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mapping Unit 8																															
VU – Lc – 3.I																															
195495	IV	3	sp	36	46	2	11	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	sp	—	—	—
496	IV	3	sp	30	61	—	2	—	—	—	1	—	—	—	—	—	2	—	1	—	—	—	—	—	—	—	—	sp	—	—	—
497	IV	1	1	44	47	1	2	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	3	—
498	IV	3	sp	31	59	2	sp	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	3	—
499	IV	9	1	30	49	—	—	—	—	—	1	—	—	—	—	—	sp	—	—	—	—	—	—	—	—	—	—	—	—	10	—
VU – Lo – 3.I																															
195368	IV	7	sp	66	27	sp	3	—	—	—	—	—	—	—	—	—	3	—	—	—	sp	—	—	—	—	—	—	—	—	—	—
369	IV	7	—	65	16	3	7	—	—	—	—	sp	—	—	—	—	2	—	—	—	sp	—	—	—	—	—	—	—	—	—	—
370	IV	6	—	61	27	2	sp	—	—	2	—	sp	—	—	—	—	1	—	—	—	sp	—	—	—	—	—	—	—	—	1	—
371	IV	7	sp	61	24	3	1	—	—	1	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	1	—
372	IV	6	sp	65	26	1	—	—	—	sp	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	sp	—
Mapping Unit 9																															
VU – Lc – 3.I																															
195490	IV	18	—	46	25	3	2	—	—	4	—	—	—	—	—	—	sp	—	—	—	—	—	—	2	—	—	—	—	sp	—	—
491	IV	10	—	46	18	1	5	—	—	16	1	—	—	—	—	—	2	—	—	—	—	—	—	1	—	—	—	sp	—	—	—
492	IV	18	sp	53	17	2	—	—	—	6	1	—	—	—	—	—	sp	—	1	—	—	—	—	2	—	—	sp	—	sp	—	—
493	IV	19	—	60	13	2	1	—	—	3	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—
494	IV	10	—	65	13	3	sp	—	—	8	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	sp	—	—	—	—
VU – Lo – 3.I																															
195318	IV	28	sp	64	3	—	2	—	—	—	1	sp	—	—	—	—	sp	—	—	—	—	—	—	1	—	—	—	—	—	1	—
319	IV	22	—	57	17	1	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	sp	1	sp	—	—	—	sp	sp	—
320	IV	22	—	55	9	2	1	sp	—	2	1	—	—	—	—	—	2	—	—	—	—	—	—	6	—	—	—	—	—	sp	—
321	IV	13	—	68	6	1	1	—	—	8	—	—	—	—	—	—	1	—	—	—	—	—	sp	2	—	—	—	—	—	—	—
322	IV	18	—	57	8	3	2	—	—	4	—	—	—	—	—	—	1	—	—	—	—	—	—	4	—	—	—	—	—	3	—

Appendix 4B : Mineral composition of the sand fraction of the detailed survey area

SRI No.	Fraction	Opaque	Zircon	Turbid quartz	Transparent quartz	Iron concretion	SiO2 Organic	Zeolite	Hydrargilite	Weathered mineral	Rock Fragment	Volcanic glass	Oligoclase	Int. Plagioclase	Basic Plagioclase	Orthoclase	Sanidine	Muscovite	Biotite	Green amphibole	Brown amphibole	Augite	Hypersthene	Basaltine	Orthite	Zelosite	Epidote	Tourmaline	Andalusite	Kaolinite
Mapping Unit 1																														
AO – Hf–9.h																														
195359	IV	3	–	32	–	1	4	–	–	21	18	–	–	–	11	2	sp	1	–	–	2	–	1	4	–	–	–	–	–	–
360	IV	3	–	17	–	–	–	1	–	10	23	sp	–	–	32	4	2	–	–	–	1	–	2	3	–	–	–	–	–	2
361	IV	1	–	20	1	1	–	sp	–	35	9	1	–	–	23	–	1	sp	–	–	1	–	2	3	–	–	–	–	–	2
362	IV	1	–	4	3	–	–	–	–	37	10	1	–	–	36	–	3	–	–	–	–	–	1	4	–	–	–	–	–	–
Mapping Unit 2						Not sampled																								
Mapping Unit 3																														
AU – Gd – 7.I																														
195264	IV	2	–	52	2	9	3	–	1	10	12	1	–	sp	–	–	3	–	–	–	sp	sp	sp	–	–	–	–	–	sp	5
265	IV	–	–	49	–	17	4	1	–	8	12	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	7
266	IV	2	–	40	2	28	1	sp	–	2	14	2	–	sp	–	–	1	–	–	sp	–	sp	sp	–	–	–	–	–	–	8
267	IV	–	–	20	–	21	–	sp	–	9	5	–	–	–	–	–	sp	–	–	–	–	–	–	–	–	–	–	–	–	45
268	IV	–	–	21	–	20	–	–	1	17	6	–	–	–	–	–	sp	–	–	–	–	–	sp	–	–	–	–	–	–	35
269	IV	–	–	26	1	10	–	–	2	21	7	–	–	–	–	–	1	–	–	sp	–	–	–	–	–	–	–	–	–	32
195339	IV	1	–	70	3	1	5	sp	sp	1	14	1	–	–	–	–	2	–	–	–	–	sp	1	–	–	–	–	sp	–	1
340	IV	–	–	62	1	4	2	1	1	7	15	sp	sp	sp	–	–	6	–	–	–	–	–	sp	–	–	–	–	–	–	1
341	IV	2	–	60	–	9	1	–	–	–	17	1	–	–	–	–	3	–	–	–	–	sp	sp	–	–	–	–	–	–	7
342	IV	–	–	23	1	55	sp	1	sp	7	6	–	–	–	–	–	1	–	–	–	–	sp	–	–	–	–	–	–	–	6
343	IV	–	–	32	–	14	–	–	–	11	10	2	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	24
Mapping Unit 4																														
AU – Gd – 8.I																														
195323	IV	2	–	60	–	3	1	sp	–	–	23	sp	–	sp	–	–	1	–	–	–	–	sp	–	sp	–	–	–	sp	–	10
324	IV	1	–	62	1	5	5	sp	–	1	10	3	–	–	–	–	sp	–	–	–	–	–	sp	–	–	–	–	–	–	12
325	IV	sp	–	53	3	14	3	2	–	2	12	3	–	–	–	–	1	–	–	–	–	–	–	sp	–	–	–	–	–	7
326	IV	–	–	14	1	62	–	sp	–	–	5	–	sp	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	18
327	IV	–	–	1	–	75	–	sp	–	1	–	1	–	–	–	–	–	–	–	–	–	–	sp	–	–	–	–	–	–	22
Mapping Unit 5																														
AC – Bd – 3.I																														
195258	IV	12	–	31	3	4	sp	–	2	30	14	sp	–	–	–	–	2	–	–	sp	1	–	1	–	–	–	–	–	–	sp
259	IV	12	–	33	–	9	sp	–	5	29	7	–	–	–	–	–	4	–	–	sp	1	–	sp	–	–	–	–	–	–	–
260	IV	12	–	22	2	8	–	sp	6	36	9	–	–	–	–	–	3	–	–	–	2	–	–	–	–	–	–	–	–	–
261	IV	6	–	25	–	11	–	–	10	34	9	–	–	–	–	–	2	–	–	–	1	–	sp	–	–	–	–	–	–	2
262	IV	13	–	10	–	9	–	–	13	38	7	–	–	–	–	–	2	–	–	–	6	–	–	–	–	–	–	–	–	2
263	IV						Not sampled																							
195307	IV	21	–	30	2	5	–	–	–	30	7	–	–	–	–	–	2	–	–	–	sp	sp	1	–	–	–	–	sp	–	2
308	IV	15	–	22	3	4	2	–	–	27	20	1	1	–	–	–	1	–	–	–	sp	–	sp	–	–	–	–	–	–	4
309	IV	11	sp	30	–	5	–	–	1	30	13	1	–	–	–	–	5	–	–	sp	1	–	–	–	–	–	–	–	–	3
310	IV	7	–	19	3	2	sp	–	–	52	7	1	–	–	–	–	4	–	–	–	sp	–	sp	–	–	–	–	–	–	5
311	IV	2	–	21	1	2	–	–	1	55	8	–	–	–	–	–	3	–	–	–	sp	–	–	–	–	–	–	–	–	7

Appendix 4B (continued)

SRI No.	Fraction	Opaque	Zircon	Turbid quartz	Transparent quartz	Iron concretion	SiO2 Organic	Zeolite	Hydrargillite	Weathered mineral	Rock Fragment	Volcanic glass	Oligoclase	Int. Plagioclase	Basic Plagioclase	Orthoclase	Sanidine	Muscovite	Biotite	Green amphibole	Brown amphibole	Augite	Hypersthene	Basaltine	Orthite	Zelosite	Epidote	Tourmaline	Andalusite	Kaolinite
Mapping Unit 6																														
AC – Bd – 5.I																														
195270	IV	2	–	41	2	13	1	–	–	20	11	sp	sp	sp	–	–	1	–	–	1	–	–	sp	–	–	–	–	–	–	8
271	IV	2	–	55	3	12	2	–	–	11	12	1	–	–	–	–	sp	–	–	–	–	sp	–	–	–	–	–	–	–	2
272	IV	–	–	45	3	10	sp	2	–	20	13	1	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	4
273	IV	–	–	32	1	33	sp	–	–	9	5	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	18
274	IV	–	–	24	–	15	–	2	–	23	11	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	23
275	IV	1	–	25	–	13	–	–	2	26	11	–	–	–	–	–	sp	–	–	–	–	–	–	–	–	–	–	–	–	22
195312	IV	6	sp	47	5	3	1	2	–	19	11	sp	–	–	–	–	3	–	–	–	–	–	sp	–	–	–	–	–	–	3
313	IV	3	–	45	3	12	sp	–	–	19	10	–	–	–	–	–	5	–	–	–	–	–	–	–	–	–	–	–	–	3
314	IV	2	–	48	2	8	1	–	–	17	18	sp	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	4
315	IV	1	–	37	1	11	1	–	–	18	18	1	–	–	–	–	4	–	–	–	–	–	–	–	–	sp	–	–	–	8
316	IV	2	–	16	–	13	–	–	–	46	5	–	–	–	–	–	sp	–	–	–	–	–	–	–	–	–	–	–	–	18
317	IV	5	–	23	–	23	–	1	–	29	7	sp	–	–	–	–	3	–	–	sp	–	–	–	–	–	sp	–	–	–	4
Mapping Unit 7																														
AU – Bd – 2.I																														
195247	IV	3	–	59	1	8	1	sp	1	7	16	1	–	–	–	–	1	–	–	sp	–	sp	1	–	–	–	–	–	–	1
248	IV	–	–	65	4	8	1	sp	1	7	8	1	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	2
249	IV	1	–	41	–	12	4	–	–	6	31	3	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
250	IV	2	–	36	–	24	sp	–	2	14	15	2	–	sp	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	4
251	IV	–	–	24	1	11	sp	1	1	40	14	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	7
195297	IV	4	–	53	1	3	sp	1	–	19	15	1	–	–	–	–	2	–	–	–	–	–	sp	–	–	–	–	–	–	1
298	IV	4	–	61	3	3	sp	1	–	13	10	2	–	–	–	–	1	–	–	–	–	sp	–	sp	–	–	–	–	–	2
299	IV	1	–	54	1	4	–	sp	–	24	11	1	–	–	–	–	2	–	–	–	–	–	–	–	–	sp	–	–	–	3
300	IV	1	–	31	1	13	1	–	–	22	18	2	–	–	–	–	sp	–	–	–	–	–	–	–	–	–	–	sp	–	11
301	IV	3	sp	34	1	11	–	–	–	25	16	–	–	–	–	–	sp	–	–	–	–	–	–	–	–	–	–	–	–	10
195349	IV	2	–	78	2	9	sp	sp	–	5	2	–	–	–	–	–	1	–	–	–	sp	–	–	–	–	–	–	–	sp	1
350	IV	2	–	66	1	17	sp	–	–	2	8	–	–	–	–	–	2	–	–	–	sp	–	–	–	–	–	–	–	–	2
351	IV	–	–	63	1	23	1	–	–	5	6	–	–	–	–	–	sp	–	–	sp	sp	–	–	–	–	–	–	–	sp	1
352	IV	1	–	53	1	23	1	sp	sp	2	13	–	–	–	–	–	1	–	–	–	–	sp	–	–	–	–	–	–	–	2
Mapping Unit 8																														
AU – Bd – 5.I																														
195252	IV	–	–	54	4	17	7	–	–	3	7	2	–	sp	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	5
253	IV	3	–	43	1	22	7	sp	–	10	11	sp	–	sp	–	–	sp	–	–	–	–	–	–	–	–	–	–	–	–	3
254	IV	1	–	36	3	44	4	–	sp	8	2	sp	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
255	IV	–	–	39	5	28	2	sp	–	5	13	sp	–	–	–	–	3	–	–	sp	–	–	sp	–	–	–	–	sp	–	5
256	IV	–	–	34	–	45	sp	–	–	10	4	sp	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	6
257	IV	26	–	12	–	5	–	–	10	33	6	–	–	–	–	–	1	–	–	sp	1	–	2	–	–	–	sp	–	–	4
195276	IV	3	–	81	2	3	2	–	–	sp	3	1	–	–	–	–	5	–	–	–	–	–	–	–	–	–	–	–	–	–
277	IV	1	–	93	–	sp	–	–	–	–	3	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	sp	–	–
278	IV	2	–	73	4	9	2	–	sp	3	2	sp	–	–	–	–	5	–	–	–	–	–	–	–	–	–	–	–	–	sp
279	IV	–	–	62	3	27	sp	–	–	sp	4	–	–	–	–	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–
280	IV	–	sp	64	3	21	sp	–	–	4	4	–	–	–	–	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–
281	IV	1	–	52	1	42	–	sp	–	1	1	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–

Appendix 4B (continued)

SRI No.	Fraction	Opaque	Zircon	Turbid quartz	Transparent quartz	Iron concretion	SiO2 Organic	Zeolite	Hydrargilite	Weathered mineral	Rock Fragment	Volcanic glass	Oligoclase	Int. Plagioclase	Basic Plagioclase	Orthoclase	Sanidine	Muscovite	Biotite	Green amphibole	Brown amphibole	Augite	Hypersthene	Basaltine	Orthite	Zelosite	Epidote	Tourmaline	Andalusite	Kaolinite
195302	IV	1	–	59	4	7	1	–	–	13	9	4	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
303	IV	–	–	61	4	5	sp	sp	–	20	7	–	–	–	–	–	1	–	–	sp	–	–	–	–	–	–	–	–	–	2
304	IV	1	–	53	1	6	1	sp	–	15	9	1	–	–	–	–	3	–	–	–	–	–	sp	–	–	–	–	–	sp	10
305	IV	1	–	47	6	8	sp	sp	–	21	11	sp	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	5
306	IV	–	–	46	6	9	–	–	–	23	11	–	–	–	–	–	sp	–	–	–	–	–	–	–	–	–	–	–	–	5
195344	IV	8	–	41	6	11	sp	–	2	20	7	sp	–	–	–	–	2	–	–	sp	sp	–	–	–	–	–	–	–	sp	3
345	IV	1	–	40	3	18	1	1	–	25	6	–	–	–	–	–	2	–	–	–	–	–	sp	–	–	–	–	–	–	3
346	IV	2	–	42	2	8	sp	–	–	23	13	–	–	–	–	–	4	–	–	4	1	–	–	–	–	–	–	–	–	5
347	IV	–	–	33	1	21	1	–	sp	32	9	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
348	IV	3	–	15	2	40	–	sp	2	27	7	–	–	–	–	–	sp	–	–	–	sp	–	–	–	–	–	–	–	–	4
195363	IV	sp	–	64	–	18	3	sp	–	3	10	1	sp	–	–	–	1	sp	–	–	sp	–	–	–	–	–	–	sp	–	–
364	IV	–	–	26	–	68	sp	–	–	–	5	–	sp	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
365	IV	–	–	50	–	40	1	sp	–	4	3	sp	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
366	IV	–	–	40	–	42	–	–	–	7	8	–	–	–	–	–	1	–	–	–	sp	–	–	–	–	–	–	–	–	2
367	IV	sp	–	48	–	21	–	sp	–	9	13	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	8
Mapping Unit 9																														
AU – Bd – 6.I																														
195333	IV	sp	–	74	2	7	sp	1	–	7	7	sp	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	sp
334	IV	–	–	80	2	2	1	–	–	2	6	–	sp	–	–	–	4	–	–	–	–	–	sp	–	–	–	–	–	–	3
335	IV	–	–	73	3	4	–	sp	sp	1	14	1	–	–	–	–	2	–	–	–	–	–	sp	–	–	–	sp	–	–	2
336	IV	–	–	68	4	7	1	–	sp	2	10	1	–	–	–	–	1	–	–	–	–	–	sp	–	–	–	sp	sp	sp	6
337	IV	–	–	40	–	31	–	–	–	–	10	1	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	17
338	IV	–	–	18	5	60	–	1	–	2	5	1	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	5
195353	IV	1	–	67	5	4	4	–	2	8	3	2	sp	sp	–	–	1	–	–	sp	–	sp	1	–	–	–	sp	sp	–	2
354	IV	sp	–	54	1	10	2	–	–	26	4	–	–	–	–	–	1	–	–	–	–	sp	–	–	–	–	–	–	–	2
355	IV	1	sp	50	3	10	1	–	1	23	8	1	–	–	–	–	1	sp	–	–	–	–	–	–	–	–	–	–	–	1
356	IV	3	–	28	2	11	2	–	sp	43	6	sp	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	2
357	IV	–	–	19	1	8	–	–	–	66	3	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	1
358	IV	–	–	12	1	7	–	sp	–	70	8	–	–	–	–	–	sp	–	–	–	–	–	–	–	–	–	–	–	–	2
Mapping Unit 10																														
TU – Pc – 5.I																														
195291	IV	1	sp	75	19	1	1	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	sp	sp	–	sp	–	1
292	IV	1	sp	80	16	sp	1	–	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	sp	–	–	–	–
293	IV	4	sp	69	26	1	sp	–	–	–	–	–	–	–	–	–	sp	–	–	–	–	–	–	–	–	sp	–	–	–	sp
294	IV	4	sp	61	30	1	1	–	–	–	sp	–	–	–	–	–	2	–	–	–	–	sp	–	–	–	–	–	sp	–	1
295	IV	3	sp	78	9	5	1	–	–	1	1	–	–	–	–	–	sp	–	–	–	–	–	–	–	..	sp	–	1	sp	1
296	IV	3	sp	85	1	9	–	–	–	1	–	-	–	–	–	–	sp	–	–	–	–	–	–	–	–	sp	–	–	–	1
Mapping Unit 11																														
VU – Lo – 3.I																														
195368	IV	7	sp	66	21	sp	3	–	–	–	–	–	–	–	–	–	3	–	–	–	sp	–	–	–	–	–	–	–	–	–
369	IV	7	–	65	16	3	7	–	–	–	–	sp	–	–	–	–	2	–	–	–	sp	–	–	–	–	–	–	–	–	–
370	IV	6	–	61	27	2	sp	–	–	2	–	sp	–	–	–	–	1	–	–	–	sp	–	–	–	–	–	–	–	–	1
371	IV	7	sp	61	24	3	1	–	–	1	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	1
372	IV	6	sp	65	26	1	–	–	–	sp	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	sp

Appendix 5. Placement for comparison of tentative soil series in the Sitiung - S. Jujuhan soil survey according to Great Soil Group as used in Indonesia, the USDA system of soil classification and the units of the Soil Map of the World

Number	Soil series	M. Soepraptohardjo 1)	USDA Soil Taxonomy, 1975 2)	FAO/UNESCO, Units Soil map of the World 3)
1.	AO - Hf - 9 h	Mesotrophic Organosols	Sapric Terric Tropofibrists	Dystric Histosols
2.	AE - Jd - 3 1	Yellowish Brown Alluvial soils	Tropofluvents, fine silty over coarse silty, mixed, isohyperthermic	Eutric Fluvisols
3.	AE - Jd - 5 1	Brown Alluvial soils	Tropofluvents, stratified, fine silty, mixed, isohyperthermic	Eutric Fluvisols
4.	AE - Jd - 8 1	Yellowish Brown Alluvial soils	Tropic Fluvaquents/Aeric Tropaquepts, stratified, fine clayey, mixed, isohyperthermic	Dystric Gleysols
5.	AL - Jd - 3 1	Brown Alluvial soils	Tropofluvents, stratified, loamy, mixed, isohyperthermic	Eutric Fluvisols
6.	AC - Jd - 3 1	Brown Alluvial soils	Tropofluvents, stratified, clayey, mixed, isohyperthermic	Eutric Fluvisols
7.	AC - Jd - 5 1	Yellowish Brown Alluvial soils	Fluventic Dystropepts, fine silty over clayey, mixed, isohyperthermic	Dystric Cambisols
8.	UA - Jd - 8 1	Yellowish Brown Alluvial soils	Tropic Fluvaquents/Aeric Tropaquepts, stratified, fine clayey, mixed, isohyperthermic	Dystric Gleysols
9.	AU - Jd - 9 1	Gray Alluvial soils	Tropic Fluvaquents, stratified, fine clayey, mixed, isohyperthermic	Dystric Gleysols
10.	AU - Gd - 7 1	Grayish Brown Low Humic Gley soils	Dystric Tropaquepts, stratified, fine clayey, mixed, isohyperthermic	Dystric Gleysols
11.	AU - Gd - 8 1	Gray Low Humic Gley soils	Typic Tropaquults, fine clayey, mixed, isohyperthermic	Gleyic Acrisols
12.	AC - Bd - 3 1	Brown Tropical Soils/Acid Brown Forest Soils	Oxic Dystropepts, stratified, clayey, mixed, isohyperthermic	Dystric Cambisols
13.	AC - Bd - 5 1	(Yellowish Brown) Brown Tropical Soils/Acid Brown Forest Soils	Typic Dystropepts, stratified, clayey, mixed, isohyperthermic	Dystric Cambisols
14.	AU - Bd - 2 1	(Yellowish Red) Brown Tropical Soils/Acid Brown Forest Soils	Oxic Dystropepts, stratified, fine clayey and clayey, mixed, isohyperthermic	Dystric Cambisols
15.	AU - Bd - 3 1	Brown Tropical Soils/Acid Brown Forest Soils	Oxic Dystropepts, stratified, fine clayey, mixed, isohyperthermic	Dystric Cambisols
16.	AU - Bd - 5 1	(Yellowish Brown) Brown Tropical Soils/Acid Brown Forest Soils	Aeric Tropaquults, fine clayey, mixed, isohyperthermic	Gleyic Acrisols
17.	AU - Bd - 6 1	(Yellowish Brown) Brown Tropical Soils/Acid Brown Forest Soils	Aeric Tropaquults, fine clayey, mixed, isohyperthermic	Gleyic Acrisols
18.	AU - Pc - 5 1	Yellowish Brown Podzolic soils	Orthoxic Tropudults, fine clayey, kaolinitic, isohyperthermic	Ferric Acrisols
19.	TU - Pc - 5 1	Yellowish Brown Podzolic soils	Orthoxic Tropudults, fine clayey, kaolinitic, isohyperthermic	Ferric Acrisols
20.	VU - Lo - 3 1	Yellowish Brown Latosols (Oxic Latosols)	Tropeptic Haplorthox, fine clayey, kaolinitic, isohyperthermic	Xanthic Ferralsols
21.	VU - Lc - 3 1	Brown Latosols (Chromic Latosols)	Typic Haplorthox, fine clayey, kaolinitic, isohyperthermic	Orthic Ferralsols

1) Sistim klasifikasi tanah di Balai Penyelidikan Tanah, M.Soepraptohardjo, Bogor, 1961

2) Soil Taxonomy. A basic system of soil classification for making and interpreting soil survey. USDA, Soil Con. Service, 1973. Agricultural Handbook No. 436.

3) Key to soils units for the Soil Map of the World. R.Dudal. FAO/UNESCO, Rome, 1970

Appendix 6. Permeability, bulk density and moisture characteristics of some soil series of the Sitiung – S. Jujuhan area.

Sample No.		Soil series	Depth (cm)	B.D. (g/cc)	Total pore space (% vol.)	Moisture content (% vol)				Drainage pore (% vol.)		Available water (% vol.)	Permeability (cm/hr)
SRI.	Field					10 cm pF 1	100 cm pF 2	1/3 atm pF 2.54	15 atm pF 4.2	Quick	Slow		
1	2	3	4	5	6	7	8	9	10	11	12	13	14
7831	WT 1/I	AU–Bd–5 I	0 – 5	1.11	58.11	57.64	51.84	47.37	32.20	6.27	4.47	15.17	0.03
7832	II		25 – 30	0.98	63.02	61.81	57.30	51.72	38.02	5.72	5.58	13.70	1.06
7833	WT 2/I	AU–Bd–2 I	0 – 5	1.11	58.11	57.68	52.83	48.69	35.04	5.28	4.17	13.65	0.22
7834	II		20 – 25	1.02	61.51	58.82	53.76	49.08	36.39	7.75	4.68	12.69	0.14
7835	III		+ 90										0.60
7836	WT 3/I	AU–Gd–7 I	0 – 5	0.92	65.28	59.95	55.42	50.57	36.70	5.33	4.85	13.87	1.05
7837	II		15 – 20	1.13	57.36	56,57	52.20	47.21	34.80	5.16	4.99	12.41	0.42
7838	III		+ 80										2.42
7839	WT 4/I	AC – Bd – 3 I	0 – 5	1.01	61.89	60.75	56.15	51.88	34.45	5.74	4.27	17.43	2.09
7840	II		20 – 25	1.04	60.75	59.54	54.88	49.49	36.55	5.87	5.39	12.94	1.35
7841	III												0.64
7842	WT 5/I	AC – Bd – 5 I	5 – 10	1.08	59.24	58.89	54.85	50.40	35.24	4.39	4.45	15.16	2.14
7843	II		25 – 30	0.97	63.40	61.24	56.00	51.90	38.32	7.40	4.10	13.58	0.32
7344	III		+100										1.07
7845	WT 7/I	AC – Bd – 3 I	13 – 15	0.99	62.64	53.23	48.81	44.90	32.66	13.83	3.91	12.24	1.42
7846	II		30 – 35	1.03	61.13	56.47	51.27	46.66	32.61	9.86	4.61	14.05	0.41
7847	III		70 – 75										
7848	WT 8/I	AC–Bd–5 I	26 – 31	1.00	62.26	54.42	49.01	45.22	32.42	13.25	3.79	12.80	2.67
7849	II		46 – 51	0.98	63.02	55.04	50.27	45.79	34.52	12.75	4.48	11.27	1.03
7850	III		83 – 88										1.64
7851	WT 9/I	AC–Bd–5 I	0 – 13	1.06	60.00	56.50	52.01	47.46	35.02	7.99	4.55	12.44	1.02
7852	II		37 – 42	1.02	61.51	57.43	51.85	47.77	36.19	9.66	4.08	12.58	0.90
7853	III		64 – 69										2.24
7854	WT 10/I	AU–Bd–2 I	0 – 5	0.94	64.53	48.95	45.21	41.24	29.17	19.32	3.97	12.07	3.20
7855	II		33 – 38	0.95	64.15	52.03	47.45	43.41	31.62	16.70	4.04	11.79	2.43
7856	III		93 – 98										3.00
7857	WT 11/I	AU–Bd– 5 I	0 – 5	0.92	65.28	51.52	48.06	43.87	31.08	17.22	4.19	12.79	4.00
7858	II		20 – 25	1.05	60.38	58.60	52.70	48.17	34.06	7.68	4.53	14.11	
7859	III		–	1.09	58.87	55.87	50.33	46.02	34.68	8.54	4.31	11.34	2.44
7860	IV												5.88
7861	WT 12/I	AU–Bd–3 I	0 – 5	0.89	66.41	50.04	46.05	42.24	30.02	20.36	3.81	12.22	1.78
7862	II		30 – 35	0.97	63.40	54.59	49.96	45.30	33.89	13.44	4.66	11.41	0.48
7863	III												1.33
7864	WT 13/I	VU–Lo–3 I	0 – 5	0.80	69.81	45.58	39.88	36.63	26.83	29.93	3.25	9.80	8.90
7865	II		10 – 15	0.92	65.28	50.43	46.15	42.34	31.98	19.13	3.81	10.36	4.47
7866	III		40 – 45										5.31
7867	WT 14/I	TU–Pc–5 I	0 – 5	0.98	63.02	53.20	48.63	44.83	32.88	14.39	3.80	11.95	1.13
7868	II		10 – 15	1.04	60.75	58.54	53.46	49.62	37.67	7.29	3.84	11.95	0.95
7869	III		46 – 51										1.54
7870	WT 15/I	AU–Bd–2 I	0 – 5	1.08	59.24	58.02	52.52	47.82	35.74	6.72	4.70	12.08	0.16
7871	II		10 – 15	1.07	59.62	55.68	50.32	45.86	33.87	9.30	4.46	11.99	0.16
7872	III		40 – 45										0.38
7873	T 20/I	VU–Lo–3 I	0 – 20	0.96	63.77	53.09	47.58	43.50	32.68	16.19	4.08	10.82	0.76
7874	II		20 – 40	0.97	63.40	56.85	51.42	47.17	34.13	11.98	4.25	13.04	1.19
7875	MS 27/I	AU–Bd–6 I	0 – 20	1.04	60.75	60.06	54.22	50.23	36.50	6.53	3.99	13.73	0.66
7876	III		20 – 40	1.16	56.23	55.97	50.48	46.45	35.53	5.75	4.03	10.92	0.40
7877	SK 28/I	AU–Bd–5 I	0 – 20	1.08	59.24	57.89	53.23	48.74	33.91	6.01	4.49	14.83	0.26
7878	II		20 – 40	1.08	59.24	58.00	53.14	49.19	35.74	6.10	3.95	13.45	1.38

Appendix 7. Stability index and Atterberg value of some soil series of the Sitiung - S. Jujuhan area

Sample No.		Soil series	Depth (cm)	Aggregate (%)	Stability index	Atterberg value		
SRI	Field					Liquid limit	Plastic limit	Plasticity index
7831	WT 1/I	AU-Bd-5 1	0-5	75.49	117.65	65.75	46.23	19.52
7832	II		25-30	85.26	64.94	75.40	55.63	19.77
7833	WT 2/I	AU-Bd-2 1	0-5	81.74	81.31	79.80	49.57	30.23
7834	II		20-25	75.30	70.42	79.80	48.27	31.53
7836	WT 3/I	AU-Gd-7 1	0-5	81.82	263.16	85.50	60.63	24.87
7837	II		15-20	81.26	133.33	69.15	41.43	27.72
7839	WT 4/I	AC-Bd-3 1	0-5	84.25	216.76	64.85	46.30	18.55
7840	II		20-25	57.28	344.83	71.85	49.13	22.72
7842	WT 5/I	AC-Bd-5 1	5-10	76.48	88.50	67.45	46.23	21.22
7843	II		25-30	82.05	49.50	89.70	59.87	29.83
7845	WT 7/I	AC-Bd-3 1	13-15	74.76	68.97	67.90	44.76	23.14
7846	II		30-35	68.13	71.94	70.40	44.70	25.70
7848	WT 8/I	AC-Bd-5 1	26-31	83.36	54.64	82.80	52.07	30.73
7849	II		46-51	73.01	53.76	87.30	52.63	34.67
7851	WT 9/I	AC-Bd-5 1	8-13	83.39	78.13	84.30	49.93	34.37
7852	II		37-42	73.12	66.67	93.80	50.53	43.27
7854	WT 10/I	AU-Bd-2 1	0-5	75.03	46.30	110.30	51.27	59.03
7855	II		33-38	82.82	100.00	97.60	45.40	52.20
7857	WT 11/I	AU-Bd- 5 1	0-5	73.12	106.38	75.40	45.07	30.33
7858	II		20-25	73.97	81.30	79.50	45.67	33.83
7861	WT 12/I	AU-Bd-3 1	0-5	76.30	62.89	80.65	45.77	34.88
7862	II		30-35	79.76	54.35	82.10	44.83	37.27
7864	WT 13/I	VU-Lo-3 1	0-5	77.96	84.75	76.20	44.33	31.87
7865	II		8-13	80.94	78.74	78.50	44.43	34.07
7867	WT 14/I	TU-Pc-3 1	0-5	75.15	188.68	70.55	46.37	24.18
7868	II		10-15	77.16	106.38	77.30	46.57	30.73
7870	WT 15/I	AU-Bd-2 1	0-5	75.35	133.33	68.85	44.83	24.02
7871	II		10-15	71.04	45.45	76.85	49.87	26.98

Appendix 8. Infiltration rate (cm/hour) of some soils of the Sitiung – S. Jujuhan area

Time (minute)	AU-Bd-5 I WT_1/SK_2	AU-Bd-2 I WT_2/SK_1	AU-Gd-7 I WT_3/T_1	AC-Bd-3 I WT_4/MS_1	AC-Bd-5 I WT_5/MS_3	AC-Bd-5 I WT_6/T_2	AC-Bd-3 I WT_7/SK_4	AC-Bd-5 I WT_8/SK_6	AU-Bd-2 I WT_{10}/SK_{12}	AU-Bd-5 I WT_{11}/SK_9	AU-Bd-3 I WT_{12}/MD_{10}	VU-Lo-3 I WT_{13}/MS_{12}	TU-Pc-5 I WT_{14}/MS_{17}	AU-Bd-2 I WT_{15}/SK_{16}
5	3.90	3.96	405.66	76.38	17.14	3.40	4.07	2.55	4.69	6.45	3.91	177.09	5.43	6.11
15	2.72	1.22	237.42	39.25	9.34	1.40	1.02	1.02	2.94	3.56	1.36	137.20	1.95	1.78
30	0.96	0.61	240.17	33.95	6.90	0.38	0.77	0.96	1.04	3.34	0.96	125.60	1.22	0.87
60	0.96	0.50	214.15	32.25	7.07	0.26	0.49	0.23	0.33	1.95	0.54	105.66	1.19	0.33
90	0.91	0.31	231.97	32.26	5.40	0.20	0.37	0.28	0.24	1.41	0.30	92.41	0.34	0.33
150	0.34	0.31	229.14	32.36	4.64	0.20	0.31	0.21	0.24	1.50	0.14	92.86	0.11	0.16
210	–	0.31	229.63	–	5.09	0.11	0.18	0.04	0.22	1.22	0.12	83.24	0.11	0.08
270	–	0.17	219.17	–	5.16	0.05	0.14	0.04	0.09	1.13	0.12	78.17	0.11	0.03
330	–	0.08	216.27	–	4.57	0.05	0.14	0.04	0.09	1.41	0.12	48.80	0.11	0.03
390	–	–	196.68	–	4.89	0.05	0.11	0.04	0.10	–	–	–	–	0.03

Appendix 9 .Criteria of soil chemical data

Factors	Very low	Low	Medium	High	Very high
C (%)	<1.00	1.00 - 2.00	2.01 - 3.00	3.01 - 5.00	>5.00
N (%)	<0.10	0.10 - 0.20	0.21 - 0.50	0.51 - 0.75	>0.75
C/N	< 5	5 - 10	11 - 15	16 - 20	> 20
P_2O_5 HCl (mg/100 g)	< 10	10 - 20	21 - 40	41 - 60	> 60
P_2O_5 Olsen (mg/100 g)	< 5	5 - 10	11 - 15	16 - 25	> 25
K_2O HCl (mg/100 g)	< 10	10 - 20	21 - 40	41 - 60	> 60
K_2O Olsen (mg/100 g)	< 5	5 - 10	11 - 15	16 - 25	> 25
CEC soil (me/100 g)	< 5	5 - 12	13 - 25	26 - 40	> 40
Cation composition:					
K (me/100 g)	< 0.2	0.2 - 0.3	0.4 - 0.5	0.6 - 1.0	>1.0
Na (me/100 g)	< 0.1	0.1 - 0.3	0.4 - 0.7	0.8 - 1.0	>1.0
Ca (me/100 g)	< 2	2 - 5	6 - 10	11 - 20	>20
Mg (me/100 g)	< 0.3	0.4 - 1	1.1 - 3	3.1 - 8	> 8
Base saturation (%)	<20	20 - 40	41 - 60	61 - 80	81-100
Mineral reserve (%)	< 5	5 - 10	11 - 20	21 - 40	>40

pH (H_2O) value

<4.5	4.6-5.0	5.1-5.5	5.6-6.0	6.1-6.5	6.6-7.3	7.4-7.8	7.9-8.4	8.5-9.0
Extremely acid	Very strongly acid	Strongly acid	Medium acid	Slightly acid	Neutral	Mildly alkaline	Moderately alkaline	Strongly alkaline

Morgan-Venema value (ppm)

Criteria	Ca	Mg	K	Mn	Al	Fe	P	NH_4	NO_3	SO_4	Cl
Very high	>572	>60	>58	>23	>40	>56	>13	>21	>20	>400	>600
High	286	23	36	9	21	19	9	8	10	250	325
Medium	143	6	21	3	8	5	3	3	4	100	100
Low	107	4	12	1	3	3	3	2	2	40	50
Very low	< 71	< 2	<8	<1	<1	<1	<1	<2	<1	<20	<30

Appendix 10. The criteria to evaluate the soil physical characteristics

1. Aeration pores

%	Class
<5	very low
5 - 10	low
10 - 15	medium
>15	high

2. Available water pores

%	Class
<5	very low
5 - 10	low
10 - 15	medium
15 - 20	high
>20	very high

3. Plasticity

Index	Class
< 10	very low
10 - 20	low
20 - 30	medium
> 30	high

4. Aggregate stability

index	Class
>80	very good
80 - 65	good
65 - 50	medium
50 - 40	bad
<40	very bad

5. Permeability

cm/hr	Class
<0.125	very slow
0.125 - 0.5	slow
0.5 - 2.0	moderately slow
2.0 - 6.35	moderate
6.35 - 12.7	moderately rapid
12.7 - 25.4	rapid
> 25.4	very rapid

Appendix 11 . Rating of soil properties and environment for soil suitability classes .

1. Plant nutrient content

Plant nutrient content includes available N, P (as P_2O_5) and exchangeable K (as K_2O) in kg/ha.

N (kg/ha)	Rating	P_2O_5 (kg/ha)	Rating	K_2O (kg/ha)	Rating
>145	1.00	>75	1.00	>300	1.00
100-145	0.95	60 - 75	0.95	240 - 300	0.95
80 - 100	0.85	50 - 60	0.85	160 - 240	0.85
40 - 80	0.75	40 - 50	0.75	110 - 160	0.75
< 40	0.60	< 40	0.60	50 - 110	0.60
				< 50	0.55

- For rubber the rating value should be one degree higher than these figures.
- Rating of the plant nutrient content = Add ratings of N, P_2O_5 and K_2O then divided by 3.

2. Macro relief (slope)

Slope	Rating for	
	Arable	Rubber
0 - 2%	1.00	1.00
3 - 8%	0.95	1.00
9 - 15%	0.85	0.90
16 - 30%	0.70	0.70
31 - 45%	0.45	0.50
> 45%	0.15	0.25

3. Micro relief

Amplitude	Rating for	
	Arable	Rubber
0 - 0.25 m	1.00	1.00
0.26 - 0.50 m	0.95	1.00
0.51 - 1.00 m	0.85	0.90
1.01 - 1.50 m	0.80	0.80

4. Drainage

Condition	Rating for		
	Arable		Rubber
	H_4H_5	H_2H_3	
- Waterlogging, water table almost reaches the surface all year round (hydromorphic surface horizon at a death of 30 cm or less) - Waterlogging for periods from 2-4 months	0.10	0.40	0.05
- Water table being sufficiently close to the surface to harm deep rooting plants (hydromorphic horizon surface at a depth of 30 - 60 cm) - Waterlogging for periods from a day to 2 months	0.40	0.80	0.10
- Good drainage, water table sufficiently low not to impede crop growing (hydromorphic horizon over a depth of 60 cm below the surface) - Possible waterlogging for brief period (flooding) less than 8 days each time	0.80	0.90	0.40-0.60
- Well drained soil, deep water table (hydromorphic horizon at over 120 cm below the surface), no waterlogging in profile	1.00		1.00

5. Soil moisture content

Condition			Rating for	
			Arable	Rubber
H_1	Rooting zone below wilting point all the year round		0.05	0.05
H_2	Rooting zone below wilting point for 9 to 11 months of the year			
	H_{2a}	11 months	0.10	0.10
	H_{2b}	10 months	0.20	0.10
	H_{2c}	9 months	0.40	0.10
H_3	Rooting zone below wilting point for 6 to 8 months of the year			
	H_{3a}	8 months	0.50	0.10
	H_{3b}	7 months	0.60	0.20
	H_{3c}	6 months	0.70	0.40
H_4	Rooting zone below wilting point for 3 to 5 months and wet below field capacity for over 6 months of the year			
	H_{4a}	5 months	0.80	0.70
	H_{4b}	4 months	0.90	0.90
	H_{4c}	3 months	1.00	1.00
H_5	Rooting zone wet above wilting point and below field capacity for most of the year		1.00	1.00

6. Base saturation

Base saturation	Rating for	
	Arable	Rubber
< 15%	0.40	0.80
15 - 35%	0.50	0.90
35 - 50%	0.60	1.00
50 - 75%	0.80	1.00
75 -100%	1.00	1.00
> 100% (calcareous)	0.80	0.80

7. Organic matter (O.M.) content of the surface soil

Organic matter	Rating for	
	Arable	Rubber
$>5\%$	1.00	1.00
2 - 5%	0.95	1.00
1 - 2%	0.90	0.95
$<1\%$	0.85	0.90

8. Thickness of organic matter of soil profile

Organic matter	Rating for	
	Arable	Rubber
<10 cm	0.75	0.60
10 - 30 cm	0.95	0.85
30 - 50 cm	1.00	1.00
>50 cm	0.95	0.85

9. Texture and structure

The texture and structure are evaluated together with soil moisture regime.

T_1 Pebbly, stony or gravelly soil

T_{1a} Pebbly, stony or gravelly >60 percent by weight

T_{1b} Pebbly, stony or gravelly from 40 to 60 percent

T_{1c} Pebbly, stony from 20 to 40 percent

T_2 Extremely coarse textured soil

T_{2a} Pure sand of particle structure

T_{2b} Extremely coarse textured soil (>45 percent coarse sand)

T_{2c} Soil with non-decomposed raw humus (>30 percent organic matter), and fibrous structure

T_3 Dispersed clay of unstable structure (often $\frac{Na}{T}$ >15 percent)

T_4 Light textured soil, fine sand, loamy sand of light sandy loam, or coarse sand and silt

T_{4a} Unstable structure

T_{4b} Stable structure

T_5 Heavy textured soil: clay or silty clay

T_{5a} Massive to large prismatic structure

T_{5b} Angular to crumb structure or massive but highly poreous (e.g. soils with a high sesquioxide content)

T_6 Medium-heavy soil: heavy sandy loam, sandy clay, clay loam, silty clay loam or silt

T_{6a} Massive to large prismatic structure

T_{6b} Angular to crumb structure (or massive but poreous)

T_7 Soil average, balanced texture: loam, silt loam and sandy clay loam

Rating of texture/structure

Code	Rating for					
	Arable			Rubber		
T_{1a}	0.10			0.50		
T_{1b}	0.30			0.80		
T_{1c}	0.60			1.00		
	$H_4H_5H_6AB$	H_3	H_1H_2	$H_4H_5H_6AB$	H_3	H_1H_2
T_{2a}	0.10	0.10	0.10	0.10	0.10	0.10
T_{2b}	0.30	0.20	0.10	0.30	0.20	0.10
T_{2c}	0.30	0.30	0.30	0.30	0.30	0.30
T_3	0.30	0.20	0.10	0.30	0.20	0.10
T_{4a}	0.40	0.30	0.30	0.40	0.30	0.30
T_{4b}	0.50	0.50	0.60	0.50	0.50	0.50
T_{5a}	0.50	0.60	0.20	0.50	0.60	0.20
T_{5b}	0.80	0.80	0.60	0.80	0.80	0.60
T_{6a}	0.80	0.80	0.60	0.80	0.80	0.60
T_{6b}	0.90	0.90	0.90	0.90	0.90	0.90
T_7	1.00	1.00	1.00	1.00	1.00	1.00

10. Cation exchange capacity of clay (CEC)

C E C	Rating
>40 me / 100 gr clay	1.00
16 - 40 me / 100 gr clay	0.95
5 - 16 me / 100 gr clay	0.90
<5 me / 100 gr clay	0.80 - 0.85

11. Mineral reserve

Mineral reserve is counted from the percentage of weatherable minerals present in the sand fraction

Weathered mineral	Rating
High (from basic materials)	1.00
High (from acid materials)	0.95 - 1.00
High (from sandy materials)	0.90 - 0.95
Fair (from basic materials)	0.95 - 1.00
Fair (from acid materials)	0.90 - 0.95
Fair (from sandy materials)	0.85 - 0.90
Very low to nil (< 1%)	0.85

12. Effective soil depth

Effective soil depth is the depth of solum as limited by hard pan impermeable layer, gypsic horizon, lithic or paralithic contact etc.

Effective soil depth	Rating for	
	Arable	Rubber
0 - 15 cm	+	+
15 - 30 cm	0.50	0.25
30 - 60 cm	0.70	0.45
60 - 90 cm	0.90	0.60
90 -120 cm	1.00	0.90
>120 cm	1.00	1.00

Soil suitability classes for Arable crops/Rubber

Multiplication of all the resulting ratings (12 parameters) gives a final result, comparing this final result with the following rating, will arrive on certain soil suitability classes.

Class I	=	very well suited	=	>0.66
II	=	well suited	=	0.33 - 0.66
III	=	moderately well suited	=	0.18 - 0.33
IV	=	marginally suited	=	0.10 - 0.18
V	=	poorly suited	=	0.04 - 0.10
VI	=	not suited	=	<0.04

Appendix 12. Actual and Potential Soil Suitability Rating for Arable crops (A) and Rubber (R) of the Mapping Units in the Semi-Detailed Sitiung II - S. Jujuhan area

No.	Parameters	MU 1								MU 3								MU 4			
		195480/484 (MS.15)				195528/531 (T.11)				195469/474 (SK.18)				195524/527 (T. 9)				195282/286 (SK.13)			
		Act.		Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.	
		A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
1.	Plant nutrient content	0.85	0.85	0.85	0.85	0.75	0.75	0.85	0.85	0.65	0.65	0.85	0.85	0.65	0.65	0.85	0.85	0.75	0.75	0.85	0.85
2.	Macro relief/slope	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	1.00	1.00
3.	Micro relief	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	1.00	1.00	1.00	1.00
4.	Drainage	0.80	0.40	0.80	0.40	0.80	0.40	0.80	0.40	0.10	0.05	0.40	0.40	0.10	0.05	0.40	0.40	1.00	1.00	1.00	1.00
5.	Soil moisture content	1.00	0.70	1.00	0.90	1.00	0.70	1.00	0.90	0.50	0.10	0.80	0.40	0.50	0.10	0.60	0.40	1.00	1.00	1.00	1.00
6.	Base saturation	0.60	1.00	0.60	1.00	0.60	1.00	0.60	1.00	0.60	0.90	0.80	1.00	0.60	0.90	0.80	1.00	0.40	0.80	0.60	0.90
7.	Organic matter content	1.00	1.00	1.00	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.90	1.00	0.90	1.00
8.	Thickness of organic matter	0.95	0.85	0.95	0.85	1.00	1.00	1.00	1.00	0.95	0.85	0.95	0.85	0.95	0.85	0.95	0.85	0.95	0.85	0.95	0.85
9.	Texture/structure	0.90	0.90	0.90	0.90	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
10.	CEC	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
11.	Mineral reserve	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
12.	Effective soil depth	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Product	0.27	0.14	0.26	0.18	0.21	0.13	0.24	0.18	0.001	0.002	0.11	0.07	0.001	0.002	0.11	0.07	0.15	0.33	0.28	0.42
	Class	III	IV	III	IV	III	IV	III	IV	VI	VI	IV	V	VI	VI	IV	V	IV	III	III	II
	Subclass	IIIf	IVf	IIIf	IVf	IIIf	IVf	IIIf	IVf	VI	VI	IVfn	Vfn	VI	VI	IVfn	Vf	IVn	IIIn	IIIn	IIn

No.	Parameters	MU 4								MU 5											
		195475/479(MS.13)				195510/514(MD.11)				195297/301 (SK.16)				195500/504 (MS.24)				195505/509 (MD.10)			
		Act.		Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.	
		A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
1.	Plant nutrient content	0.75	0.75	0.85	0.85	0.60	0.60	0.85	0.85	0.75	0.75	0.85	0.85	0.70	0.70	0.85	0.85	0.75	0.75	0.85	0.85
2.	Macro relief/slope	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.	Micro relief	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.	Drainage	0.80	0.60	0.90	0.70	0.80	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.	Soil moisture content	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.	Base saturation	0.50	0.90	0.60	1.00	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90
7.	Organic matter content	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00
8.	Thickness of organic matter	0.95	0.85	0.95	0.85	1.00	1.00	1.00	1.00	0.75	0.60	0.95	0.85	0.95	0.85	0.95	0.85	0.95	0.85	0.95	0.85
9.	Texture/structure	0.90	0.90	0.90	0.90	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
10.	CEC	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
11.	Mineral reserve	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
12.	Effective soil depth	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Product	0.20	0.24	0.30	0.37	0.11	0.25	0.31	0.49	0.14	0.23	0.30	0.42	0.16	0.31	0.30	0.42	0.16	0.33	0.30	0.42
	Class	IV	III	III	II	IV	III	III	II	IV	III	III	II	IV	III	III	II	IV	III	III	II
	Subclass	IVn	IIIn	IIIn	IIn	IVn	IIIn	IIIn	IIn	IVn	IIIn	IIIn	IIn	IVn	IIIn	IIIn	IIn	IVn	IIIn	IIIn	IIn

Appendix 12. (continued)

Parameter	MU 5: 195349/352 (MD.28)				195532/536 (T.19)				195344/348 (MD.26)				195333/338 (MS.27)				195302/306 (SK.28)			
	Act.		Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.	
	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
1. PNC	0.65	0.65	0.85	0.85	0.75	0.75	0.85	0.85	0.70	0.70	0.85	0.85	0.70	0.70	0.85	0.85	0.65	0.65	0.85	0.85
2. Slp	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3. MiP	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4. Dr	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.60	1.00	0.70	0.90	0.40	1.00	0.60	0.90	0.60	1.00	0.80
5. SMC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.70	0.90	0.90	0.80	0.70	1.00	1.00	0.90	0.40	1.00	0.70
6. BS	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90
7. OM	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	1.00	0.95	0.95	1.00	0.95	1.00
8. TOM	0.75	0.60	0.95	0.85	0.95	0.85	0.95	0.95	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85
9. TeS	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
10. CEC	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
11. MR	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
12. ESD	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Product	0.10	0.20	0.33	0.42	0.17	0.33	0.30	0.42	0.08	0.09	0.25	0.26	0.08	0.09	0.31	0.24	0.10	0.05	0.30	0.23
Class	V	III	III	II	IV	III	III	II	V	V	III	III	V	V	III	III	V	V	III	III
Subclass	Vd	IIIn	IIId	IIn	IVn	IIIn	IIIn	IIn	Vd	Vd	IIId	IIId	Vn	Vd	IIId	IIId	Vn	Vd	IIIn	IIId

Parameter	MU 6: 196328/332 (MS.16)				195515/518 (MD.16)				195519/523	
	Act.		Pot.		Act.		Pot.		Act	
	A	R	A	R	A	R	A	R	A	R
1. PNC	0.75	0.75	0.85	0.85	0.65	0.65	0.85	0.85	0.70	0.70
2. Slp	0.95	1.00	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00
3. MiP	0.95	1.00	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00
4. Dr	0.10	0.05	0.80	0.40	1.00	1.00	1.00	1.00	0.10	0.05
5. SMC	0.80	0.70	0.90	0.60	1.00	1.00	1.00	1.00	0.50	0.10
6. BS	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80
7. OM	1.00	1.00	1.00	1.00	0.95	1.00	0.95	1.00	0.95	1.00
8. TOM	0.95	0.85	0.95	0.85	0.95	0.85	0.95	0.85	0.95	0.85
9. TeS	0.80	0.80	0.80	0.80	1.00	1.00	1.00	1.00	0.80	0.80
10. CEC	0.95	0.95	0.95	0.95	0.90	0.90	0.90	0.90	0.90	0.90
11. MR	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
12. ESD	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Product	0.008	0.002	0.20	0.10	0.14	0.27	0.28	0.40	0.007	0.002
Class	VI	VI	III	V	IV	III	III	II	VI	VI
Subclass	VI	VI	IIIn	Vfn	IVn	IIIn	IIIn	IIn	VI	VI

Parameter	MU 6: (MD.19)		MU 7: 195287/290 (SK.14)				195291/296 (SK.15)				195485/489 (MS.17)			
	Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.	
	A	R	A	R	A	R	A	R	A	R	A	R	A	R
1. PNC	0.85	0.85	0.60	0.60	0.75	0.75	0.70	0.70	0.85	0.85	0.70	0.70	0.85	0.85
2. Slp	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00
3. MiR	1.00	1.00	0.95	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00
4. Dr	0.80	0.40	0.80	0.60	1.00	0.80	0.80	0.60	1.00	0.80	0.80	0.60	1.00	0.80
5. SMC	1.00	0.40	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6. BS	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90
7. OM	0.95	1.00	0.90	1.00	0.90	1.00	0.95	1.00	0.95	1.00	0.90	1.00	0.90	1.00
8. TOM	0.95	0.85	0.95	0.85	0.95	0.85	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85
9. TeS	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
10. CEC	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
11. MR	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
12. ESD	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Product	0.21	0.06	0.09	0.15	0.20	0.28	0.08	0.12	0.26	0.32	0.08	0.12	0.23	0.30
Class	III	V	V	IV	III	III	V	IV	III	III	V	IV	III	III
Subclass	IIIf	Vfn	Vtn	IVsn	IIItn	IIIsn	Vtn	IVsn	IIItn	IIIsn	Vtn	IVsn	IIItn	IIIsn

Parameter	MU 8: 195495/499 (MS.22)				195368/372 (T.20)				MU 9: 195490/594 (MS.18)				195318/322 (MS.12)			
	Act.		Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.	
	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
1. PNC	0.65	0.65	0.70	0.95	0.65	0.65	0.70	0.85	0.70	0.70	0.80	0.85	0.60	0.60	0.75	0.85
2. Slp	0.85	0.90	0.85	0.95	0.25	0.90	0.85	1.00	0.70	0.70	0.75	0.85	0.70	0.70	0.75	0.75
3. MiR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4. Dr	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5. SMC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6. BS	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90
7. OM	0.90	1.00	0.90	1.00	0.90	1.00	0.90	1.00	0.90	1.00	0.90	1.00	0.95	1.00	0.95	1.00
8. TOM	0.75	0.60	0.90	0.85	0.75	0.60	0.90	0.85	0.75	0.60	0.90	0.85	0.95	0.85	0.95	0.85
9. TeS	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
10. CEC	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
11. MR	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
12. ESD	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Product	0.09	0.17	0.17	0.37	0.09	0.17	0.17	0.40	0.08	0.14	0.17	0.33	0.10	0.17	0.18	0.33
Class	V	IV	IV	II	V	IV	IV	II	V	IV	IV	III	V	IV	IV	III
Subclass	Vtn	IVtn	IVtn	IIt	Vtn	IVtn	IVtn	IItn	Vtn	IVtn	IVtn	IIItn	Vtn	IVtn	IVtn	IIItn

Note: PNC = Plant nutrient content; MiR = Micro relief; SMC = Soil moisture content; OM = Organic matter content; TeS= Texture/structure; MR = Mineral reserve;
Slp = Macro relief/slope; Dr = Drainage; BS = Base saturation; TOM= Thickness of organic matter; CEC= Cation exchange capacity; ESD= Effective soil depth.

Appendix 13. Actual and Potential Soil Suitability Rating for Arable crops (A) and Rubber (R) of the Soil Series (Mapping Units) in the Detailed sample blocks

No.	Parameters	AO-Hf-9.h				AU-Gd-7.1								AU-Gd-8.1				AC-Bd-3.1			
		195359/362 (T.4)				195264/269 (SK.5)				195339/343 (MD.6)				195323/327 (MS.8)				195258/263 (SK.4)			
		Act.	Pot.	Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.	
		A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
1.	Plant nutrient content	0.82	0.82	0.82	0.82	0.73	0.73	0.85	0.85	0.65	0.65	0.85	0.85	0.65	0.65	0.85	0.85	0.65	10.65	0.85	0.85
2.	Macro relief/slope	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.	Micro relief	0.95	1.00	0.95	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.	Drainage	0.10	0.05	0.10	0.05	0.10	0.05	0.80	0.40	0.10	0.05	1.00	0.40	0.10	0.05	0.80	0.40	1.00	1.00	1.00	1.00
5.	Soil moisture content	0.10	0.10	0.10	0.10	0.80	0.70	1.00	0.90	0.80	0.70	1.00	0.10	0.90	0.10	1.00	0.40	1.00	1.00	1.00	1.00
6.	Base saturation	0.50	0.90	0.50	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90
7.	Organic matter content	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00
8.	Thickness of organic matter	0.95	0.85	0.95	0.85	0.95	0.85	0.95	0.85	0.75	0.60	0.95	0.85	0.95	0.85	0.95	0.85	0.75	0.60	0.95	0.85
9.	Texture/structure	0.30	0.30	0.30	0.30	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
10.	CEC	0.95	0.95	0.95	0.95	0.95	1.00	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
11.	Mineral reserve	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
12.	Effective soil depth	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Product	0.001	0.001	0.001	0.001	0.01	0.01	0.24	0.15	0.14	0.10	0.30	0.15	0.01	0.03	0.24	0.07	0.12	0.20	0.30	0.42
	Class	VI	VI	VI	VI	VI	VI	III	IV	IV	V	III	IV	VI	VI	III	V	IV	III	III	II
	Subclass	VI	VI	VI	VI	VI	VI	IIIdn	IVds	IVd	Vd	IIIdn	IVds	VI	VI	IIIdn	Vds	IVn	IIIn	IIIn	IIn

No.	Parameters	AC-Bd-3.1				AC-Bd-5.1								AU-Bd-2.1							
		195307/311 (MS.1)				195270/275 (SK.6)				195312/317 (MS.3)				195247/251 (SK.1)				195297/301 (SK.16)			
		Act.		Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.	
		A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
1.	Plant nutrient content	0.70	0.70	0.85	0.85	0.68	0.68	0.85	0.85	0.65	0.65	0.85	0.85	0.65	0.65	0.85	0.85	0.65	0.65	0.85	0.85
2.	Macro relief/slope	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.	Micro relief	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.	Drainage	1.00	1.00	1.00	1.00	0.90	0.40	0.95	0.60	0.90	0.40	1.00	0.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5.	Soil moisture content	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.	Base saturation	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90
7.	Organic matter content	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.90	1.00	0.95	1.00
8.	Thickness of organic matter	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85
9.	Texture/structure	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
10.	CEC	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
11.	Mineral reserve	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
12.	Effective soil depth	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Product	0.13	0.22	0.30	0.42	0.11	0.08	0.30	0.25	0.11	0.08	0.30	0.25	0.13	0.23	0.33	0.47	0.13	0.23	0.33	0.47
	Class	IV	III	III	II	IV	V	III	III	IV	V	III	III	IV	III	III	II	IV	III	III	II
	Subclass	IVn	IIIn	IIIn	II n	IVn	Vdn	IIIn	IIIsn	IVn	Vdn	IIIn	IIIsn	IVn	IIIn	IIIn	IIn	IVn	IIIn	IIIn	IIn

Appendix 13. (continued)

No.	Parameters	AU-Bd-2.1				AU - Bd - 5.1															
		195349/352 MD.28)				195252/257 (SK.2)				195276/281 (SK.9)				195302/306 (SK.28)				195344/348 (MD.26)			
		Act.		Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.		Po		Pot.	
		A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
1.	Plant nutrient content	0.70	0.70	0.85	0.85	0.68	0.68	0.85	0.85	0.70	0.70	0.85	0.85	0.65	0.65	0.85	0.85	0.70	0.70	0.85	0.85
2.	Macro relief/slope	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3.	Micro relief	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.	Draingae	1.00	1.00	1.00	1.00	0.90	0.40	1.00	0.60	0.90	0.40	1.00	0.60	0.90	0.60	1.00	0.80	0.90	0.60	1.00	0.70
5.	Soil moisture content	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.40	1.00	0.70	0.80	0.70	0.90	0.90
6.	Base saturation	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90
7.	Organic matter content	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00
8.	Thickness of organic matter	0.95	0.85	0.95	0.85	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85
9.	Texture/structure	0.80	0.80	0.90	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
10.	CEC	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
11.	Mineral reserve	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
12.	Effective soil depth	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Product	0.16	0.31	0.33	0.42	0.11	0.09	0.30	0.25	0.11	0.10	0.30	0.25	0.10	0.05	0.30	0.23	0.09	0.09	0.27	0.26
	Class	IV	III	III	II	IV	V	III	III	IV	V	III	III	V	V	III	III	V	V	III	III
	Subclass	IVn	IIIn	IIIn	IIn	IVdn	Vdn	IIIn	III sn	IVdn	Vdn	IIIn	IIIsn	Vn	Vdn	IIIn	III sn	Vn	Vdn	IIIn	IIIsn

No.	Parameters	AU-Bd-5.1								AU-Bd-6.1				TU-Pc-5.1				VU-Lo-3.1			
		195363/367 (T.7)				195353/358 (T.2)				195333/338 (MS.27)				195291/296 (SK.15)				195368/372 (T.20)			
		Act.		Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.		Act.		Pot.	
		A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
1.	Plant nutrient content	0.65	0.65	0.85	0.85	0.70	0.65	0.85	0.85	0.70	0.70	0.85	0.85	0.70	0.70	0.85	0.85	0.65	0.65	0.85	0.85
2.	Macro relief/slope	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	1.00	0.85	0.90	0.95	1.00
3.	Micro relief	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4.	Drainage	0.90	0.40	1.00	0.60	0.90	0.40	1.00	0.60	0.90	0.40	1.00	0.60	0.80	0.60	1.00	0.80	1.00	1.00	1.00	1.00
5.	Soil moisture content	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6.	Base saturation	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90	0.40	0.80	0.60	0.90
7.	Organic matter content	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00	0.95	1.00
8.	Thickness of organic matter	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85	0.75	0.60	0.95	0.85
9.	Texture/structure	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
10.	CEC	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
11.	Mineral reserve	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
12.	Effective soil depth	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Product	0.11	0.08	0.30	0.25	0.12	0.08	0.30	0.25	0.12	0.08	0.30	0.25	0.09	0.12	0.28	0.32	0.10	0.17	0.27	0.40
	Class	IV	V	III	III	IV	V	III	III	IV	V	III	III	V	IV	III	III	III	IV	III	II
	Subclass	IVdn	Vdn	IIIn	IIIsn	IVdn	Vdn	IIIn	IIIsn	IVn	Vd	IIIn	IIIsn	Vtn	IVsn	IIIn	IIIsn	Vtn	IVtn	IIItn	IItn

Appendix 14 . Draft instruction for soil surveys of the Sitiung Transmigration Project Area

I. DRAFT Instructions for surveys of sample blocks

1. Six blocks will be soil surveyed in detail. These are 4 blocks of approximately 1 km^2 each, one block approximately 1.5 km^2 and one block of 0.5 km^2. The location of the blocks is described in detail below. Five blocks have been chosen at sites considered representative for the main units of the previous soil survey (Sungai Dareh - Kotabaru, 1977), that are to be brought under irrigation. These are mainly Mapping Units 7, 8, 9 and 10. In addition, one block should be surveyed in detail in the Sitiung II area, according to instructions given below.

2. Each block should be surveyed using a grid of 100 x 100 m, with augerings to a depth of at least 125 cm. Additional augerings must be made where obvious changes in topography or vegetation are recognized.

3. Profile pits should be dug to a depth of at least 150 cm in each of the mapping units recognized in each block, with a minimum of 5 profiles per block (4 in Sungai Atang I). In the Piruko and Sungai Atang I blocks one profile will be immediately adjacent to the experimental plots in these blocks.

4. The soils for each mapping unit should have laboratory data.

5. Soil maps will be produced at a scale of 1:5,000. Location of augerings and profiles must be shown on the maps. If contour maps at the same scale are available,it is desirable that copies of each block are attached to the soil survey report.

6. The survey should pay particular attention to soil colour and mottling, soil texture (distribution), depth of toposoil and presence and size of iron/manganese concretions.

7. The areas where organic topsoil has been accumulated in the land clearing process should be indicated on the maps.

8. The Piruko block should be surveyed with highest priority and preliminary results should be discussed with Mr. Karyotomo (Dir. Irigasi) and Mr. Beeny (Consultant). This information is required urgently in connection with the siting of a pilot project in this area.

9. It would be appreciated if a soil profile (pit) could be described and analyzed immediately adjacent to the project's experimental plot at KBS (Central Seed Station).

BLOCK PIRUKO

A site of slightly less than 1 km^2, to be representative for Mapping Unit 7. The site is located along the road between settlement blocks Sitiung I A and A'.

The northern boundary of the site is the Piruko river, extending for 700 m east of the bridge near the project's experimental site. Then 1000 m south, subsequently 1000 m west and finally approximately 500 m north, till the river is reached; from there along the river to the bridge.

BLOCK SUNGAI ATANG I

A site of approximately 0.5 km^2 to be representative for Mapping Unit 10. The site is located along the road from Kotabaringin to Sungaidua, approximately 1.5 km northwest of Kotabaringin. The reference point for the survey is the southernmost point of the curved, steep valley, immediately west of the project's experimental plot.

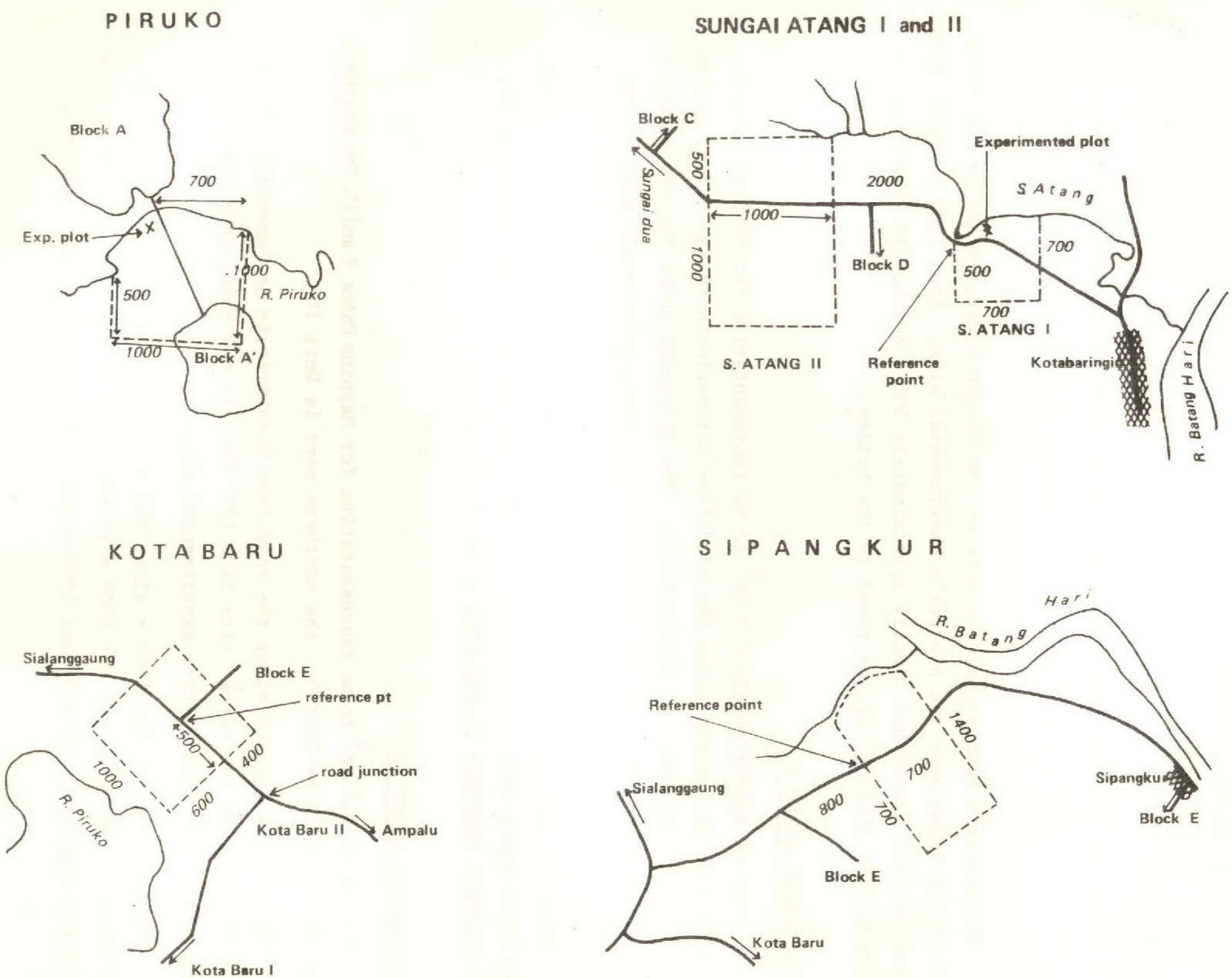
From the reference point, the site boundary runs for 500 m to the south; then 700 m east; then 700 m north, i.e. till the valley of the Sungai Atang. The northern boundary is the edge of the steep valley.

BLOCK SUNGAI ATANG II

A site of 1.5 km^2 to be representative for Mapping Units 9 and 10. The southern part of the block is Unit 9, the northern part is Unit 10.

The site is located along the road from Kotabaringin to Sungaidua. The reference point for the survey site is a 135° bend in the road, approximately 2 km west of the Sungai Atang experimental site.

The site extends for 1000 m along the road in an easterly direction and for 500 m to the north and for 1000 m to the south of the road. The site is a rectangle with sides of 1000 and 1500 m and compass bearings of 0 and 90°.



Sketch map of the proposed areas (blocks) for the detailed soil survey.

BLOCK KOTABARU

A site of 1 km^2, to be representative for Mapping Unit 8, but may include small areas of Mapping Unit 2.

The site is located along the road from Kotabaru II to Sialanggaung. The reference point for the site is the junction of above road with the road to Block E, approximately 900 m NW of the road junction at Kotabaru II.

From the reference point the area extends for 500 m to the northwest and for 500 m to the southeast. The limits of the site are straight lines, forming a square, of which the sides have compass bearings of 45^o and 135^o.

BLOCK SIPANGKUR

A site of approximately 1 km^2 to be representative for Mapping Unit 7.

The site is situated along the road from Sialanggaung to Sipangkur. The reference point for the survey is 2100 m from the junction of the Sialanggaung-Sipangkur and Sialanggaung - Kotabaru roads and approximately 800 m NE a junction with a road leading to Block E. At the reference point a minor valley is close to the road on the NW side.

From the reference point the survey extends for 700 m in a NE direction. The area forms an approximately rectangular block of 700 x 1400 m. The SE boundary of the block runs in a SW-NE direction at a (shortest) distance of 700 m from the reference point. The NW boundary is the upper edge of the steep valley, approximately 300 - 400 NW of the reference point.

ONE BLOCK IN SITIUNG II

A site of 1 km^2 should be chosen by the LPT staff, in consultation with the Consultant, Mr. Beeny, to be representative for the main mapping unit with irrigation potential in the Sitiung II semi-detailed survey area. This implies that this detailed survey can only be carried out after some progress has been made with the semi-detailed survey.

It is expected that a site can be found without great difficulty along the road, running near the Batanghari river, between settlement Blocks E and F.

II. <u>DRAFT Instructions for Semi-detailed soil survey of Jujuhan and Sitiung II</u>

An area of approximately 20,000 ha is to be surveyed at a semi-detailed level. This consists of:

± 5,000 ha in Sitiung II, east of the Siat river.

± 15,000 ha within the Jujuhan area of 21,390 ha.

<u>Selection of site</u>

The location of the 5,000 ha Sitiung II extension area as well as the 21,390 ha Jujuhan area is given in Fig. 1 of the Inception Report of the project.

Dr. Moffatt in his report suggested a survey of the Jujuhan area, but he expected that as a result of topographic surveys some parts of the area would be eliminated because they are considered to be unsuitable for irrigation. He estimated that about 15,000 ha need to be surveyed. This 15,000 ha formed the basis for the contract with LPT.

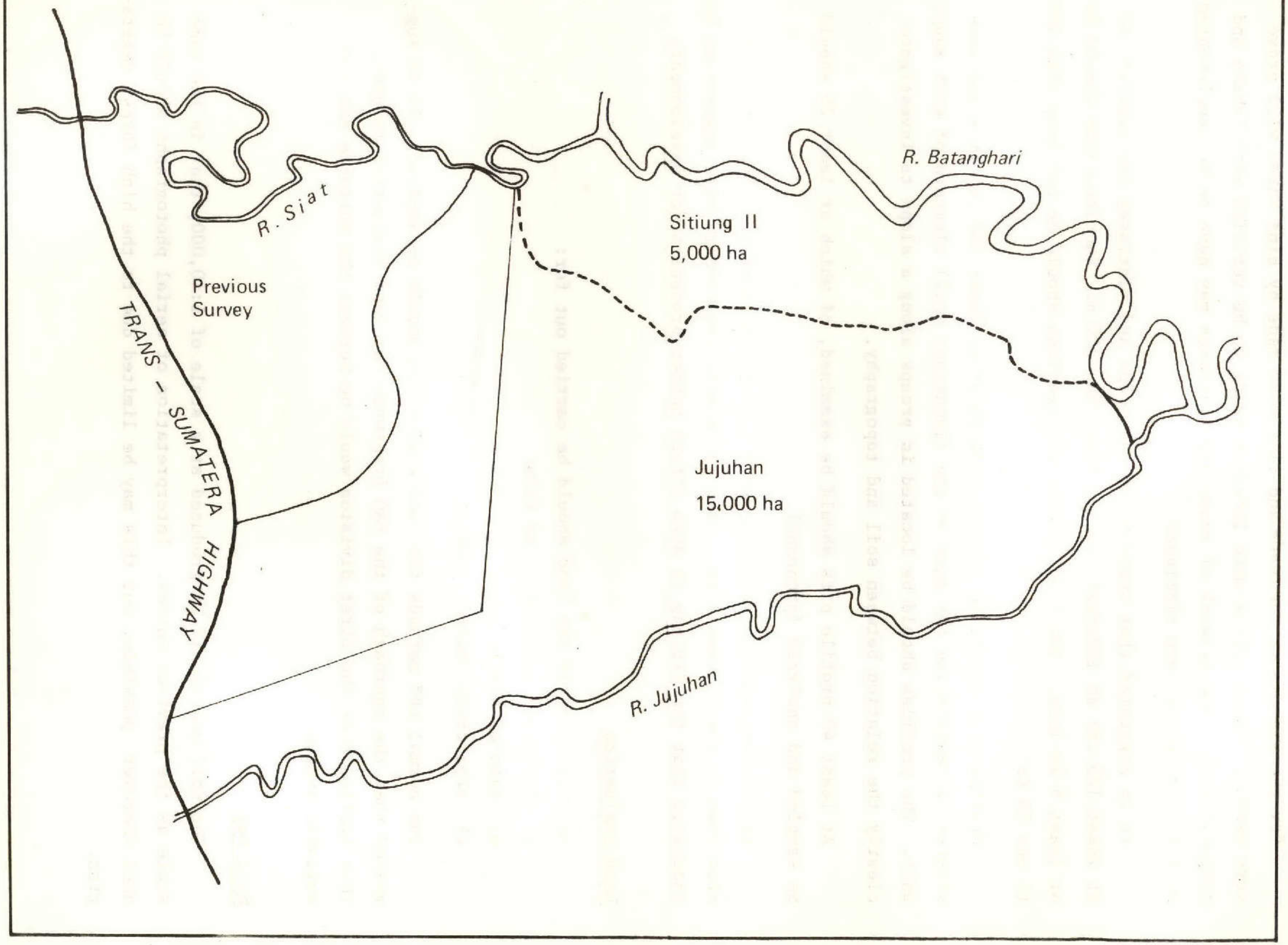
Unfortunately the results of the topographic survey are not yet available and hence the selection of the 15,000 ha had to be based on other factors.

Preliminary investigations of the Sitiung II and Jujuhan areas have shown that much of the land is rolling terrain with a difference in height from crest to valley of approximately 30-40 m. Land with better topography is probably restricted to relatively narrow areas along the Batanghari and Jujuhan rivers.

Therefore it has been decided that a strip of land approximately 3-4 km wide along the northern side of the Jujuhan river should be surveyed. To make up for the 15,000 ha in the contract, in addition all land should be surveyed to the east of a N-S line through the westernmost extension of the Sitiung II survey area.

The Sitiung II and Jujuhan areas are contiguous and should be treated as one survey. The northern boundary of the area are the Siat and Batanghari rivers; the southern boundary is the Jujuhan river. The western boundary runs from the confluence of the Ambai and Siat rivers, due south for 11 km, then on a bearing of 250^{o} for about 8 km, i.e. till the Trans-Sumatera Highway and then follows this road till the Jujuhan river.

Sketch map of the proposed SITIUNG II and S. JUJUHAN survey areas



Methods

For the field work the roads and rintisses made by Bina Marga will prove very useful. Their approximate location needs to be verified with "chain and compass" work. The network of roads and rintisses may have to be complemented by a few additional new rintisses.

It is suggested that sections of the roads and rintisses are augered (to at least 125 cm) at intervals of not less than 200 m. Such sections should be at least 5 km long. The total number of augerings should be not less than 400 (1 per 50 ha).

Profile pits should be dug (to a depth of at least 150 cm) at sites considered representative for each of the (landscape soil) elements of each mapping unit. The profiles should be located in groups along a slope to investigate clearly the relation between soil and topography.

At least 40 profile pits should be examined, of which at least 25 should be sampled and analyzed (proposal).

The concentration of augerings and pits may be denser in the Sitiung II area than in the Jujuhan area. This is because preliminary site inspection has indicated that the Sitiung II area offers better prospects for development.

Land evaluation

An evaluation of the land should be carried out for:

a) irrigated cultivation of rice
b) rainfed arable crops
c) tree crops (mainly rubber).

The normal LPT methods for land evaluation should be applied. It is suggested that the approach of the FAO framework for land evaluation is used. This implies that the first division would be between the suitable and non-suitable orders.

Soil map

The soil map should be produced at a scale of 1:40,000, that is the same scale as the previous survey. Interpretation of aerial photographs should be used wherever possible, but this may be limited due to the high forest vegetation.

The map should show the location, with number, of all profile pits.

The mapping units recognized in the previous survey should be used as much as possible. It is suggested that the lay-out of the legend be re-arranged to show the inter-relation between the mapping units in a better way.

The legend should give an indication of the uniformity of the soil units.

Soil classification, etc.

The soils should be classified according to the system in use in Indonesia, but a correlation with the classification of the U.S. Soil Taxonomy should also be given. Correlation (of series and families) with soils of similar survey areas should be carried out.

Report

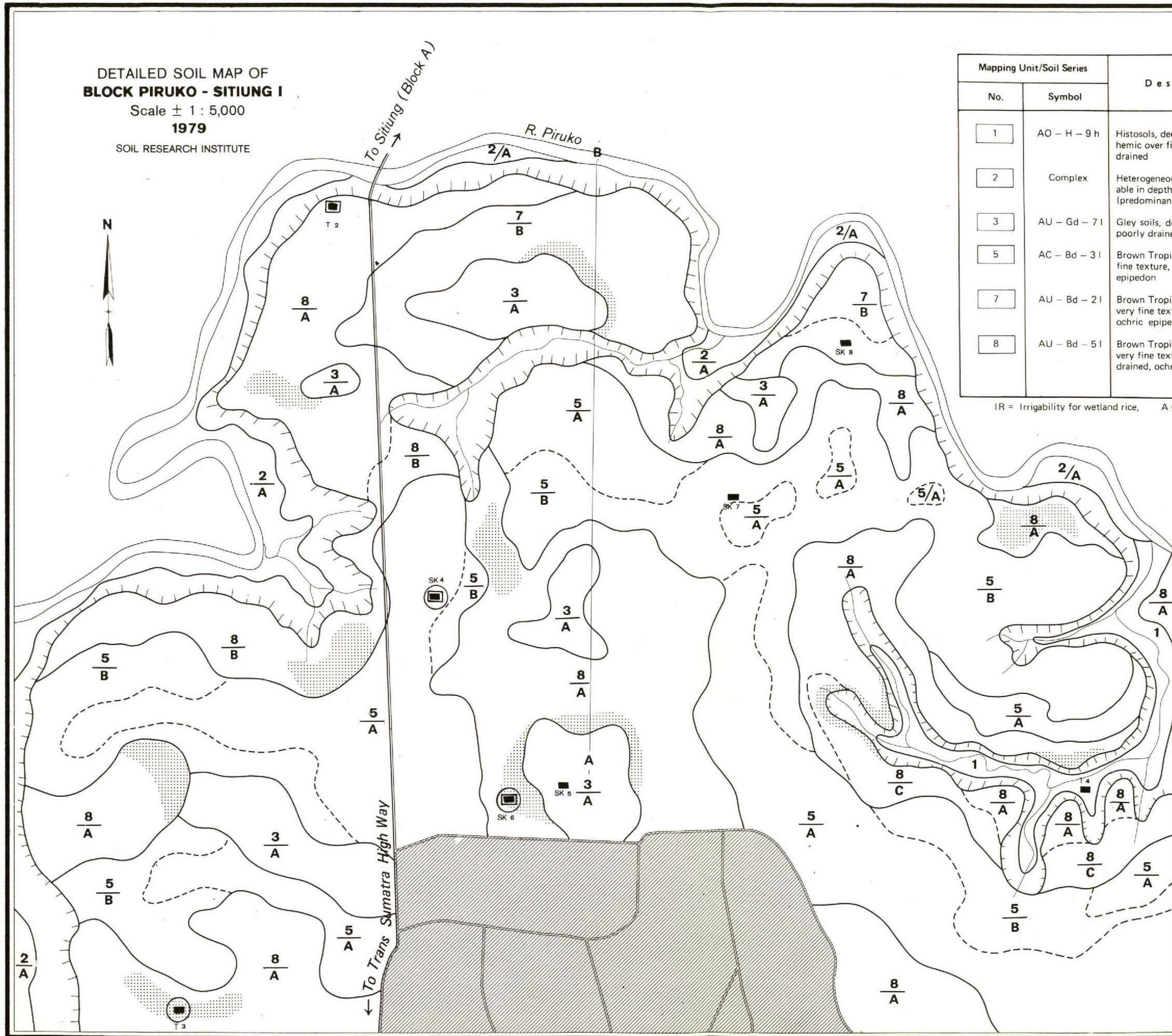
The report should include the following sections:

a) Methods
b) Environment
c) General soil description
d) Soil classification and correlation
e) Description of mapping units
f) Land evaluation
g) Discussion and recommendations.

In the section of methods the location of all augerlines should be given.

The general soil description should explain the relation between soil, topography and parent materials, etc., as well as the main soil properties and the characteristics used to distinguish between the mapping units. Technical terms should be kept to a minimum in this section to make it easily understood by the "non-soil" reader.

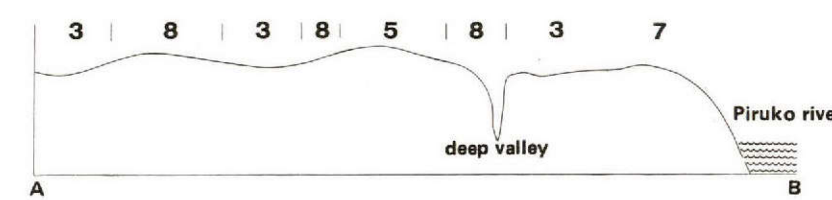
The description of the mapping units should describe the landscape elements and the soils associated with each element. The approximate extent of each soil-landscape element within the mapping unit should be estimated.



LEGEND

Mapping Unit/Soil Series No.	Symbol	Description	Parent Material	Land form: Main Unit	Land form: Position (slope)	Soil suitability subclasses: IR	Actual: A	Actual: R	Potential: A	Potential: R	Acreage: Ha	Acreage: %
1	AO – H – 9 h	Histosols, deep to moderately deep, hemic over fibric, very poorly drained	Recent organic deposit	Valley floor (marshy)	– (< 3 %)	VI	VI	VI	VI	VI	3	2.8
2	Complex	Heterogeneous Alluvial soils, variable in depth, texture, and drainage (predominantly poorly drained)	Heterogeneous textured recent alluvium		– (< 3 %)	VI	VI	VI	VI	VI	5	4.8
3	AU – Gd – 7 l	Gley soils, deep, very fine texture, poorly drained, ochric epipedon	Very fine textured subrecent alluvium	Subrecent river terrace	Depression/ concave (< 3 %)	IInf	VI	VI	IIIdn	IVds	7	6.7
5	AC – Bd – 3 l	Brown Tropical Soils, very deep, fine texture, well drained, ochric epipedon	Fine textured subrecent alluvium		Low ridge/ convex (1 – 5%)	IIsn	IVn	IIIn	IIIn	IIn	40	38.1
7	AU – Bd – 2 l	Brown Tropical Soils, very deep, very fine texture, well drained, ochric epipedon	Very fine textured subrecent alluvium		Low ridge/ convex (1 – 5%)	IIsn	IVn	IIIn	IIIn	IIn	16	15.2
8	AU – Bd – 5 l	Brown Tropical Soils, very deep, very fine texture, moderately well drained, ochric epipedon			Flat to slightly sloping (< 3 %)	IIn	IVdn	Vdn	IIIn	IIsn	34	32.4
							Total				105	100

IR = Irrigability for wetland rice, A = Arable (upland) crops, R = Rubber



CONVENTIONAL SIGNS

All season motorable road

River/stream

Settlement

Mapping unit boundary with number

Phase boundary

Soil pit, infiltration rate measurement and undisturbed soil sampling with number

Phases

Accumulation of manganese concretion

Slope

A 0 – 3 %

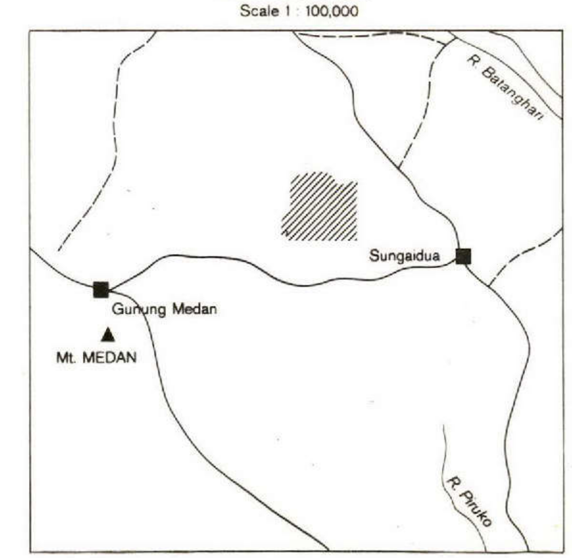
B 3 – 8 %

C 8 – 15%

Steep slope (>15 %)

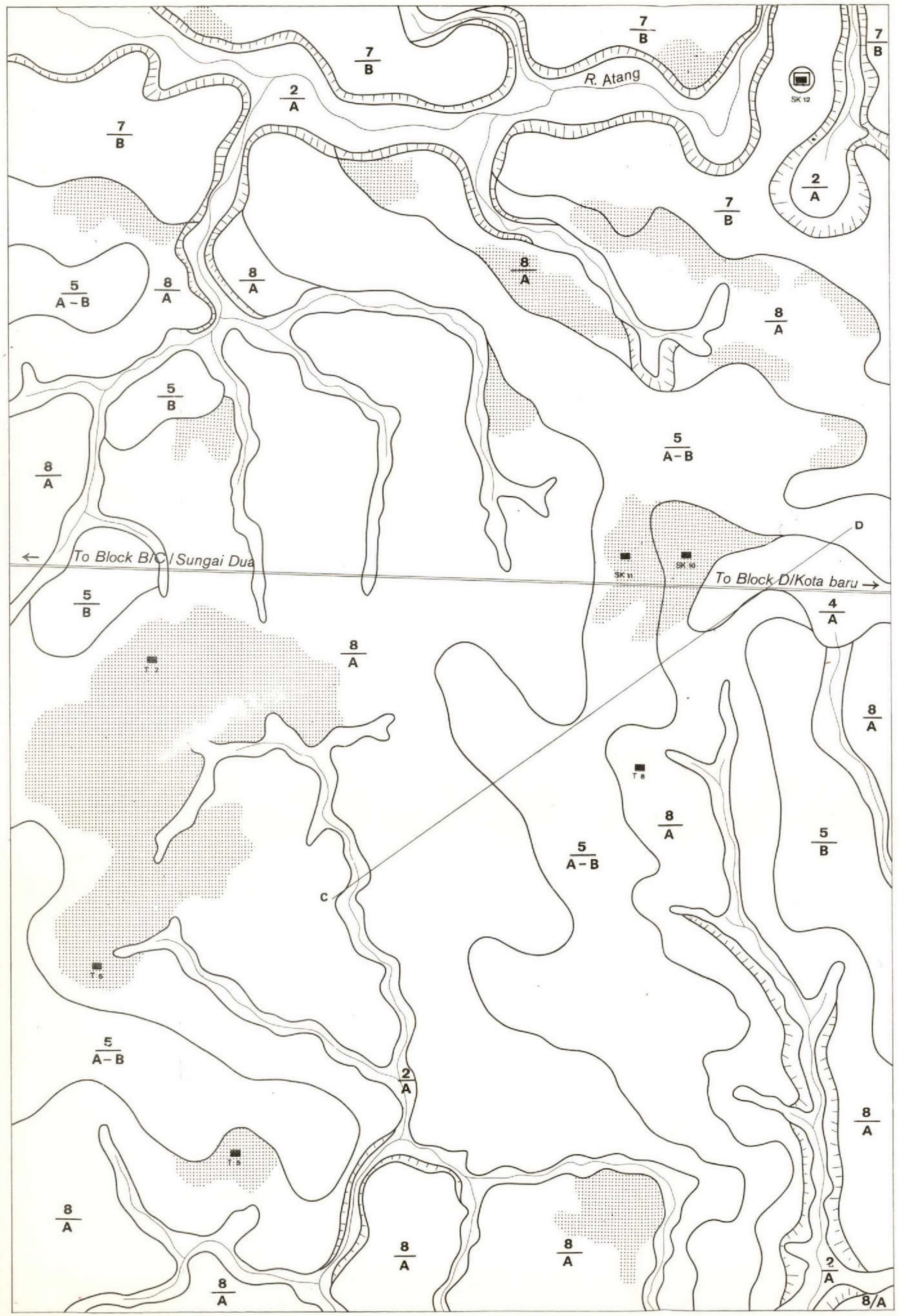
LOCATION MAP

Scale 1 : 100,000



Air – photos of approx 1 : 5,000 scale were used as base map

PRINTED BY : SOIL RESEARCH INSTITUTE, BOGOR 1979



SCHEMATIC DETAILED SOIL MAP OF

BLOCK R. ATANG II - SITIUNG I

Scale ± 1: 4.500

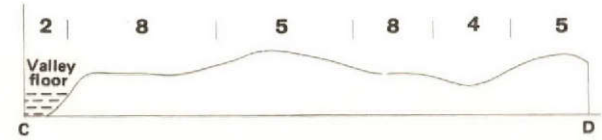
1979

SOIL RESEARCH INSTITUTE

L E G E N D

Mapping Unit/Soil Series		Description	Parent Material	Land form		Soil suitability subclasses					Acreage	
							Actual		Potential			
No.	Symbol			Main Unit	Position (slope)	IR	A	R	A	R	Ha	%
2	Complex	Heterogeneous Alluvial soils, variable in depth, texture, and drainage (predominantly poorly drained)	Heterogeneous textured recent alluvium/colluvium	Valley floor (marshy)	– (<3%)	VI	VI	VI	VI	VI	26	14.6
4	AU – Gd – 8 l	Gley soils, deep, very fine texture, poorly drained, ochric epipedon	Very fine textured subrecent alluvium	Subrecent river terrace	Depression/ concave (<3 %)	IInf	VI	VI	III dn	Vds	2	1.1
5	AC – Bd – 3 l	Brown Tropical Soils, very deep, fine texture, well drained, ochric epipedon	Fine textured subrecent alluvium		Low ridge/ convex (1 – 5%)	IIsn	IVn	IIIn	IIIn	IIn	33	18.5
7	AU – Bd – 2 l	Brown Tropical Soils, very deep, very fine texture, well drained, ochric epipedon	Very fine textured subrecent alluvium		Low ridge/ convex (1 – 5%)	IIsn	IVn	IIIn	IIIn	IIn	14	7.9
8	AU – Bd – 5 l	Brown Tropical Soils, very deep, very fine texture, moderately well drained, ochric epipedon			Flat to slightly sloping (<3%)	IIn	IVdn	Vdn	IIIn	IIIsn	103	57.9
							. Total				178	100

IR = Irrigability for wetland rice, A = Arable (upland) crops, R = Rubber



CONVENTIONAL SIGNS

All season motorable road

River/stream

Mapping Unit boundary with number

Soil pit, Infiltration rate measurement and undisturbed soil sampling with number

SK12

Slope

A : 0 – 3 %

B : 3 – 8 %

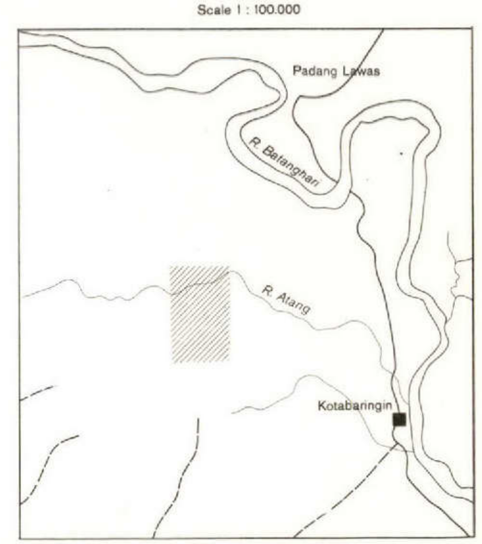
Steep slope (> 15 %)

Phases

Accumulation of manganese concretions

LOCATION MAP

Scale 1 : 100.000



Air – photos of approx 1 : 5.000 scale were used as base map

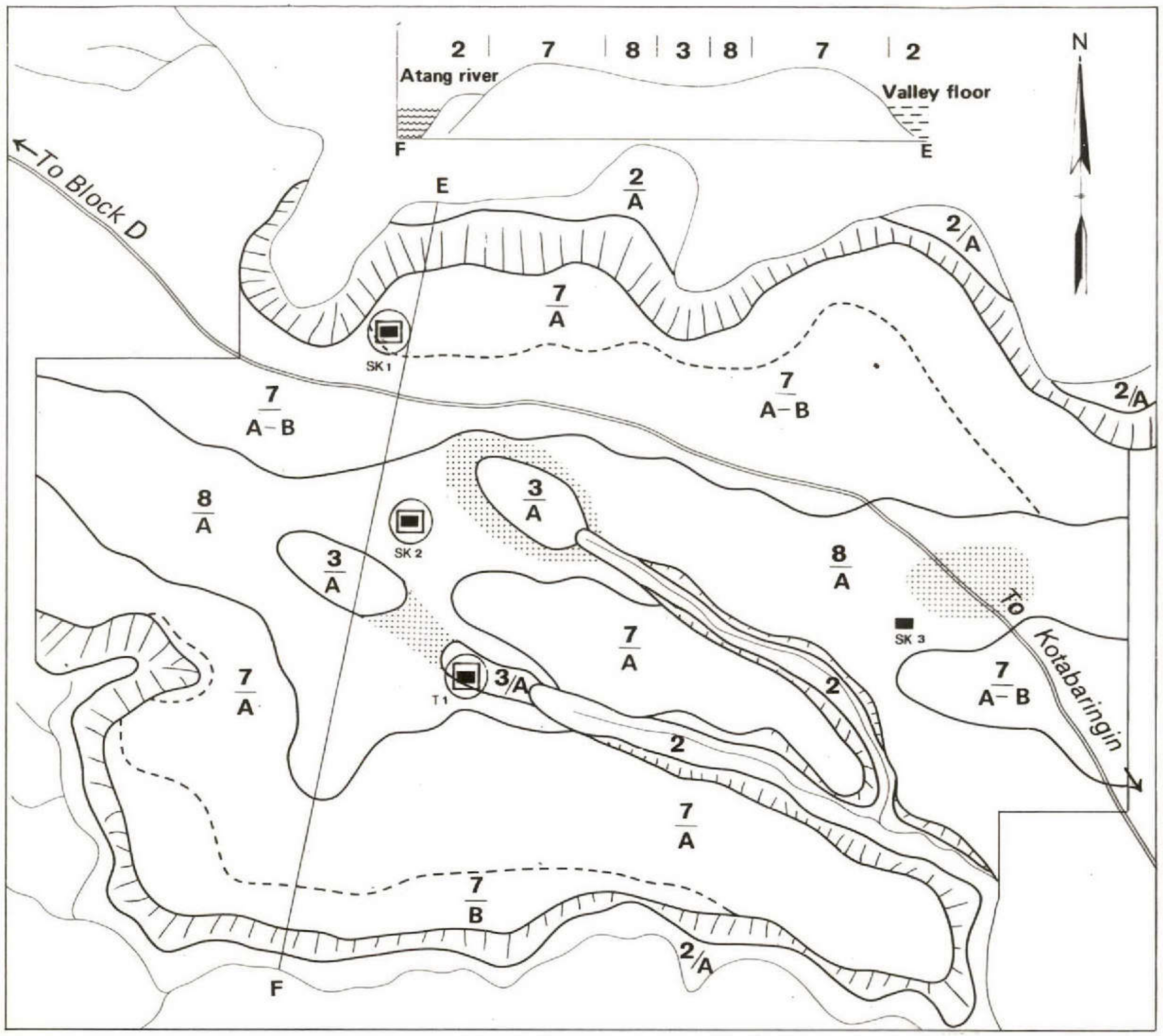
PRINTED BY : SOIL RESEARCH INSTITUTE, BOGOR 1979

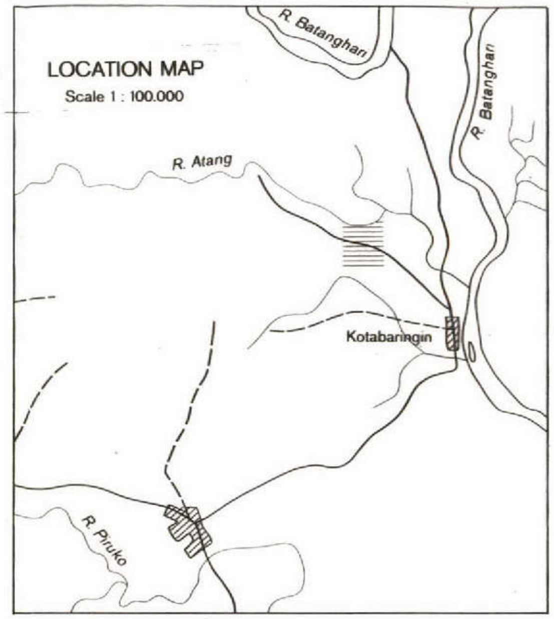
DETAILED SOIL MAP OF
BLOCK R. ATANG I - SITIUNG I

Scale ± 1 : 5,000

1979

SOIL RESEARCH INSTITUTE





CONVENTIONAL SIGNS

Seasonal motorable road

River/stream

Mapping Unit boundary with number

Phase boundary

Soil pit, Infiltration rate measurement and undisturbed soil sampling with number

Phases

Accumulation of manganese concretions

Slope

A : 0 – 3 %

B : 3 – 8 %

Steep slope (> 15 %)

LEGEND

Mapping Unit/Soil Series		Description	Parent Material	Land form		Soil suitability subclasses					Acreage	
No.	Symbol			Main Unit	Position (slope)	IR	Actual A	Actual R	Potential A	Potential R	Ha	%
2	Complex	Heterogeneous Alluvial soils, variable in depth, texture, and drainage (predominantly poorly drained)	Heterogeneous textured recent alluvium	Valley floor (marshy)	– (< 3 %)	VI	VI	VI	VI	VI	8	24.2
3	AU – Gd – 7 I	Gley soils, deep, very fine texture, poorly drained, ochric epipedon	Very fine textured sub-recent alluvium	Sub recent river terrace	Depression/ concave (< 3 %)	IInf	VI	VI	IIIdn	IVds	1	3.1
7	AU – Bd – 2 I	Brown Tropical Soils, very deep, very fine texture, well drained, ochric epipedon			Low ridge/ convex (1 – 5 %)	IIsn	IVn	IIIn	IIIn	IIn	16	48.5
8	AU – Bd – 5 I	Brown Tropical Soils, very deep, very fine texture, moderately well drained, ochric epipedon			Flat to slightly sloping (< 3 %)	IIn	IVdn	Vdn	IIIn	IIIsn	8	24.2
							Total				33	100

IR = Irrigability for wetland rice, A = Arable (upland) crops, R = Rubber

Air – photos of approx 1 : 5.000 scale were used as base map

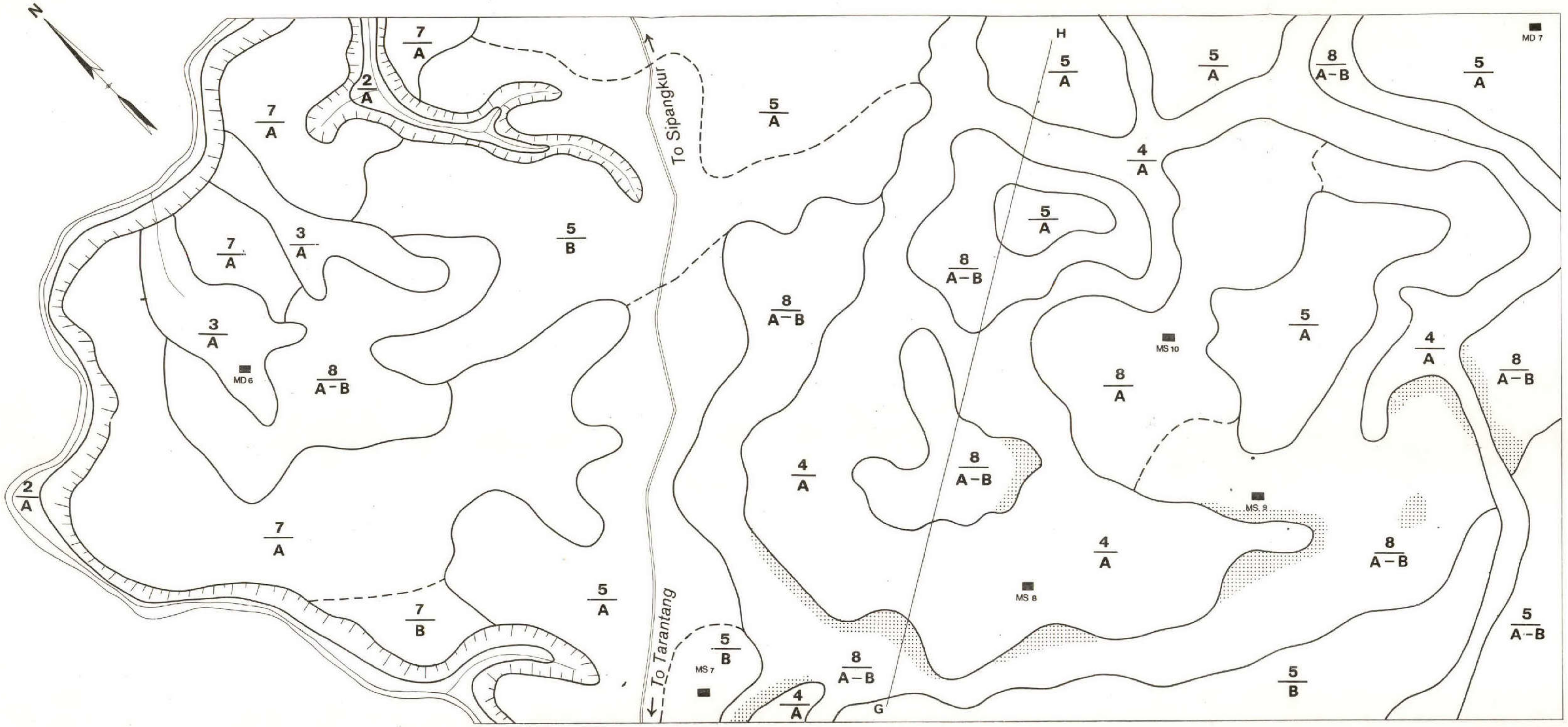
PRINTED BY : SOIL RESEARCH INSTITUTE, BOGOR 1979

DETAILED SOIL MAP OF BLOCK SIPANGKUR - SITIUNG I

Scale ±1 : 5,000

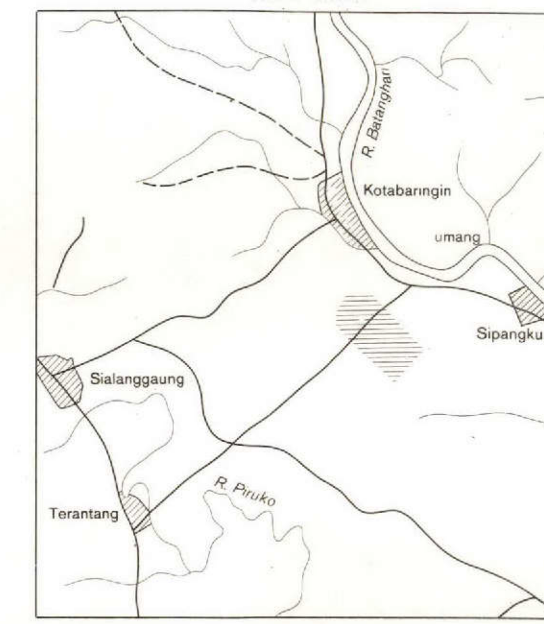
1979

SOIL RESEARCH INSTITUTE



LOCATION MAP

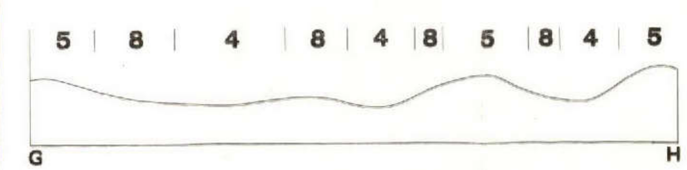
Scale 1 : 100.000



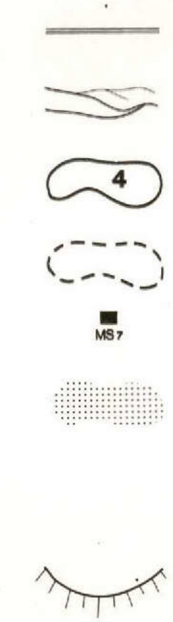
LEGEND

Mapping Unit/Soil Series No.	Symbol	Description	Parent Material	Land form: Main Unit	Land form: Position (slope)	Soil suitability subclasses: IR	Actual A	Actual R	Potential A	Potential R	Acreage Ha	Acreage %
2	Complex	Heterogeneous Alluvial soils, variable in depth, texture, and drainage (predominantly poorly drained).	Heterogeneous textured recent alluvium	Valley floor (marshy)	– (< 3 %)	VI	VI	VI	VI	VI	2	2.0
3	AU – Gd – 7 I	Gley soils, deep, very fine texture, poorly drained, ochric epipedon.	Very fine textured subrecent alluvium	Subrecent river terrace	Depressions/ gullies, concave (< 3%)	IInf	VI	VI	IIIdn	IVds	3	2.9
4	AU – Gd – 8 I	Gley soils, deep, very fine texture, poorly drained, ochric epipedon.				IInf	VI	VI	IIIdn	Vds	18	17.6
5	AC – Bd – 3 I	Brown Tropical Soils, very deep, fine texture, well drained, ochric epipedon.	Fine textured subrecent alluvium		Low ridge/ convex (1 – 5 %)	IIsn	IVn	IIIn	IIIn	IIn	33	32.4
7	AU – Bd – 2 I	Brown Tropical Soils, very deep, very fine texture, well drained, ochric epipedon.	Very fine textured subrecent alluvium		Low ridge/ convex (1 – 5 %)	IIsn	IVn	IIIn	IIIn	IIn	17	16.7
8	AU – Bd – 5 I	Brown Tropical Soils, very deep, very fine texture, moderately well drained, ochric epipedon.			Flat to slightly sloping (< 3 %)	II n	IVdn	Vdn	IIIn	IIIsn	29	28.4
							Total				102	100

IR = Irrigability for wetland rice, A = Arable (upland) crops, R = Rubber



CONVENTIONAL SIGNS



All season motorable road

River/stream

Mapping unit boundary with number

Phase boundary

Soil pit with number

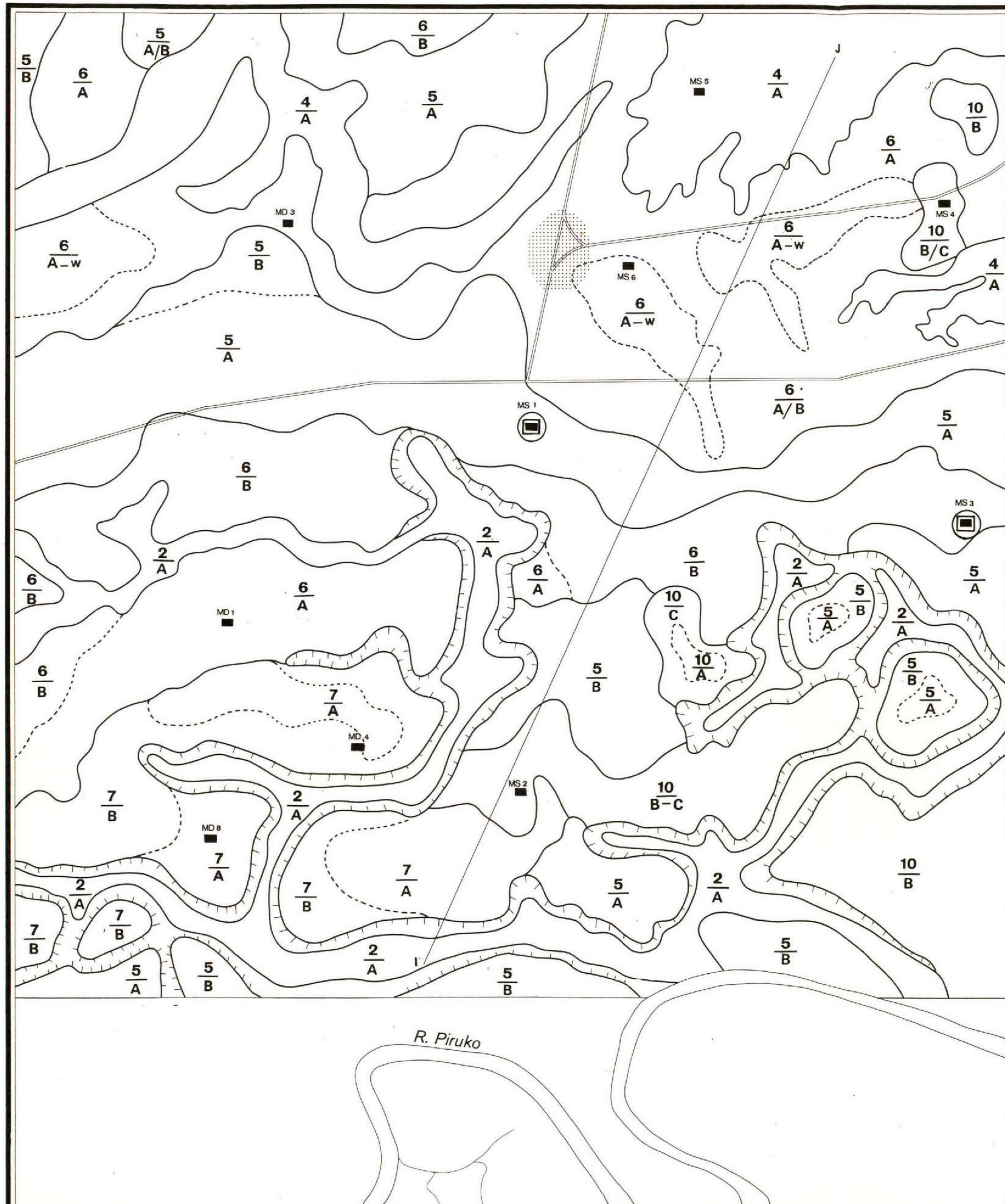
Accumulation of manganese concretions

Slope
A : 0 – 3 %
B : 3 – 8 %

Steep slope (> 15 %)

Air – photos of approx 1 : 5.000 scale were used as base map

PRINTED BY : SOIL RESEARCH INSTITUTE, BOGOR 1979



DETAILED SOIL MAP OF
BLOCK KOTABARU - SITIUNG I

Scale ± 1 : 5,000

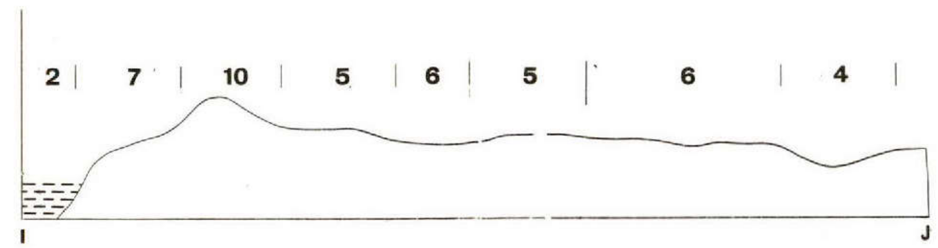
1979

SOIL RESEARCH INSTITUTE

L E G E N D

Mapping Unit/Soil Series		Description	Parent Material	Land form		Soil suitability subclasses					Acreage	
						IR	Actual		Potential			
No.	Symbol			Main Unit	Position (slope)		A	R	A	R	Ha	%
2	Complex	Heterogeneous Alluvial soils, variable in depth, texture, and drainage (predominantly poorly drained).	Heterogeneous textured recent alluvium	Valley floor (marshy)	– (< 3 %)	VI	VI	VI	VI	VI	18	13.8
4	AU – Gd – 8 I	Gley soils, deep, very fine texture, poorly drained, ochric epipedon.	Very fine textured subrecent alluvium	Subrecent river terrace	Depression / concave (< 3 %)	IInf	VI	VI	IIIdn	V ds	8	6.2
5	AC – Bd – 3 I	Brown Tropical Soils, very deep, fine texture, well drained, ochric epipedon.	Fine textured subrecent alluvium		Low ridge/ convex (1 – 5 %)	II sn	IVn	IIIn	IIIn	IIn	30	23.1
6	AC – Bd – 5 I	Brown Tropical Soils, very deep, fine texture, moderately well drained, ochric epipedon.			Flat to slightly sloping (< 3 %)	IIn	IVdn	Vdn	IIIn	IIIsn	57	43.8
7	AU – Bd – 2 I	Brown Tropical Soils, very deep, very fine texture, well drained, ochric epipedon.	Very fine textured subrecent alluvium		Low ridge / convex (1 – 5 %)	IIsn	IVn	IIIn	IIIn	IIn	9	6.9
10	TU – Pc – 5 I	Chromic Podzolic soils, deep, very fine texture, moderately well drained, ochric epipedon.	Very fine textured tertiary river terrace materials	Peneplain	Slightly high isolated ridge (5 – 10 %)	IVtn	Vtn	IVsn	IIIn	IIIsn	8	6.2
							Total				130	100

IR = Irrigability for wetland rice, A = Arable (upland) crops, R = Rubber



CONVENTIONAL SIGNS

All season motorable road

River/stream

Mapping unit boundary with number

Phase boundary

Soil pit, Infiltration rate measurement and Undisturbed soil sampling with number

Phase

Tuff materials < 50 cm below the surface

W Water table

Slope

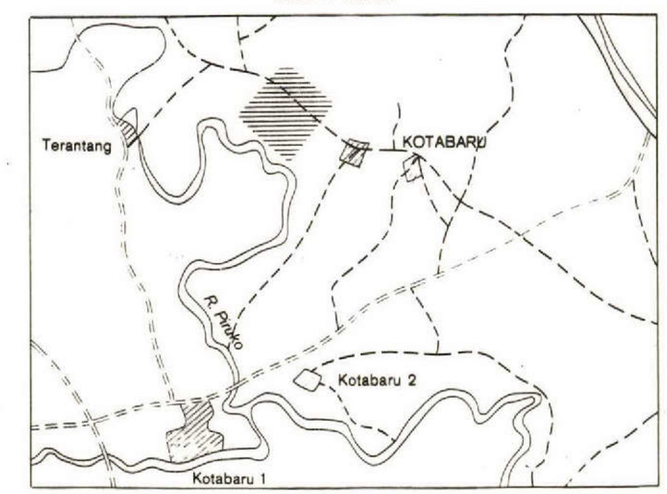
A : 0 – 3 %
B : 3 – 8 %
C : 8 – 15%

Steep slope (> 15%)

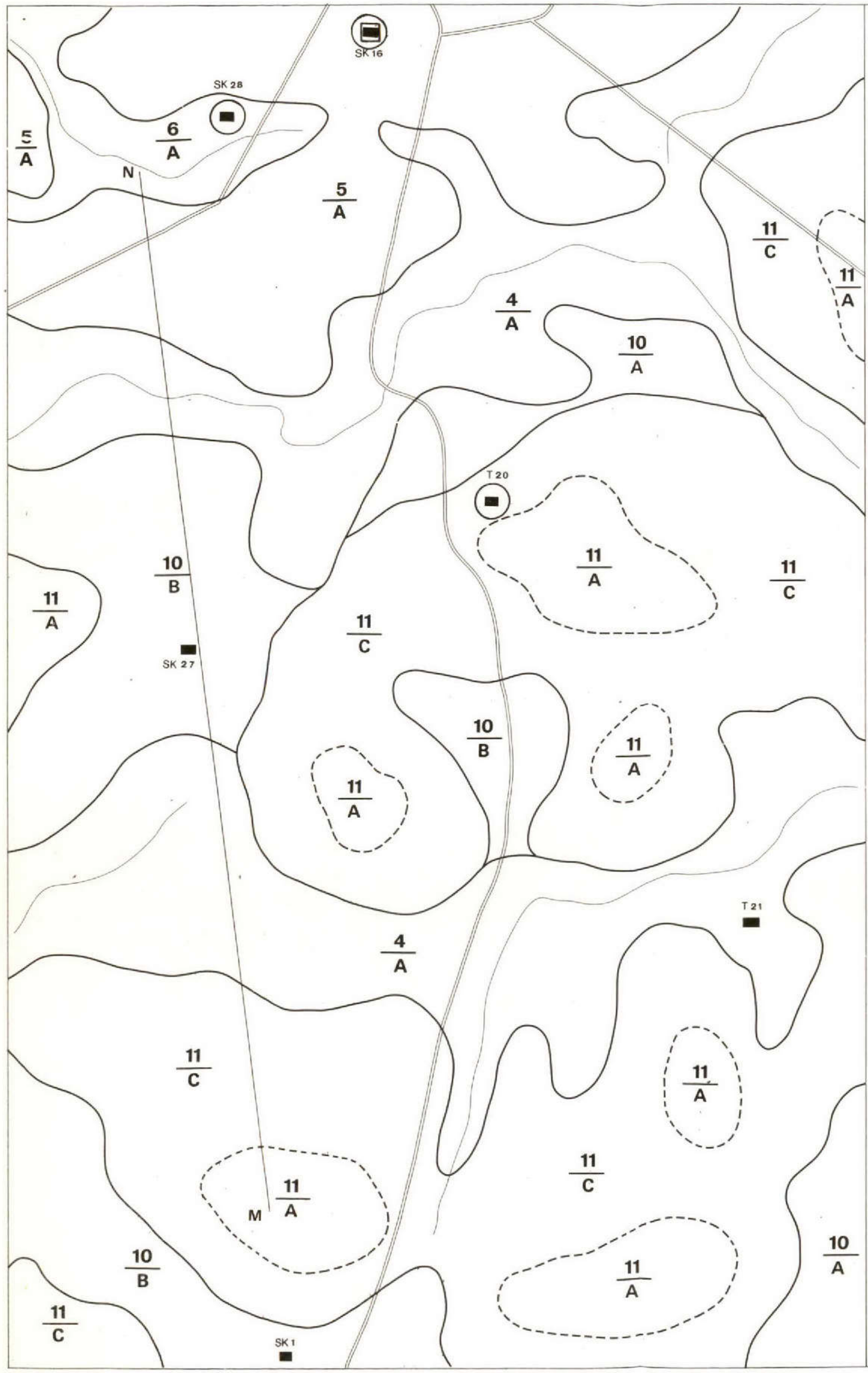
Air – photos of approx 1 : 5.000 scale were used as base map

LOCATION MAP

Scale 1 : 100.000



PRINTED BY : SOIL RESEARCH INSTITUTE, BOGOR 1979



DETAILED SOIL MAP OF

BLOCK E - SITIUNG II

Scale ± 1 : 5,000

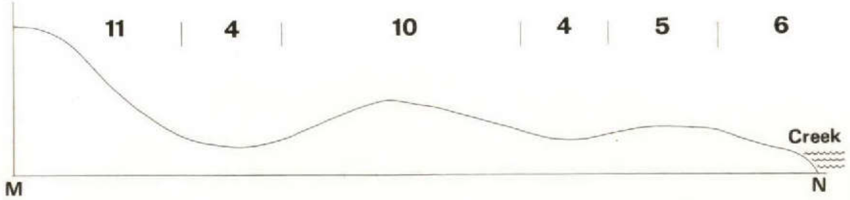
1979

SOIL RESEARCH INSTITUTE

L E G E N D

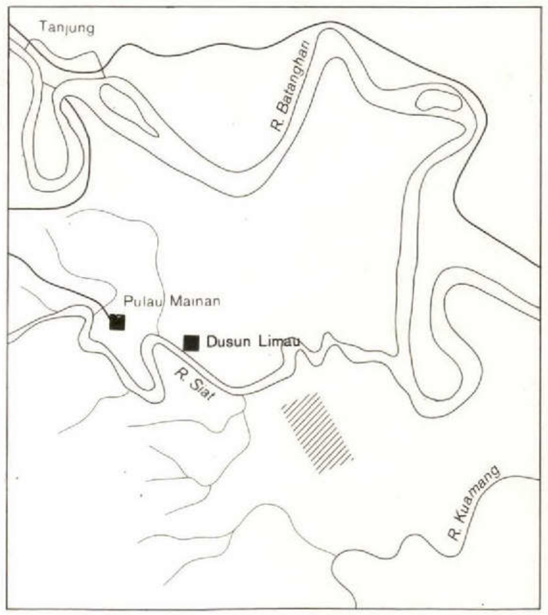
Mapping Unit/Soil Series		Description	Parent Material	Land form		Soil suitability subclasses					Acreage	
						IR	Actual		Potential			
No.	Symbol			Main Unit	Position (slope)		A	R	A	R	Ha	%
4	AU – Gd – 8 I	Gley soils, deep, very fine texture, poorly drained, ochric epipedon.	Very fine textured sub-recent alluvium/colluvium	Valley floor	– (< 3 %)	IInf	VI	VI	IIIdn	Vds	21	25.0
5	AC – Bd – 3 I	Brown Tropical Soils, very deep, fine texture, well drained, ochric epipedon.	Fine textured subrecent alluvium	Subrecent river terrace	Low ridge/ convex (1 – 5 %)	IIsn	IVn	IIIn	IIIn	IIn	11	13.1
6	AC – Bd – 5 I	Brown Tropical Soils, very deep, fine texture, moderately well drained, ochric epipedon.	Fine textured subrecent alluvium	Subrecent river terrace	Flat to slightly sloping (< 3 %)	IIn	IVdn	Vdn	IIIn	IIIsn	2	2.4
10	TU – Pc – 5 I	Chromic Podzolic soils, deep, very fine texture, moderately well drained, ochric epipedon.	Very fine textured tertiary terrace materials mixed with volcanic materials	Peneplain	Undulating (3 – 8 %)	IVtn	Vt n	IVsn	IIIn	IIIsn	13	15.5
11	VU – Lo – 3 I	Oxic Latosols, very deep, very fine texture, well drained, ochric epipedon.	Very fine textured acid volcanic tuff	Peneplain volcanic cover	Undulating to rolling (1–15 %)	IVts	Vtn	IVtn	IIItn	IItn	37	44.0
							Total				84	100

IR = Irrigability for wetland rice, A = Arable (upland) crops, R = Rubber



LOCATION MAP

Scale 1 : 100.000



CONVENTIONAL SIGNS

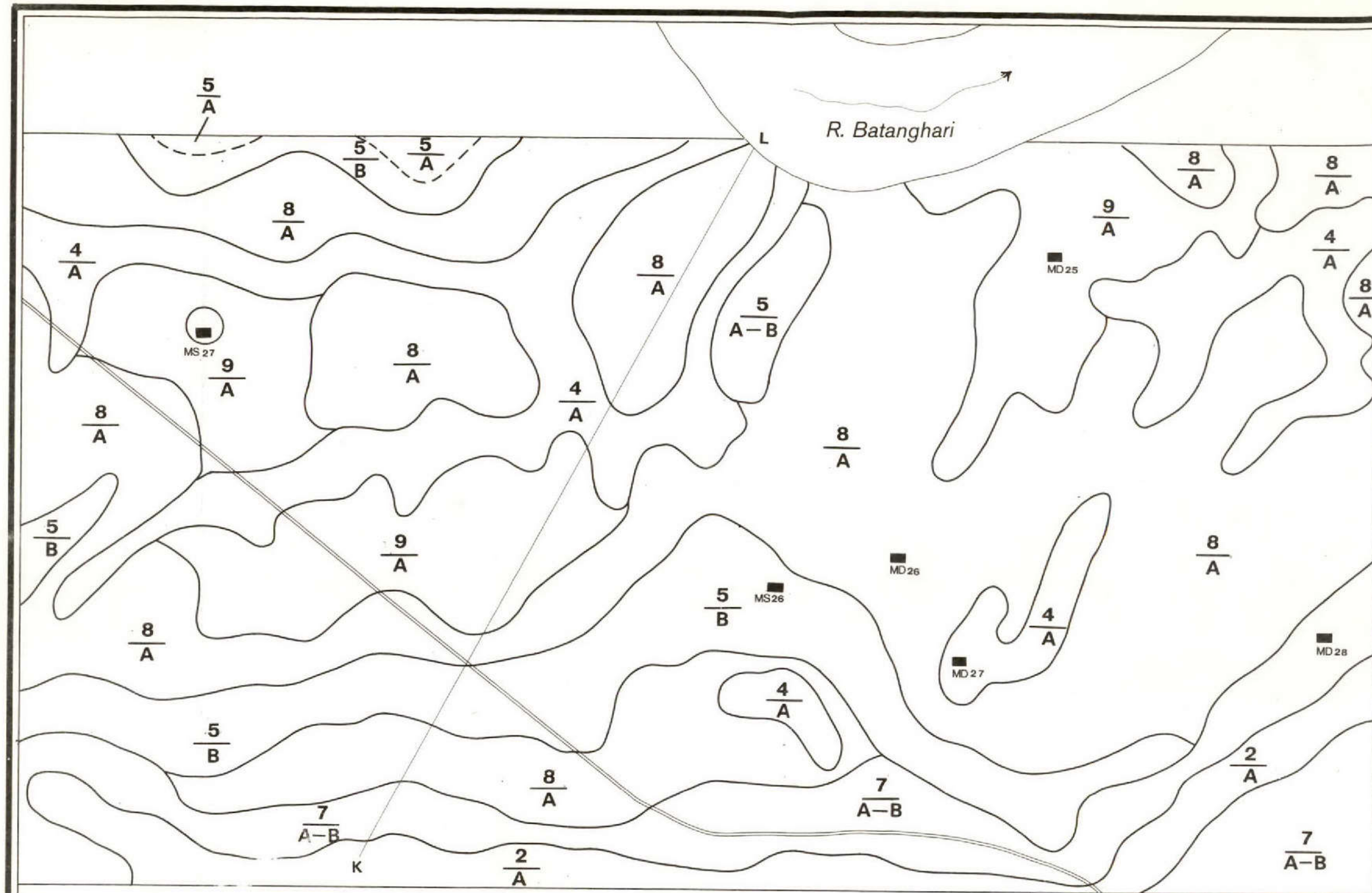
- Seasonal motorable road
- River/stream
- 4 Mapping unit boundary with number
- Phase boundary
- SK16 Soil pit, Infiltration rate measurement and undisturbed soil sampling with number

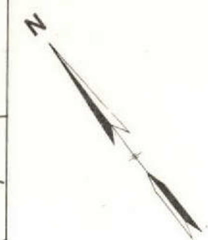
Slope

- A : 0 – 3 %
- B : 3 – 8 %
- C : 8 – 15%

Base map from the enlargment of air photo, approx 1 : 20,000 scale

PRINTED BY : SOIL RESEARCH INSTITUTE, BOGOR 1979





DETAILED SOIL MAP OF

BLOCK F - SITIUNG II

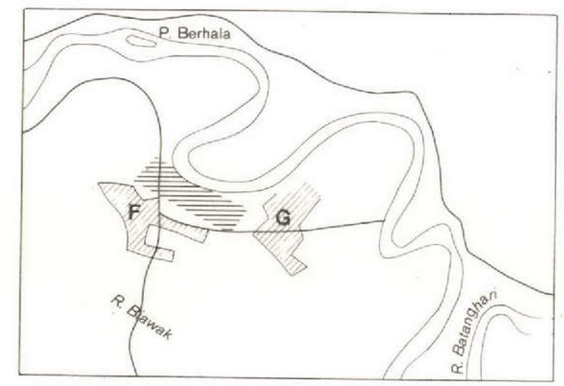
Scale ± 1 : 5,000

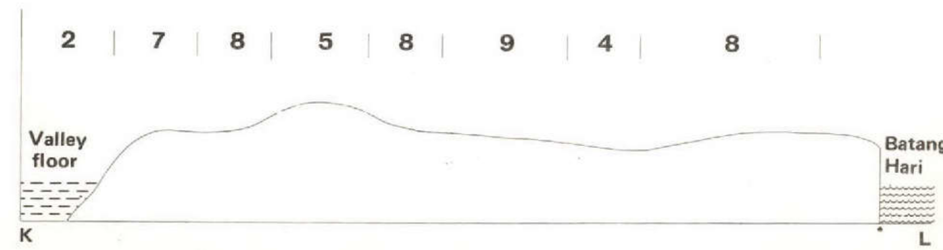
1979

SOIL RESEARCH INSTITUTE

LOCATION MAP

Scale 1 : 100.000





L E G E N D

Mapping Unit/Soil Series		Description	Parent Material	Land form		Soil suitability subclasses					Acreage	
							Actual		Potential			
No.	Symbol			Main Unit	Position (slope)	IR	A	R	A	R	Ha	%
2	Complex	Heterogeneous Alluvial soils, variable in depth, texture, and drainage (predominantly poorly drained).	Heterogeneous textured recent alluvium	Valley floor (marshy)	– (< 3 %)	VI	VI	VI	VI	VI	4	6.7
4	AU – Gd – 8 I	Gley soils, deep, very fine texture, poorly drained, ochric epipedon	Very fine textured sub-recent alluvium		Depression / gully, concave (< 3 %)	IInf	VI	VI	IIIdn	Vds	9	15.0
5	AC – Bd – 3 I	Brown Tropical Soils, very deep, fine texture, well drained, ochric epipedon	Fine textured subrecent alluvium		Low ridge/ convex (1 – 5 %)	IIsn	IVn	IIIn	IIIn	IIn	2	3.3
7	AU – Bd – 2 I	Brown Tropical Soils, very deep, very fine texture, well drained, ochric epipedon		Subrecent river terrace	Low ridge/ convex (1 – 5 %)	IIsn	IVn	IIIn	IIIn	IIn	7	11.7
8	AU – Bd – 5 I	Brown Tropical Soils, very deep, very fine texture, moderately well drained, ochric epipedon.	Very fine textured subrecent alluvium		Flat to slightly sloping (< 3 %)	IIn	IVdn	Vdn	IIIn	IIIsn	31	51.6
9	AU – Bd – 6 I	Brown Tropical Soils, deep, very fine texture, imperfectly drained, ochric epipedon.			Flat to slightly sloping (< 3 %)	IIn	IVdn	Vdn	IIIn	IIIsn	7	11.7
							Total				60	100

IR = Irrigability for wetland rice, A = Arable (upland) crops, R = Rubber

CONVENTIONAL SIGNS

All season motarable road (hardened)

River/stream

Mapping unit boundary with number

Phase boundary

Soil pit, Undisturbed soil sampling with number

MS27

Phases

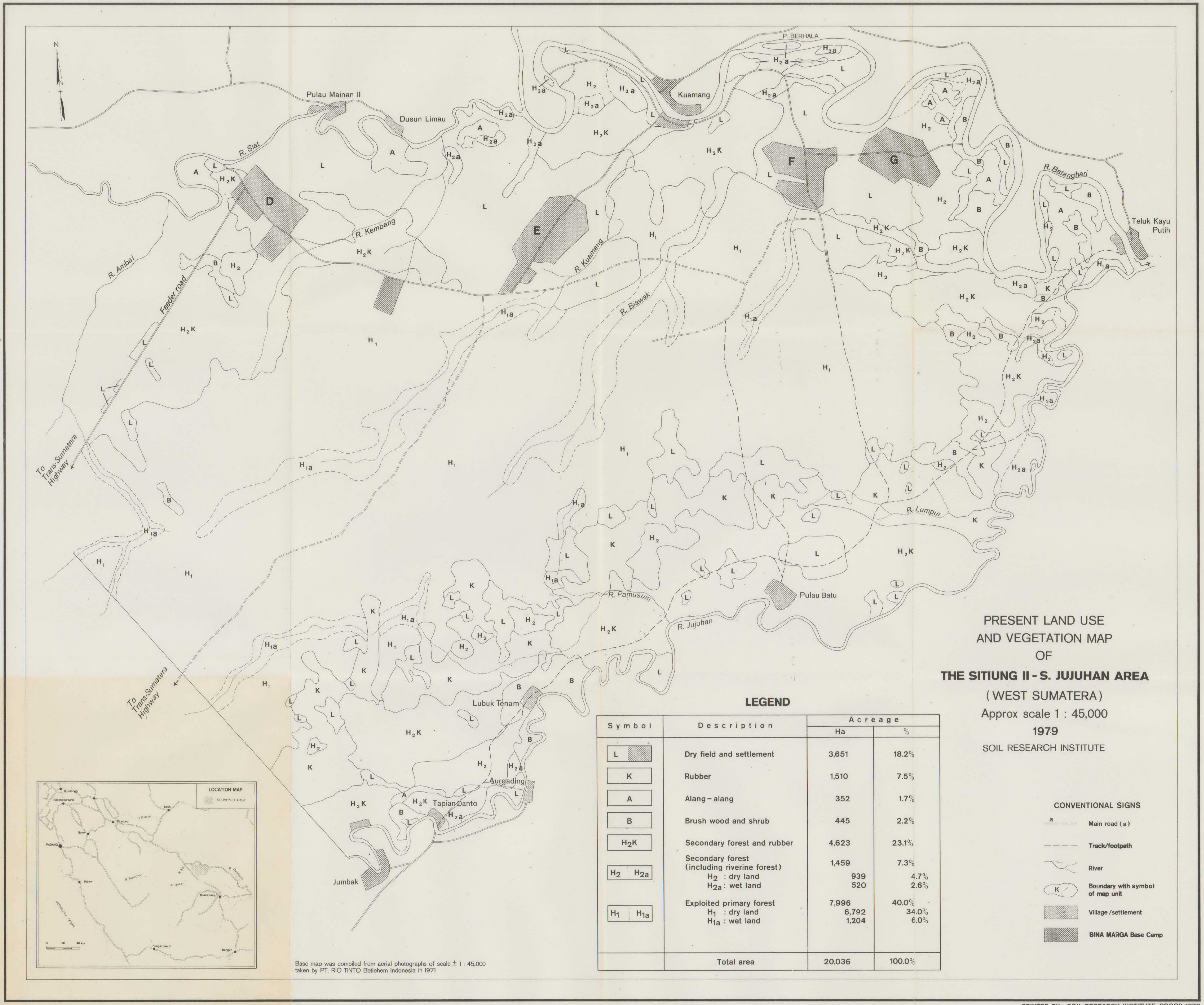
A : 0 – 3 %

B : 3 – 8 %

Air – photos of approx 1 : 50 5.000 scale were used as base map

PRINTED BY : SOIL RESEARCH INSTITUTE, BOGOR 1979

Printed by : Soil Research Institute, Bogor



PRESENT LAND USE AND VEGETATION MAP OF THE SITIUNG II - S. JUJUHAN AREA (WEST SUMATERA)

Approx scale 1 : 45,000

1979

SOIL RESEARCH INSTITUTE

LEGEND

Symbol	Description	Acreage Ha	Acreage %
L	Dry field and settlement	3,651	18.2%
K	Rubber	1,510	7.5%
A	Alang - alang	352	1.7%
B	Brush wood and shrub	445	2.2%
H_2K	Secondary forest and rubber	4,623	23.1%
H_2 H_{2a}	Secondary forest (including riverine forest)	1,459	7.3%
	H_2 : dry land	939	4.7%
	H_{2a} : wet land	520	2.6%
H_1 H_{1a}	Exploited primary forest	7,996	40.0%
	H_1 : dry land	6,792	34.0%
	H_{1a} : wet land	1,204	6.0%
	Total area	20,036	100.0%

CONVENTIONAL SIGNS

- Main road (a)
- Track/footpath
- River
- Boundary with symbol of map unit
- Village /settlement
- BINA MARGA Base Camp

Base map was compiled from aerial photographs of scale ± 1 : 45,000 taken by PT. RIO TINTO Betlehem Indonesia in 1971

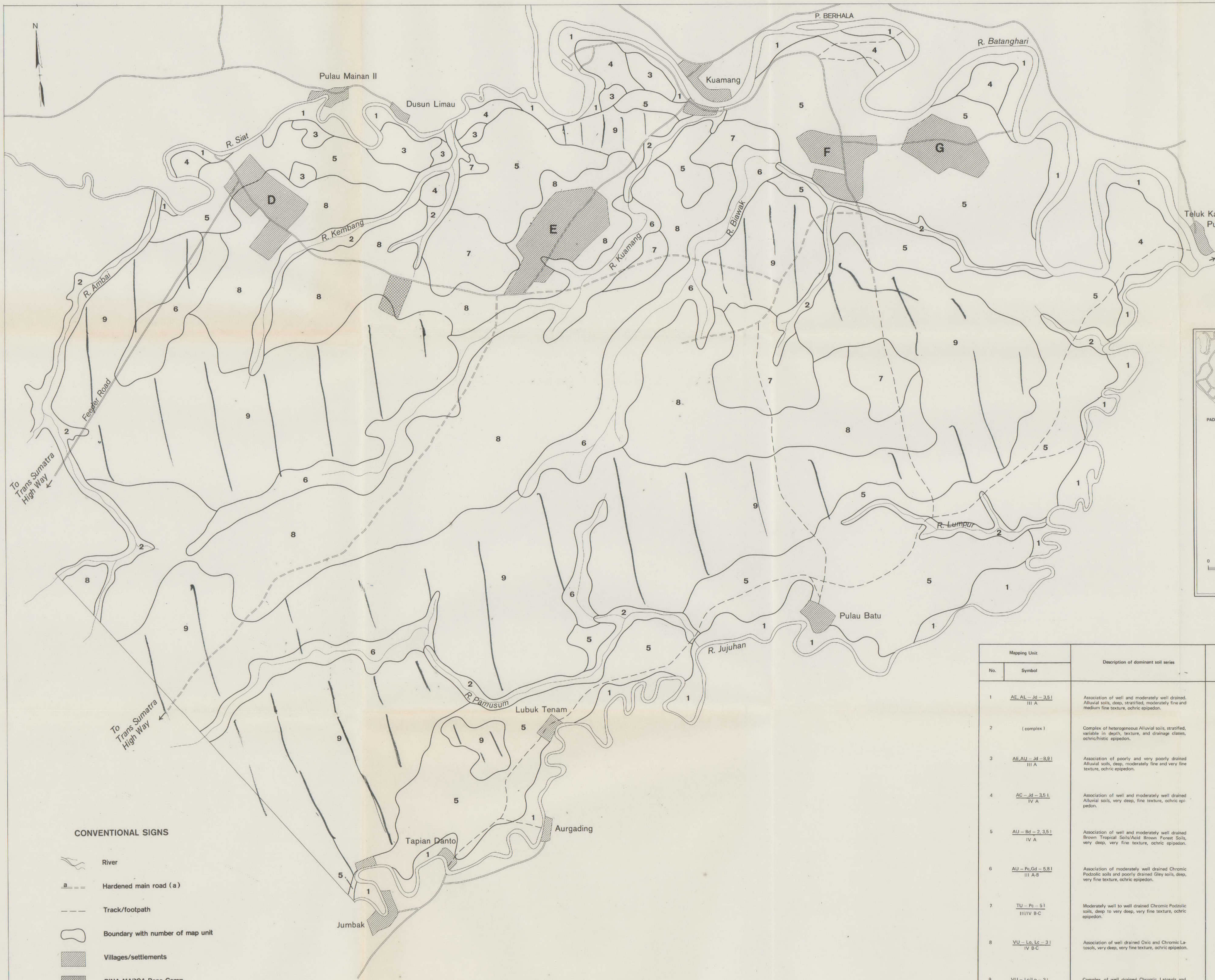
PRINTED BY : SOIL RESEARCH INSTITUTE, BOGOR 1979

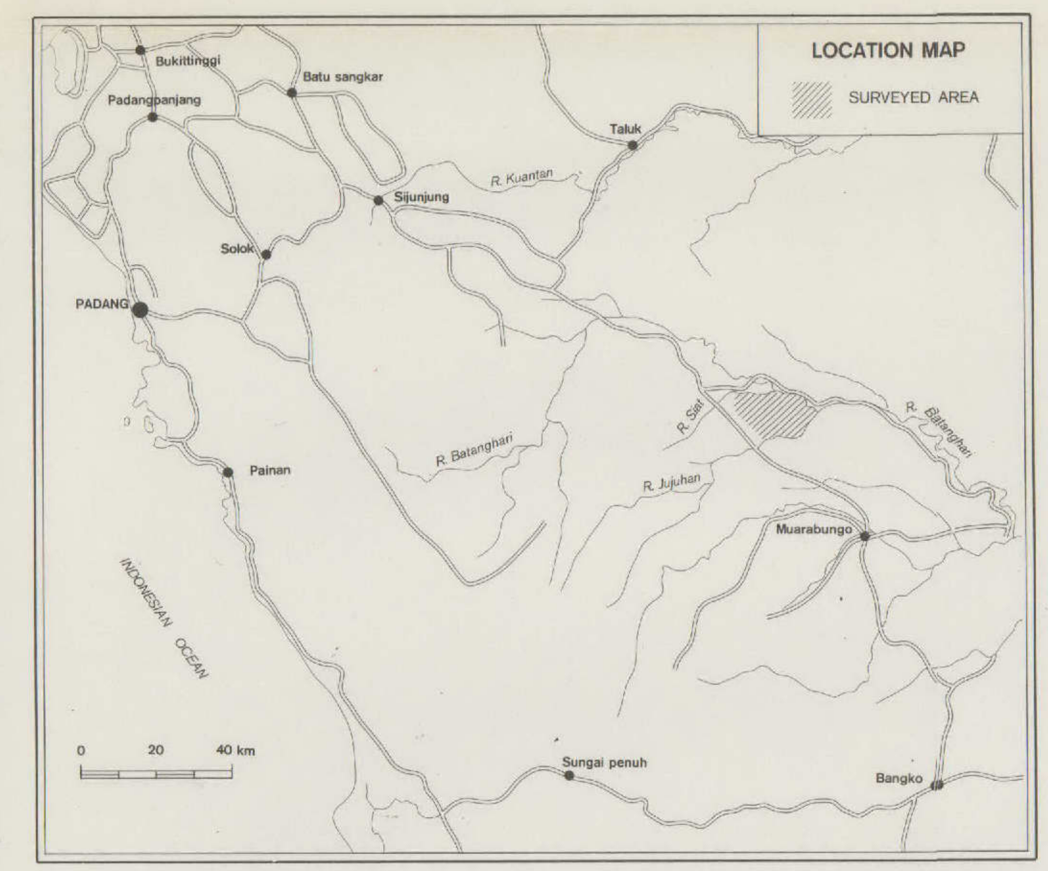
SEMI DETAILED SOIL MAP OF THE SITIUNG II - S. JUJUHAN AREA (WEST SUMATRA)

Approx scale 1 : 45,000

1979

SOIL RESEARCH INSTITUTE





L E G E N D

Mapping Unit No.	Mapping Unit Symbol	Description of dominant soil series	Parent material	Landform (dominant slope)	Soil suitability subclasses IR	Actual A	Actual R	Potential A	Potential R	Acreage Ha	Acreage %
1	AE, AL – Jd – 3,5 l / III A	Association of well and moderately well drained. Alluvial soils, deep, stratified, moderately fine and medium fine texture, ochric epipedon.	Moderately fine and medium fine textured recent alluvium	Recent river flood-plain/meander scars (0 – 3 %)	$IV_{s,f}$	III_f	IV_f	III_f	IV_f	1,120	5.6
2	(complex)	Complex of heterogeneous Alluvial soils, stratified, variable in depth, texture, and drainage classes, ochric/histic epipedon.	Heterogeneous textured recent alluvium	Valley floors/ stream belts (0 – 3 %)	VI	VI	VI	VI	VI	859	4.3
3	AE,AU – Jd – 8,9 l / III A	Association of poorly and very poorly drained Alluvial soils, deep, moderately fine and very fine texture, ochric epipedon.	Moderately fine and very fine textured recent alluvium	Back swamps/ oxbow lakes (0 – 3 %)	$IV_{f,n}$	VI	VI	$IV_{f,n}$	$V_{f,n}$	118	0.5
4	AC – Jd – 3,5 l / IV A	Association of well and moderately well drained Alluvial soils, very deep, fine texture, ochric epipedon.	Fine textured recent alluvium	Recent (low) river terrace/ floodplain (0 – 3 %)	$II_{n,s}$	IV_n	III_n	III_n	II_n	489	2.4
5	AU – Bd – 2, 3,5 l / IV A	Association of well and moderately well drained Brown Tropical Soils/Acid Brown Forest Soils, very deep, very fine texture, ochric epipedon.	Very fine textured subrecent alluvium	Subrecent (high) river terrace (0 – 3 %)	$II_{n,s}$	IV_n V_d	III_n V_d	III_n III_d	II_n III_d	4,388	22.0
6	AU – Pc,Gd – 5,8 l / III A-B	Association of moderately well drained Chromic Podzolic soils and poorly drained Gley soils, deep, very fine texture, ochric epipedon.	Very fine textured subrecent alluvium/ colluvium	Recent and sub-recent valley floors (0 – 5 %)	$III_{t,n}$/ $IV_{f,n}$	IV_n VI	III_n VI	III_n VI	II_n $V_{f,n}$	1,356	6.8
7	TU – Pc – 5 l / III/IV B-C	Moderately well to well drained Chromic Podzolic soils, deep to very deep, very fine texture, ochric epipedon.	Very fine textured tertiary river terrace mixed with quaternary volcanic colluvium	Peneplain (5 – 10 %)	$IV_{t,n}$	$V_{n,t}$	$IV_{s,n}$	$III_{n,t}$	$III_{s,n}$	690	3.4
8	VU – Lo, Lc – 3 l / IV B-C	Association of well drained Oxic and Chromic Latosols, very deep, very fine texture, ochric epipedon.	Very fine textured quaternary acid volcanic tuff	Peneplain volcanic cover (5 – 15 %)	$IV_{t,n}$	$V_{t,n}$	$IV_{t,n}$	$IV_{t,n}$	$II_{t,n}$	4,010	20.0
9	VU – Lc/Lo – 3 l / IV C - D	Complex of well drained Chromic Latosols and Oxic Latosols, very deep, very fine texture, ochric epipedon.	Very fine textured quaternary acid volcanic tuff	Peneplain volcanic cover (10 – 25 %)	$IV_{t,n}$	$V_{t,n}$	$IV_{t,n}$	$IV_{t,n}$	$III_{t,n}$	7,006	35.0
					Total =					20,036	100

IR = Irrigability for wetland rice, A = Arable crops, R = Rubber.

PRINTED BY : SOIL RESEARCH INSTITUTE, BOGOR 1979

SOIL SURVEY OF THE IRRIGATION PROJECT AREA SITIUNG - S. JUJUHAN (WEST SUMATERA), No. 3/1979

Printed by : Soil Research Institute, Bogor