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MINISTRY OF PUBLIC WORKS AND ELECTRIC POWER
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS

FEASIBILITY

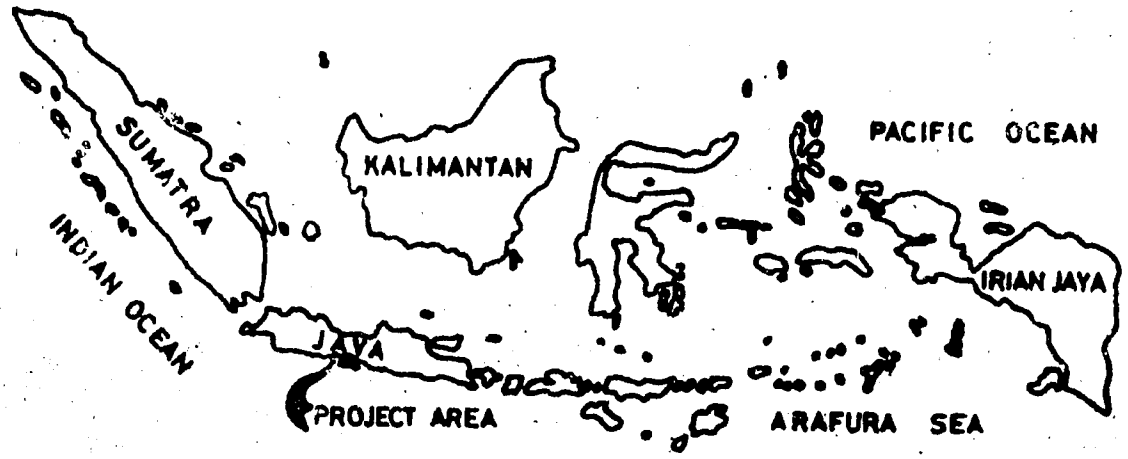
THE CITANDUY RIVER BASIN DEVELOPMENT PROJECT

PROPOSAL

PANAWANGAN PILOT WATERSHED CONSERVATION AND DEVELOPMENT PROJECT

FINAL REPORT

JULY 1976



SUBMITTED BY:

ENGINEERING CONSULTANTS, INC.
DENVER, COLORADO, U.S.A. BANJAR, INDONESIA

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MINISTRY OF PUBLIC WORKS AND ELECTRIC POWER
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS

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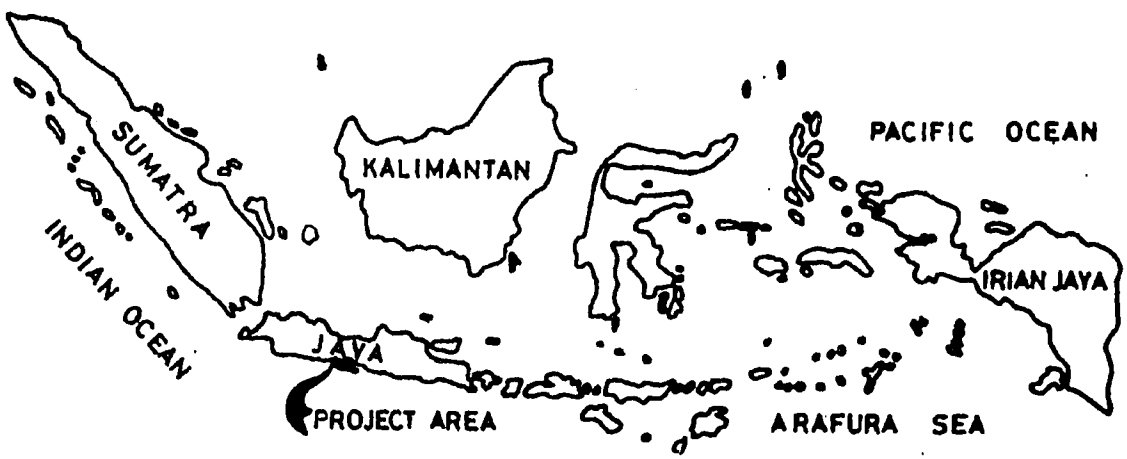

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DENVER, COLORADO, U.S.A. BANJAR, INDONESIA

PROPOSAL

PANAWANGAN PILOT WATERSHED CONSERVATION AND DEVELOPMENT PROJECT

Cooperating and Supporting Agencies

Ministry of Public Works and Electric Power, Republic of Indonesia.
- Directorate General of Water Resources Development
  - Directorate of Rivers - Citanduy River Basin Development Project
  - Directorate of Irrigation

United States Agency for International Development.

Ministry of Agriculture, Republic of Indonesia.
- Directorate General of Food Crops
- Directorate General of Forestry
- Directorate General of Fishery
- Directorate General of Livestock
- Directorate General of Plantation
- Director of Agriculture Extension, Education and Training Agencies
- Director of Research and Development

Ministry of Education, Republic of Indonesia.

Ministry of Health, Republic of Indonesia.

Ministry of Interior, Republic of Indonesia.
- Ciamis Kabupaten - Administration and Staff
- Panawangan Kecamatan - Administration and Staff
- Kawali Kecamatan - Administration and Staff

Authorization

This report was prepared by Engineering Consultants, Inc., as indicated in the "Terms of Reference" - Appendix B of Amendment No.1 to the Citanduy River Basin Development Project, and as further approved by the Steering Committee.

PROPOSAL

PANAWANGAN PILOT WATERSHED CONSERVATION

AND DEVELOPMENT PROJECT

FINAL REPORT

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LOCAL TERMS

Province	- West Java
Governor	- Governor of Province
Kabupaten	- District/Regency
Bupati	- Chief of District/Kabupaten
Kawedanaan	- Area consists of 3 to 5 Kecamatan. These areas serve under the Bupati.
Wedana	- Chief of a Kawedanaan.
Kecamatan	- Sub District (Administrative Unit)
Camat	- Chief of Kecamatan
Desa	- Village (West Java)
Kepala Desa	- Chief of Village/Desa
Kelurahan	- Sub village (West Java)
Lurah	- Chief of Sub-village
Bulog	- National agency for price control, and distribution of rice.
Dolog	- Provincial Administrative Bulog Program.
Bappenas	- National Planning Board
Bappemka	- District Planning Board

Bimas	-	Mass guidance for Agricultural intensification with government credit at low interest rate.
Inmas	-	Mass Guidance for Agricultural intensification without government credit.
Bank Rakyat Indonesia (BRI)	-	Rural bank
Ulu-Ulu	-	Field irrigation official at Tertiary Area.
Ili-Ili	-	Irrigation water gate tender
P3A (Mitra Cai)	-	Water Users Association
Penyuluh Pertanian Lapangan (PPL)	-	Agricultural Extension Agent.

PROPOSAL

PANAWANGAN PILOT WATERSHED CONSERVATION AND DEVELOPMENT PROJECT

INTRODUCTION

In the "Terms of Reference" Appendix B of Amendment No.1 to the Citanduy River Basin Development Project, it states in paragraph No. 3.5 "Upstream Watershed Land and Water Management Pilot Conservation Project", that the "Consultant will assist and advise the Ministry on the formulation and implementation of a demonstration and training program for improving land and water management practices in watershed areas subject to severe erosion".

"1. Demonstration Areas (Pilot Conservation and Water Management Watersheds). "Assist the Ministry in the selection of at least four watersheds with a minimum size of 250 hectares".

The Consultant's experts examined a number of watersheds in the upstream critical erosion and high runoff areas in the upper parts of the Citanduy Basin. In cooperation with the Forest Service, Agricultural Extension Service, and the Ciamis Bupati with his staff, two small watersheds were selected in Panawangan area above Kawali on the Ciamis Cirebon road. These two watersheds comprise approximately 442 hectares. One watershed will be treated with land and water conservation practices. The other watershed will remain untreated and will serve as the control.

These watersheds are problem areas and the watershed to be treated will require wide and varied types of conservation treatments along with water control structures to control the erosion. It will be necessary to provide technical help and labor to farmers to construct contour terraces, check dams, and other water and soil management

structures. Technical help will be needed to plan and conduct field and adaptability trials for comparison of different crops, different crop combinations, various terracing methods, multiple cropping systems, contour strip cropping versus no contour, and many other farming practices that require a resolution before general recommendations can be made for application on other watersheds in Java.

The watershed lands are in need of scientific planning and development to control the tremendous amounts of sediment that are being washed from the farms into the streams.

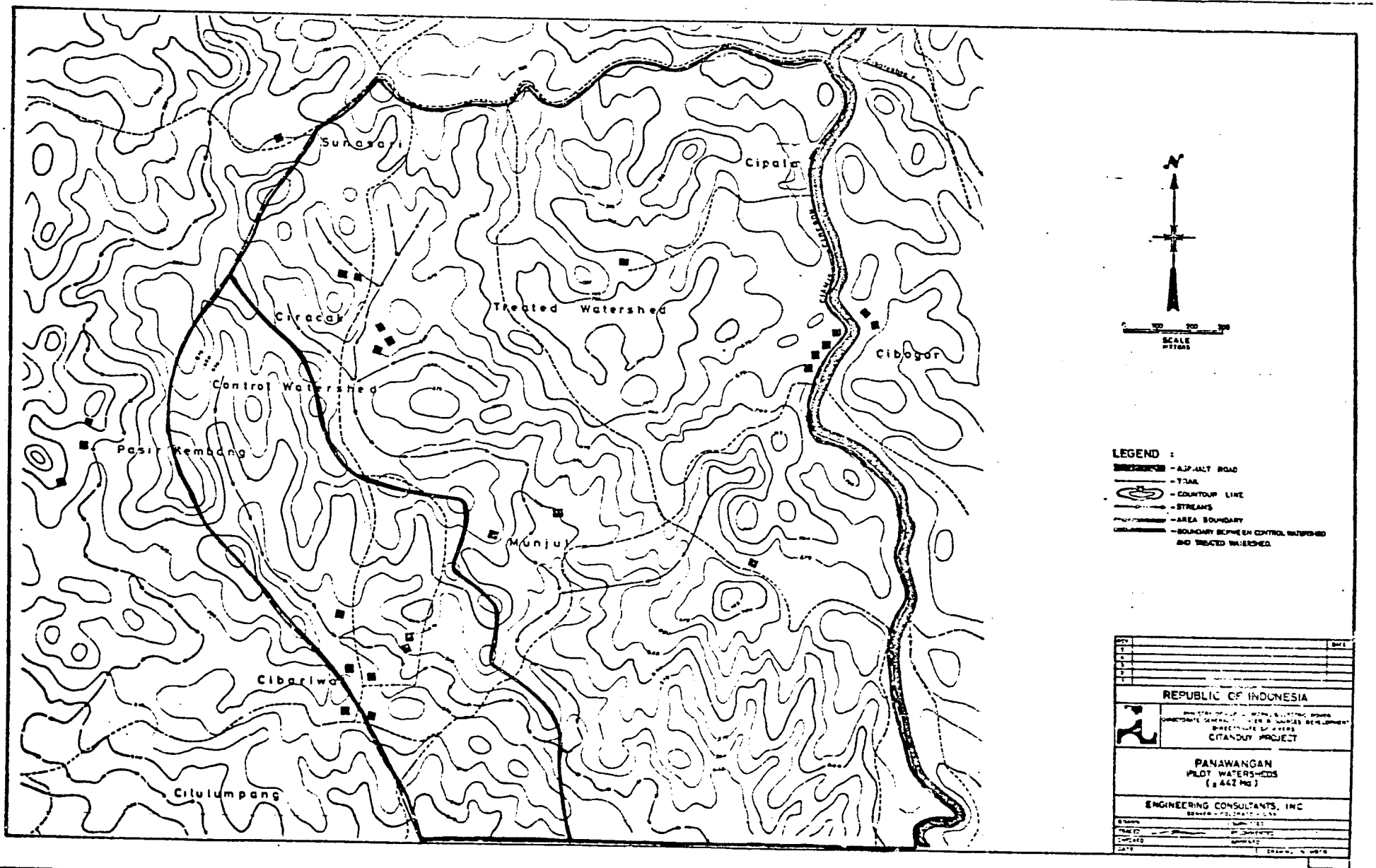
In the development of a plan for restoration of the pilot watershed, certain items should be studied and included in the overall plan and recommendations:

1. What are the major causes of erosion? Improper farming practices, overcutting and forest removal on steep land, erosion on roads and trails, or improper water control?

2. What are the rainfall patterns? Is the area subject to heavy torrential rains? Are there prolonged dry periods? Are soil conditions of such a character that infiltration rates are low? Is the water holding capacity of such a condition it will not store the heavy rainfall?

3. What is the status of erosion? Is surface runoff, subsurface flow, or gully erosion the dominant cause of erosion? Are rills and gullies just beginning or are they well intrenched?

4. What are the physical conditions? How does terrain, slope, both length and orientation, and the relation between the slope and stream pattern influence erosion? Are geologic factors influencing


Sunasari
Cipala
Treated Watershed
Ciracak
Cibogor
Control Watershed
Pasir Kembang
Munjul
Ciburiwa
Cilulumpang
N
SCALE
LEGEND :
- ASPHALT ROAD
- TRAIL
- COUNTOUR LINE
- STREAMS
- AREA BOUNDARY
- BOUNDARY BETWEEN CONTROL WATERSHED AND TREATED WATERSHED
REPUBLIC OF INDONESIA
CITANDUY PROJECT
PANAWANGAN
PILOT WATERSHEDS
ENGINEERING CONSULTANTS, INC

the runoff? Are the rocks hard or are they easily eroded? Are there adverse controlling geologic structures or formations? What are the physical, chemical and biological conditions?

5. What will be the impact of a control program on farms and villages in the watershed? How will the conservation program correct the erosion on the farms? Is reforestation a practical solution to some problems? Will the greening program influence farm practices? How will communities and villages be involved or affected?

6. Other matters relating to the water management program will need to be closely coordinated and assessed. What is the labor supply; availability of materials required; transportation problems? How will land owners and operators be taught conservation practices? Other items will need to be assessed as they arise in the development of the pilot program.

Location and Size

The Panawangan Pilot Conservation Watersheds are located approximately 7.6 km north of Kawali on the Ciamis - Cirebon highway. The Pilot watersheds are on the west side of the Ciamis-Cirebon highway. There are only a few jeep trails and foot paths that enter the selected watersheds. These are shown on the area contour map (page-3). The villages of Munjul and Ciracak are the only villages within the watersheds. The village of Cibogor is on the east boundary and the village of Cibariwal on the west boundary. (See page 56).

The Pilot Conservation Watershed area is divided into two watersheds. The watershed on the west will be used as the control and will be left untreated. This watershed is comprised of 92 hectares.

The watershed on the east is comprised of 350 hectares and will be treated with conservation and land development practices. There is a small area in the northwest corner of the Pilot Conservation area that is not in either of these two watersheds. It is included because it lies west of the highway and can be used for conservation demonstrations. Each of the two watersheds will constitute separate independent units.

Climate

There are no climate records available in the area. The watersheds are close to Kawali, elevation 300 m. The data from this station gives some indication of the precipitation in the Pilot watersheds. For example the mean annual precipitation at Kawali, is 3109 mm. Panawangan is located just north of the watershed area, and has a mean annual precipitation of 2647 mm. (See Table 1 and 2).

The Pilot Watersheds range in elevation from approximately 300 to 700 meters. The rainfall, from the storms observed, is primarily by intense storms of short duration and rather limited areal extent. They seem to be convectional in origin as they are triggered by warm air rising off the land mass in the late afternoon. The annual temperature range is small and it would be extremely difficult to attempt to distinguish seasonal temperature from data presently available.

Soil

Soils in the Pilot Watershed generally are highly sensitive to water erosion. The soils are of volcanic origin and fertility ranges from medium to poor. Erosion is classified as critical in the area.

Soil is considered an irreplaceable resource, since it takes nature from 300 to 1000 years to build 2.5 centimeters of topsoil under the most favorable conditions, including a cover of protective vegetation. Therefore, it is necessary to concentrate on physical, technical and socio-economic measures to stop erosion and restore the soil to a higher level of fertility.

Table 1 . AVERAGE MONTHLY PRECIPITATION IN PANAWANGAN STATION (Elevation ± 700 m)

YEARS *	MONTH												TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	(mm)
1958	486	584	615	432	340	40	184	331	32	114	200	594	3952
1963	177	265	485	165	0	0	0	0	0	63	302	270	1727
1967	135	490	433	357	75	0	0	0	0	0	137	164	1791
1969	560	507	267	196	157	101	0	0	10	0	162	231	2191
	RAINDAYS												
1958	21	18	26	14	14	5	9	13	4	10	11	15	160
1963	11	11	14	9	0	0	0	0	0	4	12	13	74
1967	7	13	6	9	5	0	0	0	0	0	8	8	56
1969	22	14	11	7	5	3	0	0	1	0	6	12	81

* These years are the only years when rainfall data is available for a 12 month period.

0 = No rainfall

- = No data

Table 2 . AVERAGE MONTHLY PRECIPITATION

IN KAWALI STATION

(Elevation ± 300 m)

YEARS *	MONTH												TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	(mm)
1951	483	391	234	193	176	374	168	158	142	120	109	353	2900
1952	443	590	281	161	129	120	112	162	375	581	364	263	3581
1954	483	345	384	350	430	245	221	369	196	319	827	660	4829
1956	722	414	262	345	605	416	227	371	181	585	299	526	4953
1957	360	246	541	346	78	123	615	163	95	96	349	816	3828
	RAINDAYS												
1951	29	20	15	10	10	19	9	6	6	5	11	15	155
1952	14	17	14	13	6	6	5	7	10	17	15	12	136
1954	20	18	14	14	13	16	15	14	12	17	27	18	126
1956	18	13	6	5	9	10	9	11	5	16	10	15	127
1957	15	6	18	11	5	8	17	8	7	3	11	23	132

* Only the years with complete data were used for this average.

Implementation of a Pilot Watershed Program

To carry out an effective soil and water conservation program it is necessary to involve, not only the individual farmer, but also the public interest which brings Government interests into the program. For this reason the Pilot Watershed program will involve the Kabupaten, Kecamatan, Kelurahan, and the farmer.

In selection of the Pilot Watershed, recommendations were made to the Bupati and his staff and they, together with the Project Manager, agreed that the Panawangan watersheds should be used for the Pilot Conservation program. It was agreed that the Planning Director of the Bupati staff should work with the Project Manager to implement the soil and water management program. Two meetings were held during March 1976 with the staff of the Bupati and the Project Manager. The following agencies were represented and approved the Pilot Conservation area: Animal Husbandry, Land Use (Agraria), Fishery, Rural Development, Directorate of Economics, Directorate of Irrigation, Ciamis District, Reforestation and Greening Program, Agriculture Extension Service, Plantations, Forestry, and several local government officials.

Mr. Rachlan, Director of Planning for the Bupati was designated as the leader to carry the program to the local governments and to arrange meetings with local people to explain the conservation objectives. It was emphasized in meetings at the Kabupaten level that soil and water management embraces the control of erosion and reclamation of the damaged watershed lands, and the determination of suitable systems of land-use and water management for different capabilities of land. The purposes of the Pilot Conservation program is:
1) to provide farmers with basic and technical information on how to control runoff and improve the production of the soil; 2) Stop deterioration of the production capacity of the soil by utilization of crop

rotations, grasses and/or legumes, trees, and fertilizer, and 3) To establish field trials and adaptability trials for comparison of varieties, fertilizers, planting dates, different crops, weed control methods and various other cultural and management practices.

The pilot watershed program will be a land conservation and land development program concerned with developing stable land management systems to prevent the loss of water and soil, whether the land is used for agriculture, forestry, greening program, roads, or villages. This in turn will improve the socio-economic conditions in the area.

Private ownership of the land must be recognized and certainly confers rights and privileges, but it also imposes responsibilities. It certainly does not confer the right to destroy the land resource, either deliberately or through ignorance. For this and many other reasons, the local and district government must be involved and brought into the management and planning of the water and soil conservation program of the pilot watershed. Although in specific cases the government may need to exercise control over how lands are used to achieve soil and water management, there must be safeguards against over-bearing and unreasonable use of power. There will need to be a means of supplying incentives to the farmers to encourage them to want to make changes in their land management systems, both for their own benefit and the benefit of the public. When decisions are made in the public interest, the land user should have the right to appeal, and in particular circumstances the right to seek compensation.

It will be the responsibility of the local government and Project together to inform the people in the watersheds of the objectives of the Pilot Conservation program, so these people will have a voice in planning and determining the objectives of the conservation practices to be used. Sub-units for operation will need to be agreed upon so

specific conservation measures can be developed for specific pieces of the land. Farmers will have to be taught how to use conservation practices and how to construct the necessary structures to reduce run-off and hold the soil in place. It will be necessary to acquaint farmers about the damage which soil and water losses are causing to their crop production. They will need to be trained how to prevent surface and gully erosion and how to establish a vegetation cover that will prevent such damage.

It will be necessary to strengthen the capacity of the government to progressively build a cadre of professional and sub-professional workers capable of working directly with farmers to give advice on how to apply conservation practices. This does not mean it will require a highly technical staff. High school and technical school graduates can be recruited locally and trained to provide a larger part of the technical help to the farmer. College trained people in the various disciplines will be needed in supervisory positions. These can be provided to the Bupati through the various technical agencies as needed.

From the discussions of the meetings held with the government of the Kabupaten and the Project, the Consultant recommends that a Board be established at the Kabupaten level with the Bupati as Chairman and the Project Manager as Co-Chairman. They would select other members that the Bupati and Project Manager believe are needed to coordinate and implement plans as they are submitted at the Kacamatan, the Kelurahan and Desa levels.

A committee will be formed at the level of the government, the Kecamatan, Kelurahan and Desa to plan and organize the conservation and land development program which will be designed to help the farmer with his soil and water problems and to improve the land.

Technical assistance to the farmer will be made available by the local government. The Project will provide funds, equipment, seed, fertilizer, part of the labor, or any other type of assistance through local government channels. The local government according to the Consultant's design report will determine which units will be planned first and the order each unit will be rehabilitated.

Assistance should not come directly from the Project to the farmer because the farmer should depend on the local government for his assistance and should not look directly to the Project for help. Experience has shown in other conservation programs when farmers received aid from sources other than the local government channels, it became the outside project's program and the farmers expected the outside project to keep the program going. On the other hand, if assistance comes through local government channels and the farmer is made to feel he has a responsibility to keep and maintain the conservation practices on his land, he will continue to look to the local government for assistance after the project has completed its part of the assistance. The farmer will not depend on the project to maintain the conservation practices on his farm. The local Government, with the help of the extension service and other agencies, is then looked to for the additional assistance the farmer may need in future years.

The committee of the Kabupaten in cooperation with the Project will recruit the technical personnel for the Pilot Watershed. The committee and Project in coordination with the extension services will organize training programs, specific courses and seminars, and give specific coordination to the Kecamatan and Kelurahan recommendations. The consultant in cooperation with the Kabupaten and the Project will arrange for surveys to be conducted on soils, land use, ownership, vegetation, geology, engineering, land capabilities, and any other physical or sociological studies needed to carry forward the

overall program. The committee of the Kabupaten will provide liasion with the Provincial Government for technical assistance and program evaluation. This committee will coordinate the use of all equipment, labor, and materials made available for the Pilot Watershed Program.

LAND USE

Most of the land in the Pilot Watershed is presently used for upland crops. Rice paddies occur in the bottom of the drainage ways, which are generally small and narrow. A number of springs are found in the smaller side drainage ways. This water is piped to small irrigated plots. Many farmers own a few sheep and cows. These animals are not grazed, but fodder is cut and the animals are fed in small enclosures. One swine farm is in the watershed. Green feed is cut and used for supplementary feeding.

According to the land use map, prepared by the Directorate of Land Use Planning in 1970, the larger areas are classed as bare land not suited for farming operations.

The new type of agriculture or land use that will be developed may change many presently used practices. The introduction of technical erosion control measures such as contour terraces, contour strip cropping, silt traps, and water disposal drainages may require considerable economic and sociological adjustments. This may require government support, both technical and financial.

The prevention of erosion and water management can only be achieved with rigid controls of runoff in upper areas of catchment basins. Some changes in land use may require farmers to completely alter their present systems of farming. This is usually a complex social problem and may be expensive.

When the use of some of the land is changed to manage water and control sediment, a protective type of plant will be required, such as clove, albizzia, leucaena, or plantation tree.

There does not appear to be any forest land in the watersheds. Many of the steeper lands should be managed under the greening program. This program is to be started in the Pilot Watersheds in the 1977-78 Budget Year. Major problems to be overcome are associated with finance, land ownership, and lack of land use legislation.

The agricultural extension service has initiated a terrace and rehabilitation program in a small section of the watershed near Panawangan. This and other conservation measures that are already started will need strengthening and included in the overall conservation program.

Land Classification and Capability

Land capability has to do with suitability of land for special uses. A sound farm conservation plan requires two essential elements: (1) is an inventory of physical land features, which for convenience is recorded on a map. (2) has to do with facts about the family, business, available labor, facilities, etc. Soil conservation technicians have found the land inventory map should show soil type, depth, erosion and slope. The land inventory map must be detailed to clearly show adjustments that are needed and should show separate treatments, field by field. This makes a map showing what the land is suited for and specified uses the farmer wishes to use land with the necessary water and erosion adjustments. It is apparent most upland farmers have failed to realize steeply sloping land cannot be farmed safely with level paddy practices. Many present terraces and cropping

rows are not on the contour. Rain falling on unprotected slopes removes part of the soil resources. However, soil losses come so gradually that the farmer does not realize what is happening to his resources until it is too late.

The use and conservation of land is influenced by the nature of the soil, the degree to which it has been affected by erosion, the slope, the infiltration rate and water holding capacity, and the climate. Climate must be considered because it affects crops and vegetation that can be grown and density of ground cover. These factors determine the need and control measures required for water management and erosion. Any of these factors, or several together, may limit the use of the upper watershed soils.

A land capability map prepared in 1973 by the Directorate of Land Use Planning shows a large percentage of the land is over 40 percent slope. (Page 60) The bottom drainages are 2 - 15 percent slope. All the land is subject to erosion. This is representative of the condition of the land in the Pilot Watersheds. The land falls into two broad groups, one suited for cultivation, the other not suited for cultivation. The restrictions imposed by natural land characteristics necessarily affect (a) the number and complexity of corrective practices to be used, (b) productivity of the land, and (c) intensity and manner of use.

The Land Capability map can serve as a guide in planning more detailed maps needed for farm planning. The land capability concept will be mapped to establish units bounded by different degrees of use limitations, or hazards. Local experience of land usage and population pressures must be considered in the farm plan. Considerable progress has been made in uniformity of land capability class delineations,nevertheless,each class still varies by locality and prevailing agricultural

experience. Land capability classification expressed in physically measurable units, and capable mathematical expression, could be used from one locality to another. Local application of the concept could be determined by treatment practices and costs necessary to create a desired level of plant growth and a relative benefit: cost ratio for each effect.

Significant Variation in Land Features.

Factors used to determine differences that significantly affect conservation practices are: use suitability, crop yields, and management requirements. In interpreting what the land will do and what it needs, each of the following land characteristic should be considered in relation to all of the others:

The land characteristics that have been found to be most meaningful in determining land capability are:

Effective depth of soil (as depth over rock, tough clay, or hard internal layers).

Texture of surface soil (how it influences infiltration rates, heavy clay, sand, silt).

Permeability of the subsoil (very slow, slow, moderate or rapid).

Natural soil drainage (well drained, moderately well drained, imperfectly drained, or poorly drained).

Organic content (high, medium, low).

Reaction of soil (ph), natural alkaline or acid.

Inherent fertility, high - moderate low.

Slope - 0 - 10%, 10 - 20%, 20 - 35%, 35 - 50%, over 50%.

Erosion (slight, moderate, severe).

Surface erosion or land gullied. Rill erosion present.

Land can be classified according to its capabilities when the above characteristics and a knowledge of the climate of the area are known.

Facts obtained in the field

The only dependable way of determining the capabilities of land is to make an examination in the field. This can be done by men trained to look at various factors of soil depth, texture, permeability, moisture holding capacity, inherent fertility, organic content and other factors that may affect management of soil and water. These technicians record slopes, depth of soil loss by erosion, rain drop splash, and other water hazards, that may influence how the land will need to be used. These facts are recorded for use by the farmer and advisor at a later time.

Management Systems for Erosion Control

Cover Crops

It is important that crop production practices be incorporated into a management system that will provide an acceptable income, reduce erosion to an acceptable level, and improve the fertility of the soil.

Soil, water, and crop management practices adopted by the farmer in his conservation plan should increase infiltration rate, water holding capacity, resistance to soil dispersion, and movement by rain drop splash and runoff water. Soil Management and fertility practices which increase the production of the soils also increase income potential and generally increase vegetation cover resulting in decreased erosion.

An excellent growth of vegetation is effective in reducing runoff and erosion in the following ways:

1. It intercepts a part or all of the demaging raindrop impact from precipitation. The vegetation canopy and crop residue on the surface provides good protection from raindrop impact which is serious in the watershed.

2. Vegetation and vegetative residue on the surface reduce the rapidity of the runoff, which in turn prevents concentration of runoff water, and allows more time for infiltration to take place.

3. Roots bind the soil particles together and when the roots decay, humus is added and the root channels provide openings for water to enter and flow through the soil. Decaying humus adds organic material to the soil, improving its infiltration and water holding capacity.

4. Living plants take water from the soil for their growth processes, providing more capacity for future precipitation.

5. Vegetation and its residue provide a suitable habitat for small animals, earth worms, and other biotic life to function in the process of soil stabilization and soil building. Their activity in soil improves the physical condition and influences soil infiltration.

Actual measurements show that soil is most susceptible to erosion when fields are bare of vegetation. They also show soils low in organic matter content are more easily eroded than those with high organic matter. Evidence also indicates that, except on flat or gentle slopes, soil losses are certain to occur if the soil is bare. This

is especially serious since at least three-fourths of all crops are produced on land with sufficient slope to induce erosion if not protected with vegetation or other water control measures.

Cover cropping is not a cure-all, but it represents one of several practices that can be used in any soil and water conservation program.

Some crops are said to be soil depleting, some soil conserving, and others soils building. These terms must not be confused with soil building or soil depleting and soil conserving practices. A soil may be depleted by bad practices even though the crops now are not soil depleting. Soil conserving practices involve the application of fertilizers, rotations, kinds of crops, terracing, contour strip cropping, and many other practices.

Soil Depleting Crops

A soil depleting crop may be defined as one that causes rapid use of organic matter and essential mineral elements. The term is a relative one; some crops are more soil depleting than others. Cassava is a soil depleting crop yet it may completely protect the soil from rain-drop impact. If plants are left to decay in place or incorporated into the soil, the minerals they contain are returned to the soil. All harvested crops remove something from the soil, and in so far as this is done they are soil depleting. The depletion of minerals cannot be avoided if the crop is removed from the land. Consequently, it is necessary to provide mineral elements through fertilizers and mineral supplements.

Soil Conservating Crops

Soil conserving crops must be considered in terms of the effect these crops have on the organic and mineral elements of the soil. The more intensive the cultivation on the upper watershed soils, the greater the destruction of organic matter. It is the surface soil that erodes first and the organic matter goes along with it. Non-cultivated crops, such as grass and some legumes, tend to conserve the organic matter which aids in conserving the soil. Soybeans, cowpeas, and other legumes are considered soil conserving crops because they usually add nitrogen to the soil when properly inoculated.

Soil Building Crops

Soil building crops must conserve the soil, and build it up to make it better. Plants can not build up the mineral portion of soil. All minerals in plant tissue comes from the soil. When plants are removed from the soil the minerals are removed with the plants.

Plants can build up the organic content of soil and with it the nitrogen content of the soil. Legumes are usually nitrogen builders. Some legumes provide nitrogen to the soil and, if they are incorporated into the soil, they supply organic material. Also decaying organic material, such as rice straw, when incorporated into the soil provides organic matter. However, nitrogen may become temporarily unavailable for plant growth until decomposition of the rice straw is complete. This may require a period of two or three weeks in the wet season and longer in the dry season.

The rate of runoff and erosion is greater when the soil is left bare than when a protective cover is provided by growing a permanent sod grass. Many of the Pilot Watershed steeper slopes are bare during part of the year. The kind of legume and the way it is used must be considered. Soybeans for example, cultivated in rows and harvested as hay or green fodder are not a good soil builder. Even

when the soybean is inoculated there is more nitrogen removed in the hay than the plant takes from the air. Since the root system is small, little nitrogen is returned to the soil. The same is true for other annual legumes that are harvested. When soil building crops are considered in the soil and water program, it is necessary to specify the kind of legume, and how it must be used to help in soil building.

For soil building it is necessary to turn to a permanent sod. A permanent sod will increase the organic matter in the soil, chiefly by its root growth. A healthy grass sod produces new roots every year and the decay of the old roots adds organic matter, most of which is retained because the soil is undisturbed. A grass sod if not cut or utilized by livestock is probably the only practical 100 percent soil-building cover. If it is cut for fodder or grazed it may be necessary to add fertilizer, but even then the protection from erosion that such a cover offers, together with the increase in organic matter by root growth, makes grass and legume mixtures ideal conservation measures.

Crops grown with minimum tillage of the soil are in varying degrees soil conserving crops. Close growing crops cultivated each year are to some extent soil conserving, but annual tillage of the soil induces erosion. Crops like peanuts and sweet potatoes are in this class. On the other hand, crops that are not close growing, like corn and cassava, are soil depleting crops.

A list of plant and tree species recommended for use in the watershed rotations is included in these Appendices Nos. VI-VII.

It can be broadly stated that intertilled crops or annual crops, such as cassava, cause erosion, and crops such as sweet potatoes, peanuts, and soybeans, provide some erosion protection. By alternating crops with these characteristics, a degree of protection can be achieved.

Grass is one of the better erosion and soil building crops. Contour grass strips on slopes of less than 10 percent can be used as a water management and erosion control crop.

Each management unit should have a plan showing the owner or farmer use, crops to be grown, terraces and check dams, or any other conservation measures that are to be used on the land unit. This is called the Farm Plan.

Farm or Unit Plan

One of the major objectives of the unit and farm plan is to help the farmers understand what the erosion and water problems are on their farms and how they can correct these problems and still use their land in accordance with its capabilities. Land use and land capability map are shown on pages 59 and 60, respectfully. On these maps a description of each type of land appears in the legend. These types of land are considered by the technician when helping the farmer decide how best to use his land and what conservation practices will be required. Experience has shown that it is necessary to explain to the farmer how he can continue to farm his land and still correct the soil and water problems. A locally adapted plan for each unit will show each farmer's land and how it will be managed. In some cases, erosion control measures may serve more than one piece of land. (Example of map on page 64 plate No.T1).

One of the most frequent kinds of land misuse is cultivation of steep slopes. The steeper the slope, the greater the danger of land damage. The steep slopes being cultivated are badly damaged and many are badly gullied.

Many gullies started in the banks of natural water courses are now eroded to great depth. They grow deeper as they advance up the slope. This branching continues until a network of gullies is progressing over much of the watersheds.

The first step in controlling this erosion is to plan the farms so as to make the best possible use of the land. This should include making an inventory of the steep and eroded lands which should be properly terraced and converting slopes above 50% to a permanent cover. Only the moderately sloping land should be used for cultivated crops. Waterways or natural depressions should be planted to close-growing perennial vegetation. Recommended species of trees, cover crops and legumes are included in the Appendices Nos.VI-VII.

The best known methods of controlling or preventing erosion are vegetative controls, such as mixtures of grass and legumes, and combination of vegetation and engineering controls. The use of engineering controls, such as terracing, contour cultivation, contour stripping, and water disposal structures should always be used in combination with a good crop rotation or rotation cover.

The cost of controlling steep gullied land and the protection required should be considered in relation to the use that can be made of the land according to the farmer's needs and willingness to apply conservation practices. Many times this requires resources beyond the farmer's economic ability. It is here that the Project through the local government can assist by providing some of the

fertilizer, seed, livestock, part of the labor, or other assistance as incentives to help off set the burden of putting the land in a condition so it can be maintained with proper care.

It should be emphasized that the farmer must be trained and educated to assume a responsibility to install and follow a conservation plan. It is essential he understands it is his responsibility to maintain terraces, check dams, etc. and to repair any damage that occurs. Where farmers do not understand their responsibility, conservation practices become damaged to the point they are no longer effective.

Some steps necessary in preparing a farm plan for a unit of farms are as follows:

1. The technician should point out the ability of the soil to produce crops, what are the erosion problems, and things to be done to properly manage the soil and water.

2. The technician should explain what is meant by land capability and why it is necessary to make changes in management of the land.

3. A unit map should be prepared showing land ownership of each farm and a plan on how to control erosion, changes necessary to manage water, changes in cropping systems, engineering structures necessary, what the local government and project will do, and finally what will be expected of each land owner or land operator.

4. A map and plan on how the plan will be accomplished should be prepared and each member of the unit given a copy. This plan should show what will be done on each field and when it will be done, crops to be grown, trees and shrubs to be planted, structures, terraces, and other engineering measures needed to meet the conservation objectives.

Forestry and the Greening Program

There is no Forest Service land included within the Pilot Watersheds. However, many of the steeper soils, now cultivated with new crops should not be permitted. These lands should be placed under the Greening Program and the land planted to trees and a permanent grass and legume cover crop. This may require a complete reversal of the present farming operations. Under the greening program, seed, tree seedlings, fertilizer and technical assistance can be obtained from the forest extension service to help the farmer change his cropping system. Experience has shown that converting the steeper lands to trees and a permanent cover crop, and harvesting the wood, fruit or nuts along with the fodder for livestock, a profitable operation can be maintained to provide for the family. The farmer will be required to make adjustments in his methods of operation and may require government assistance for about five years or until his tree crop is old enough to start producing profitable yields, but after this period of adjustment the new crops should be self sustaining.

Planting Seedlings

Care of seedlings and proper planting are essential to good survival of nursery planting stock. A sketch of how to handle and plant seedlings is included in the Appendix No. III. Farmers must be taught proper method of handling seedlings.

Fish Ponds

When the land owner and the conservation fish management specialist combine their talents, a contribution can be made in maintaining a high quality environment for fish, but it takes technical competence and money. Such an opportunity exists in the

Pilot Watershed. A meaningful fish pond plan requires careful planning and entails costs. Fish ponds should be a cost-sharing enterprise. If the owner is to provide land for the fish pond, fish to stock the pond should be provided from other sources.

These ponds provide water storage and this helps to reduce flood and high runoff peaks. In order for a fish pond to be successful it should be carefully managed so fish have a proper food supply. Fish foods are generally known and can be increased by good management. Too much water can be as harmful to fish as it is to farm lands. Floods can destroy food and cover and so disturb the growth of plants, that seed and food may become inadequate. Specific water quality standards are necessary for some fish while others can withstand adverse conditions. Sediment is a factor in fish culture. The adverse effects of sediment can be many: fishing is more difficult, the food chain is destroyed, the eggs are smothered, and in general the habitat is degraded.

Fish production can be an important factor in the income of land owners. A fish pond is desirable on any farm unit. It can, if properly managed, provide a portion of the protein diet. A well managed fish pond of one quarter of a hectare in size will supply approximately 200 kilograms of fish a year. However, good locations are not always available and it may be necessary for several farmers to use the same pond. Fish ponds can become an important factor in controlling runoff and flooding. Water stored in ponds can be used for irrigation and drinking water for livestock. Also, storing water in ponds helps to reduce the peak runoff in high intensity storms.

A fish pond should be designed by the engineering technician. It requires a knowledge of the soil and foundation conditions, watershed runoff potential, and a structure designed with adequate spill-

way protection in case of large floods. Sites for ponds are available in many of the side drainages and on the main streams. These ponds will help reduce peak runoff as well as provide additional irrigation water. It is not advisable to design a pond layout to fit all conditions. Consequently, the farm planner should plan as many ponds as sites will permit.

Meteorological Equipment

A complete weather station will be located near the center of the two watersheds. Six manual rain gages will be installed at selected sites over the watersheds to obtain a rainfall pattern. (See page 51 for cost estimate of weather station).

Measuring Weirs

A Broad Crested Weir will be constructed on the Cicarenang River and a Parshall Flume will be constructed on the Cinyangsang River (Designs on page 72 and 73). These measuring devices will be located just above the point where these two rivers join together. Exact locations and specifications will need to be determined by the hydrologist and the Engineer. A water stage recorder will be placed on each weir. Water and sediment flow from the control and treated watersheds can be measured to compare the effectiveness of the conservation practices in the treated watershed. Sediment discharge will be calculated from the continuously recorded streamflow and from suspended samples taken during periods of medium and high water flows. A US DH-48 Hand Sampler will be used to take sediment samples at the measuring weirs. Total sediment analyses will be done in the project soils laboratory. Total sediment load will be calculated based on determined sediment concentrations and the corresponding streamflow discharge at the measuring weirs.

Two other flow and sediment measuring weirs will be installed at the base of slopes where prominent gullies/streams now exists in the watershed. Exact locations of these weirs can not be determined until a topography map is available. All weirs will be designed by the engineer to adequately measure sediment and run-off from sub-watersheds. Cost estimates of the weirs are presented on page 53.

Sediment will be calculated by measuring the amount of sediment caught in the sediment basin. Periodically water samples shall be taken to calculate the amount of suspended sediment passing over the weir. The first samples shall be collected and analyzed before the demonstration is started.

Water Management

Water management is an indispensable part of modern agriculture. In water management, the ultimate target of any knowledge transfer must be the farmer, for it is on farm land where production resources, including water, climate, soil, crop, fertilizer, and management, are all integrated into an agricultural system. The transition from traditional farming to conservation farming methods will be difficult and sometimes costly, but this is necessary if run-off and siltation is to be controlled. Part of this expensive process will be preparation of farm land to receive and store water which will include land grading, construction of contour terraces, diversion terraces, and waterways to dispose of surplus runoff. Improvement of the entire physical system is a necessary requisite to a satisfactory pilot conservation water and soil management program.

The ultimate objective of the upstream water management program is knowledge the farmer has of his problem. To reach this objective, it will be necessary to train farm advisors, system

operators, and administrators. The farmer can be provided with necessary technical advice, seed, fertilizer, and management procedures, but unless he understands and can see a profit in his efforts, it will be difficult to get him to alter his traditional methods. Capital is scarce and labor abundant, therefore, focus of the watershed program must be on adaptability of technology to conditions that the farmer understands and can achieve.

A particular advantage of the modern water management system is that it has a considerable amount of management built into it and the farmer is automatically led to correct decision in the application or soil and water conservation measures. A farmer will make fewer mistakes with a well planned system than a farmer that does not have the technical input regarding water management. Continued focus on improved water management must become a new way of life for the farmer if he is to continue using the shallow-upper watershed-soils.

The design and construction of water control structures in the farmer's water conservation program presents a number of administrative problems. Basically, it will be necessary to include in the farm plan all the elements of the different programs. The farm planner must be acquainted with all Extension Service programs, Greening programs, Agricultural programs, and construction programs, to build this help into a coordinated financial plan for the unit of farms.

Conservation Irrigation

The term conservation irrigation is a relative new one. Only in recent years has it become part of the terminology of irrigated agriculture. "Conservation Irrigation" is simply using irrigated soils and irrigation water in a way that will insure higher production without

waste of either water or soil. Like other conservation practices used in dry land agriculture, conservation irrigation means using cropping, irrigation and cultural practices that will maintain the land for permanent agriculture. It is the simple use of irrigation and cropping method, that best fit the particular soil, slope, crop, and water supply.

Conservation irrigation can mean savings in water and control of erosion, which results in better crop yields and assurance of continued productivity from irrigated land.

In the Panawangan watershed the need for conservation irrigation is urgent. The control of water is one of the chief concerns. With better control of water with check dams and water retarding structures, additional water can be diverted to non-irrigated land. Also, water held in fish ponds and the increase in base stream flow will supply more water for irrigated crops.

The only irrigation in the Panawangan Watershed is in bottoms of small drainages and the old lake bed. Permanent water is used in these small rice paddies. As conservation practices become effective in controlling the high runoff, more water should be stored in the soil mantle and will appear later as base stream flow. This water can be controlled and used for irrigation.

When the unit planner makes the farm plan he should consider the possibilities of what lands to irrigate and what control structures will be necessary. The amount of water that may be available is a major item in farm production because in Panawangan watershed there are 3 to 4 months of the year when very little precipitation is received.

Crop Yields

Terracing or any other type of mechanical practice alone generally will not increase crop yields. Because of depleted condition of soils it will require use of fertilizer to take advantage of additional moisture that will be available. Recommendations for a two and three years rotation for the Solo Sub-watershed are shown in Appendix No. II. These rotations take into consideration principle crops grown in the Solo watersheds: cassava, dry land rice, peanuts, and corn. It would be advisable to try some other dry season crops that are more drought resistant such as sorghum or some other crop in Panawangan watershed. Crop rotations used at the Waspada Experimental Station are shown in Table 3. Some of these rotations may be applied in Panawangan Pilot Program as field trials.

Root crops should not be planted on the lip of terraces as this may damage the terrace lip when the crop is uprooted. The terrace lip should be planted to a grass and legume mixture.

Crop rotations will need to be planned with the farmer after taking into consideration the type of soil, the steepness of the land and the needs of the family. The farmer should understand why it is necessary to retire some land to grass and trees, and why it is necessary to use conservation measures to conserve the soil.

Intercropping should be given preference over sequential planting, as it insures greater economic returns and better income stability for the farmer by protecting him against the risk of a total crop failure and wide price fluctuation of a one crop system. It confers almost the same benefits as a crop rotation with regards to its effects on the soil. This is especially true if a legume is included in the combination even though the legume may be removed

for fodder the fine root system with nodules stay in the soil to decay and supply nutrients to later crops.

Fertilizers

Because of mixing the soil during terrace and contour construction it will be necessary to apply fertilizers to the soil. Fertilizer at subsidized prices should be made available through the local government for the first Five Years as an incentive to farmers to participate in the program. Rates of fertilizer for the first year should correspond with the rates applied in Solo and the field data as shown in Appendix No.II. Rates may change after experimental data are available from Panawangan Watershed field trials. It is expected that farmers will recognize the benefit of fertilizers when applied every year. An application of 150 kg/ha of urea and 200 kg/ha of TSP should correct most of the problems associated with terrace construction. However, fertilizer rates, kinds and time of application will follow the recommendation of the BIMAS program, except on some model farm units where comparison studies will be made. These studies will be outlined in the Design Report for the Panawangan upper watershed.

Table 3 CROP ROTATION USED AT WASPADA EXPERIMENTAL BASIN

Months	First Year	Second Year	Third Year
January	Upland Rice		Harvested Cassava
February	Harvest Rice		Corn
March	Corn Interplanted with Shrub-Type Legumes Harvest Corn	Cassava Interplanted with Shrub-Type Legumes and used for Mulching in cassava	Interplanted with Shrub-Type Legumes Harvest Corn
April			
May			
June			
July			
August			Upland Rice
September	Peanuts Harvest peanuts		
October			
November			
December			

SAWAH ROTATION

CROP ROTATION USED AT WASPADA
(Continued)

Months	First Year	Second Year	Third Year
January	Paddy-Rice	Paddy-Rice	Paddy-Rice
February			
March			
April	Harvest-Rice	Harvest-Rice	Harvest-Rice
May			
June	Soybeans	Sweet Potatoes	Soybeans
July	Harvest Soybeans		Harvest Soybeans
August			
September	Corn and		
October	Crotalaria yuncea Harvest	Harvest Sweet Potatoes	Corn and Peanut for fodder Harvest Corn and Peanuts.
November	Paddy Rice	Paddy Rice	Paddy Rice
December			

SAWAH ROTATION

Example of a Crop Rotation for Dry Area.

Months	First Year	Second Year	Third Year
January	Harvest Corn & Peanut	Upland Rice	
February	Grain		Start Mulching
March	Sorghum	Sorghum with	with legumes
April	Interplanted	Shrub-Type	
May	with	Legume	
June	Peanut	For	
July	Fallow Land	Forage	
August			
September	Upland Rice	Cassava	Corn
October		Interplanted	with
November		with	
December		Legumes	peanut

Grade Stabilization Measures

Structures

When the velocity of flow exceeds allowable limits for vegetation waterways then structures made from rock gabions, logs, bamboos, and other materials should be used to reduce grades. Small drop structures can be used when a small drop elevation is required. When it is necessary to handle larger flows, concrete or rock masonry structures should be used. Small drop spillways in watersheds are designed for the same flow as the waterway. The larger, most costly grade stabilization structures should be designed for the 25-year frequency flows.

In the pilot watershed, waterways are already intrenched in most cases. Therefore, to stabilize these waterways, drop and control structures will be necessary. Because of variation in size and steepness of channels and waterways, it will be necessary to determine the size of the waterway at several points. If the slope is uniform on which the terrace outlet is diverted, a wider outlet is required at the lower end where it is carrying the greatest amount of runoff.

The consultant and project engineer will calculate specifications and provide procedures for construction of waterways and other channels, such as terraces, diversions, cross slope channels, and drainage ditches.

Grassed Waterways

Grassed waterways are the most economical and most widely used means of conveying surface runoff from farm fields at non-erosive velocities. They provide protection against soil erosion and the vegetation grass or grass-legume mixtures can be cut for livestock feed.

A grassed natural water channel is the most desirable type of waterway since it is already available and the time and cost of sloping the channel and establishing vegetation generally can be avoided. However, when additional flow is added, as from a diversion or terrace system, the capacity should be carefully checked to make certain the channel will not be required to carry more water than it is capable of handling. When discharges are too large it is often necessary to divide the flow and use two or more waterways to avoid excessive velocities. The depth of the design flow in the waterway should not exceed critical depth. The waterways should be designed to convey peak rates disregarding the effect of channel storage.

The normal drainage pattern is very steep in the Pilot Watershed and any waterway will need careful planning to check and control the excessive flows. Grass or other vegetation in the waterways should be kept short to avoid obstructing flows.

Terracing

The use of terraces for controlling erosion and conserving water on rice paddies has been used for a long time. Many terraces on upland farms are improperly constructed and are not effective in the control of runoff and erosion. The use of contour terraces and bench terraces require extensive field observations,

layout, and modifications in terrace design and construction. When terraces are properly used, constructed, and adequately supported by good cropping and tillage practices, they provide one of the most effective erosion control measures for cultivated crops. When terraces are improperly constructed or not coordinated with good land use and soil building or conserving practices, they often accelerate rather than retard soil and water losses.

The basic factor that must be recognized in application of erosion control measures is proper utilization of land. The use of land in accordance with its capabilities is a must in guiding the development of lands to be terraced. Land to be used for cultivated crops should be terraced where runoff and erosion can not be controlled by the use of vegetation or tillage. Land unsuited for cultivated crops should not be terraced except in special cases. For example, land that has been severaly eroded, may require terraces to assist in establishing a permanent cover of grass. There are many examples in the Pilot Watershed where it may be necessary to construct small contour benches to establish grass and trees.

The success in terracing depends primarily on maintenance and management once the terraces have been constructed. Neglect of the terrace system will destroy the terraces and cause erosion and increased runoff. Keeping terraces repaired is a major concern of the farmer because if they are improperly maintained the entire terrace system will be damaged. Old terraces that have been well maintained seldom need repair, but new terraces require constant attention until the loose soil is settled evenly, and the low spots have built up.

A cross section of a back sloping terrace is presented on Page 65. The specifications for constructing terraces on different slopes are presented in Table 4 where the vertical interval of the benches is calculated for 0.25 meters to 1.50 meters.

When a farm has been terraced all farming operations in the future must be accomplished with the terraces as controls. The terraces must be considered as a permanent improvement and should be laid out to provide the best possible soil and water conservation. Proper spacing of the terrace on the slope, proper grade, adequate capacity to provide for runoff, and proper controls for emptying the terrace into the drainage channel must be provided in designing terraces.

In laying out a broad base terrace which can be used on slopes up to 35%, it is desirable to space them as far apart as possible. The wide terraces make it easier to farm and reduce the cost. The following factors should be considered in spacing the terrace:

1. Erosion increases with the length of slope.
2. If water concentrates between the terraces, small gullies may form and cause deposition in the channel of the terrace below.
3. Too wide spacing may overload the channel below causing overflow and damage to lower terraces. Cross checks should be provided every 3 - 4 meters.
4. Conditions affecting terrace spacing are: land slope, soil type, intensity of rainfall, infiltration rate and storage capacity of the soil, crop to be grown, and method of management.

Grade of Terraces:

The grade of the terrace should be laid out with a hand level or any type of level and should not be more than plus or minus 0.10 percent. If row crops are to be grown, the rows should be constructed on and parallel to the terrace. Only enough grade should be given to avoid ponding of water that would damage the plants. This will have to be coordinated with the infiltration rate of the soil and the water holding capacity. Soils of low permeability may need a grade of 0.20 percent. Terraces should be made to drain in one direction with the upper end turned upstream to avoid overtopping. If the terrace is constructed with too much grade, the increased velocity will erode the channel, carry soil from the surface, and cause destructive deposition in the lower terrace or drainage channel. The erodibility of soil and depth of flow built up in the channel will determine the grade that can be tolerated, but flow should not exceed 60 CMS for most soils and 6 CMS for highly erodible soils. If the terrace discharges into a grassed outlet, the grade in the outlet should not exceed 0.4% for the last 15 meter section.

Block Terraces:

On slopes from 25 - 35 percent, back sloping terraces may put too much water into the disposal system. To overcome this problem cross checks should be made every 3 to 4 meters along the terrace drain. These cross checks should be high enough to prevent overtopping. If the width of the terrace is not enough to store the larger storms, then it becomes necessary to deepen the drain at the back of the terrace. Sediment collected in the drain should be placed back on the terrace as it accumulates. It is important these drainage channels be cleaned periodically to maintain adequate water storage on

the back of the terrace. Land unsuited for cultivated crops should not be terraced, except in special cases. The terrace should be designed to control erosion and runoff under the most intensive use expected on the land. It would be a mistake to design the terrace too small to make use of as much rainfall as possible for crop production.

Erosion and Gully Control

Gullies are a symptom of functional disorder of the land, or improper land use. Gullies are not the first symptom of land misuse. They are a result of water flowing across sloping land which is not protected and the layers of fertile top soil are being removed.

These erosion conditions can be treated by using conservation measures to protect the soil and manage the water. The land in the pilot watershed was once covered with natural vegetation, trees, shrubs, grass, and other vegetation. Through long misuse, serious erosion has encroached upon the steeper slopes to the point where crop yields have been reduced.

One of the most obvious types of land misuse is the cultivation of steep slopes. This is shown on the land capability map (Page 60) which indicates many steep slopes are being farmed that should be converted to other types of crop management. Gully erosion is removing tons of soil from these areas.

To manage the concentrated volumes of water flowing in the gullies, it is necessary to find the source of the water. Gullies start where too much water flows over the land surface. As the water consentrates in the depressions, velocities increase and headcutting works its way into the soil profile. It extends back into the drainage

way and grows deeper as it advances up the slopes. Branching occurs as more water is drained into the gully, this network continues until gullies cover the entire area.

The first step in preventing the formation of gullies is to plan land practices so the surface is not left without some type of vegetation. Cover such as grass mixture, or grass and legumes, or combination of vegetation and engineering controls can be used in stabilizing active gullies. Engineering controls such as contour cultivation and terracing should always be used in combination with special crop rotations, cover crops, strip-cropping, and terrace-water disposal systems.

Mechanical structures, shown as prototype drawings, are used to control water so vegetation can become established and provide protection at points that can not be adequately controlled in any other way. These structures are generally used in gullies in which runoff must be conveyed in large amounts. Such materials as brush poles, bamboo, wire gabions, and loose rock are used until vegetation can be established to take over the control. (Pages 66, 67, 69, 70, 71)

Structures built to give reinforcement to vegetation should be made of durable materials, such as concrete or masonry. They should be used where less expensive ways are impracticable and should be supplemented by vegetation.

In the Pilot Watershed, gully erosion is very pronounced. This is causing slides and mass movement of soil. On gully banks, gravitational and seepage forces are causing movement of the soil mass from higher elevations to lower elevations and as a result, large

quantities of soil are slipping into the gully bottom, and then transported into the streams. Soil transported by gully erosion contains a high percentage of subsoil. It costs much more to bring this type of erosion under control. More engineering control measures are necessary to stabilize the gully grade.

The objective of gully erosion control is to stop head-cutting and to cause deposition of the soil so vegetation can become established. The deposition of sediment in places where it is not wanted is one of the major damages resulting from the upper parts of the watersheds. Too often erosion control and gully control measures are installed and then neglected until they become so badly damaged they are no longer effective and actually accelerate the problem. Structures, terraces, and waterways should be inspected periodically, especially after heavy rains, to determine whether repairs are needed. This is particularly true when vegetation is just getting established. Rock and brush dams are subject to failure when first installed because they do not become thoroughly settled, compacted or sealed for some time.

All structures should be inspected for burrowing rodents and large roots which can cause failure of a structure even when they are adequately settled. These conditions should be corrected immediately when they are found.

Table 4. DETAILS OF AREAS AND EARTH MOVEMENT VOLUMES FOR CONSTRUCTION OF BENCH TERRACES

SLOPE OF RISER 1 TO 2: VERTICAL INTERVAL OF BENCHES 0.25 METERS

Ground slope	%	5	10	15	20
Width of Bench Terraces	m	5.00	2.50	1.67	1.25
Width of Bench (Area of Cultivation)	m	4.48	1.98	1.14	0.72
No of benches per 100 m	No	20.0	40.0	60.0	80.0
Max. depth of Cut (Excluding drain)	m	0.11	0.10	0.09	0.07
Area of benches per ha. of terraces	ha	0.90	0.79	0.68	0.58
Horiz. area of risers, drains, lip per ha	ha	0.10	0.21	0.31	0.42
Slope area of risers drain, lip/ha	ha	0.18	0.37	0.56	0.74
Volume of cut per ha of bench ter.	m^3	335	357	379	401
Slope area of riser etc./ha of benches	ha	0.21	0.47	0.81	1.28
Volume of cut per ha of benches	m^3	374	452	553	692
Average distance of earth movement	m	3.7	1.9	1.3	1.0

Table 5. DETAILS OF AREAS AND EARTH MOVEMENT VOLUMES FOR CONSTRUCTION OF BENCH TERRACES SLOPE OF RISER 1 TO 2, VERTICAL INTERVAL OF BENCHES 0.50 METERS

Geound Slope	%	5	10	15	20	25	30	35
Width of Bench terraces	m	10.00	5.00	3.33	2.50	2.00	1.67	1.43
Width of Bench (Area of Cultivation)	m	9.35	4.35	2.68	1.85	1.35	1.02	0.78
No of benches per 100 m.	No	10.0	20.0	30.0	40.0	50.0	60.0	70.0
Max. depth of Cut (Excluding drain)	m	0.23	0.22	0.20	0.18	0.17	0.15	0.14
Area of benches per ha. of terraces	ha	0.94	0.87	0.80	0.74	0.68	0.61	0.54
Horiz.area of risers drain, lip per ha.	ha	0.06	0.13	0.20	0.26	0.32	0.39	0.46
Slope area of risers drain, lip per ha.	ha	0.12	0.24	0.36	0.48	0.60	0.72	0.84
Volume of cut per ha of bench terraces	m^3	619	613	607	601	595	589	583
Slope area of riser etc. per ha of benches	ha	0.13	0.28	0.45	0.65	0.89	1.19	1.55
Volume of cut per ha of benches	m^3	662	705	755	812	881	965	1070
Average distance earth movement	m	7.0	3.5	2.3	1.7	1.4	1.2	1.0

Table 6. DETAILS OF AREAS AND EARTH MOVEMENT VOLUMES FOR CONSTRUCTION OF BENCH TERRACES SLOPE OF RISER 1 TO 2 : VERTICAL INTERVAL OF BENCHES 0.75 METERS

Ground Slope	%	10	15	20	25	30	35	40
Width of Bench Terraces	m	7.50	5.00	3.75	3.00	2.50	2.14	1.87
Width of Bench (Area of Cultivation)	m	6.72	4.22	2.97	2.22	1.72	1.37	1.11
No of benches per 100 m	NO	13.3	20.0	26.7	33.3	40.0	46.7	53.3
Max. depth of Cut (Excluding drain)	m	0.34	0.32	0.30	0.28	0.26	0.24	0.22
Area of benches per ha. of terraces	ha	0.90	0.84	0.79	0.74	0.69	0.64	0.59
Horiz. area of risers drain, lip per ha.	ha	0.10	0.16	0.21	0.26	0.31	0.36	0.41
Slope area of risers drain, lip per ha.	ha	0.20	0.30	0.40	0.49	0.59	0.69	0.79
Volume of cut per ha of bench terraces	m^3	911	891	884	870	857	843	830
Slope area of riser etc. per ha of benches	ha	0.22	0.35	0.50	0.67	0.86	1.09	1.34
Volume of cut per ha of benches	m^3	1015	1054	1114	1173	1242	1321	1399
Average distance of earth movement	m	5.2	3.5	2.6	2.0	1.7	1.4	1.2

Table 7. DETAILS OF AREAS AND EARTH MOVEMENT VOLUMES FOR CONSTRUCTION OF BENCH TERRACES

SLOPE OF RISER 1 TO 2: VERTICAL INTERVAL OF BENCHES 1.00 METERS

Ground Slope	%	15	20	25	30	35	40	45	50
Width of Bench Terraces	m	6.67	5.00	4.00	3.33	2.86	2.50	2.22	2.00
Width of Bench (Area of Cultivation)	m	5.77	4.10	3.10	2.43	1.96	1.60	1.32	1.10
No of Benches per 100 m	No	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0
Max. depth of Cut (Excluding drain)	m	0.43	0.41	0.39	0.37	0.34	0.32	0.30	0.27
Area of benches per ha. of terraces	ha	0.86	0.82	0.77	0.73	0.68	0.64	0.60	0.55
Horiz.area of risers drain, lip per ha.	ha	0.14	0.18	0.22	0.27	0.31	0.36	0.40	0.45
Slope area of risers drain, lip per ha.	ha	0.26	0.35	0.44	0.53	0.62	0.71	0.79	0.88
Volume of cut per ha of bench terraces	m^3	1179	1155	1131	1107	1084	1060	1036	1012
Slope area of riser etc. per ha of benches	ha	0.31	0.43	0.57	0.73	0.90	1.10	1.33	1.60
Volume of cut per ha of benches	m^3	1363	1408	1459	1517	1582	1656	1742	1841
Average distance of earth movement	m	4.6	3.4	2.7	2.2	1.9	1.6	1.4	1.3

Table 8. DETAILS OF AREAS AND EARTH MOVEMENT VOLUMES FOR CONSTRUCTION OF BENCH TERRACES

SLOPE OF RISER 1 TO 2 : VERTICAL INTERVAL OF BENCHES 1.25 METERS

Ground Slope	%	20	25	30	35	40	45	50	55
Width of Bench Terraces	m	6.25	5.00	4.17	3.57	3.12	2.78	2.50	2.27
Width of Bench (Area of Cultivation)	m	5.12	3.87	3.04	2.45	2.00	1.65	1.37	1.15
No. of Benches per 100 m	No	16.0	20.0	24.0	28.0	32.0	36.0	40.0	44.0
Max. Depth of Cut (Excluding drain)	m	0.51	0.48	0.45	0.43	0.40	0.37	0.34	0.32
Area of benches per ha of terraces	ha	0.82	0.78	0.73	0.68	0.64	0.59	0.55	0.50
Horiz.area of risers, drains, lip per ha	ha	0.18	0.22	0.27	0.32	0.36	0.40	0.45	0.49
Slope area of risers drain lip per ha	ha	0.36	0.45	0.54	0.64	0.72	0.82	0.91	1.00
Volume of cut per ha of bench terraces	m^3	1448	1420	1391	1362	1334	1305	1277	1248
Slope area of riser etc. per ha of benches	ha	0.46	0.58	0.75	0.93	1.13	1.37	1.65	1.98
Volume of cut per ha of benches	m^3	1766	1832	1905	1989	2084	2194	2322	2472
Average distance of earth movement	m	4.3	3.4	2.8	2.4	2.0	1.8	1.6	1.4

Table 9. DETAILS OF AREAS AND EARTH MOVEMENT VOLUMES FOR CONSTRUCTION OF BENCH TERRACES

SLOPE OF RISER 1 TO 2 : VERTICAL INTERVAL OF BENCHES 1.5 METERS

Ground slope	%	35	40	45	50	55	60
Width of Bench terraces	m	4.29	3.75	3.33	3.00	2.73	2.50
Width of bench (Area of cultivation)	m	3.04	2.50	2.08	1.75	1.48	1.25
No of benches per 100 m	No	23.3	26.7	30.0	33.3	36.6	40.0
Max. depth of Cut (Excluding drain)	m	0.53	0.50	0.49	0.44	0.41	0.37
Area of benches per ha. of terraces	ha	0.71	0.67	0.62	0.58	0.54	0.50
Horiz.area of risers drain, lip per ha	ha	0.29	0.33	0.38	0.42	0.46	0.50
Slope area of risers drain, lip per ha	ha	0.60	0.68	0.76	0.85	0.93	1.02
Volume of cut per ha of bench terraces	m^3	1.610	1.570	1.530	1.494	1.458	1.417
Slope area of riser etc. per ha of benches	ha	0.84	1.02	1.22	1.46	1.71	2.04
Volume of cut per ha of benches	m^3	2271	2354	2452	2563	2685	2834
Average distance of earth movement	m	2.8	2.4	2.1	1.9	1.7	1.5

Table 10.

BENCH TERRACES:

DETAILS OF BENCH TERRACES							LABOUR REQUIREMENTS PER HA. 1)		TOTAL MANDAYS PER HA.
Vertical Interval of Benches a	Original Ground Slope %	to %	Width of Benches (Area of cultivation) m	to m	Average Distance of earth movement m	m	Earth movement standard 1 m^3 per m/d	Sodding 1/4 slope area sodded 6 m^2 per m/d	
0.25	5	15	4.5	1.1	3.7	1.3	357	155	512
0.50	10	20	4.4	1.8	3.5	1.7	607	150	757
0.50	15	25	2.7	1.4	2.3	1.4	601	200	801
0.75	20	30	3.0	1.7	2.6	1.7	870	205	1.075
0.75	25	35	2.2	1.4	2.0	1.4	857	246	1.103
1.00	25	35	3.1	2.0	2.7	1.9	1.107	220	1.327
1.00	30	40	2.4	1.6	2.2	1.6	1.084	259	1.343
1.25	35	45	2.4	1.6	2.4	1.8	1.334	300	1.634
1.25	40	50	2.0	1.4	2.0	1.6	1.305	342	1.647
1.50	35	45	3.0	2.1	2.8	2.1	1.570	284	1.854
1.50	45	55	2.1	1.5	2.1	1.7	1.494	355	1.849

1) Labour requirements based on standard Government rates.

Table 11.

II. WATERWAYS - For Bench Terrace Areas.

1. Earth Movement and Sodding: Number of Mandays Required for Construction.

Catchment Area less than ha.	Estimated maximum runoff per sec. 1) m^3	Minimum bed width of waterway m	Depth of Waterway m	Volume of cut per metre length 2) m3	Area of bed & Sides m2	Mandays per metre length 3 m/d	Length of construction per manday m
0.5	0.166	0.50	0.50	0.38	1.62	0.45	2.24
1.0	0.282	1.00	0.50	0.62	2.12	0.71	1.41
2.0	0.463	1.25	0.75	1.22	2.93	1.34	0.75
3.0	0.656	1.50	1.00	2.00	3.74	2.16	0.46
4.0	0.831	1.75	1.00	2.25	3.99	2.42	0.41
5.0	1.000	2.00	1.00	2.50	4.24	2.68	0.37

1) These figures are based on runoff from other tropical areas, with allowance for some runoff retention on the terraces. No figures are available for runoff from small catchment areas in Indonesia. Runoff and rainfall intensity observations are being made, by the Project, and when reliable results are available the figures will be revised if necessary.

2) Side slope of waterways 1 to 2 (1 horizontal to 2 vertical).

3) Based on 1 m^3 of earth movement per manday, and 6 m^2 of sodding per manday. One quarter of area sodded. (These are standard Government rates).

Table 12.

2. Stone Drop Structure: Mandays Required for Collection and Transportation of stone, and construction

Width of waterway m	Height of drop m	Area of stone paving m2	Volume of stone m3	LABOUR STANDARD IN MANDAYS For collecting and setting stone paving, with transportation distance of less than.						
				30 m	100 m.	200 m	300 m	400 m	500 m	600 m
0.5	0.5	0.51	0.13	1.3	1.4	1.7	1.7	1.8	1.9	2.0
	1.0	1.25	0.31	3.1	3.4	4.0	4.2	4.4	4.6	4.8
	1.5	2.25	0.56	5.6	6.2	7.2	7.6	7.9	8.3	8.6
	2.0	3.50	0.88	8.8	9.7	11.2	11.9	12.4	13.0	13.5
0.75	0.5	0.69	0.17	1.7	1.9	2.2	2.3	2.4	2.5	2.6
	1.0	1.63	0.41	4.1	4.5	5.2	5.5	5.8	6.1	6.3
	1.5	2.82	0.71	7.1	7.8	9.1	9.6	9.9	10.5	10.9
	2.0	4.25	1.06	10.6	11.7	13.6	14.3	15.0	15.7	16.3
1.00	0.5	0.88	0.22	2.2	2.4	2.8	3.0	3.1	3.3	3.4
	1.0	2.00	0.50	5.0	5.5	6.4	6.7	7.1	7.4	7.7
	1.5	3.38	0.85	8.5	9.3	10.9	11.5	12.0	12.6	13.1
	2.0	5.00	1.25	12.5	13.7	16.0	16.9	17.6	18.5	19.3
1.25	0.5	1.07	0.27	2.7	3.0	3.4	3.6	3.8	4.0	4.1
	1.0	2.38	0.60	6.0	6.6	7.7	8.1	8.4	8.9	9.2
	1.5	3.94	0.99	9.9	10.9	12.6	13.3	14.0	14.6	15.2
	2.0	5.75	1.44	14.4	15.8	18.4	19.4	20.3	21.3	22.2
1.50	0.5	1.26	0.32	3.2	3.5	4.1	4.3	4.5	4.7	4.9
	1.0	2.75	0.69	6.9	7.6	8.8	9.3	9.7	10.2	10.6
	1.5	4.50	1.13	11.3	12.4	14.4	15.2	15.9	16.7	17.4
	2.0	6.50	1.63	16.3	17.9	20.8	22.0	23.0	24.1	25.1
1.75	0.5	1.44	0.36	3.6	3.7	4.6	4.9	5.1	5.3	5.5
	1.0	3.13	0.78	7.8	8.6	10.0	10.6	11.0	11.6	12.0
	1.5	5.07	1.27	12.7	14.0	16.2	17.1	17.9	18.8	19.5
	2.0	7.25	1.81	18.1	19.9	23.2	24.5	25.5	26.8	27.9
2.00	0.5	1.63	0.41	4.1	4.5	5.2	5.5	5.8	6.1	6.3
	1.0	3.50	0.88	8.8	9.7	11.2	11.6	12.4	13.0	13.5
	1.5	5.63	1.41	14.1	15.5	18.0	19.0	19.9	20.9	21.7
	2.0	8.00	2.00	20.0	22.0	25.6	27	28.2	29.6	30.8

1) Based on Government Standards.

COST ESTIMATE

METEOROLOGICAL INSTRUMENTS

Complete weather station wm-4

Item	Quantity	Unit Cost (RP)	Total Cost
Automatic Raingage with Tipping Bucket	1	660,000	660,000
Manual Raingage (local construction)	6	11,178	67,068
Charts for Tipping Bucket	24 boxes	3,105	74,520
Evaporation Pan (local construction)	1	100,000	100,000
Sunshine Duration Recorder (Campbell Stokes)	1	450,000	450,000
Wind Recorder with parts (anemometer)	1	104,000	104,000
Maximum-Minimum Thermometers with Townsend Support	6	20,000	120,000
Sling Psychrometer	2	20,000	40,000
Shelter for Thermometers	1	350,000	350,000
Water Supply Tank (200 liters)	1	10,000	10,000
Wind Direction Charts C123-D	24 rolls	1,656	39,744
Wind Speed Chart C123-S	24 rolls	1,656	39,744
Chart 0-40° 1 year C431-A	2 sets	9,729	19,458
Thermometers HM-1AC-R	6	2,856	17,136
Enclosure fence, 11 gauge steel link wire and metal post set in concrete (6 Meters x 10 Meters) including foundation for each instrument	1	250,000	250,000
		Rp.	2,341,670
Contigency	10%		234,167
T o t al		Rp.	2,575,837
		(US$	6,206.84)

COST ESTIMATE

PANAWANGAN PILOT WATERSHED

Size of Control Watershed	92 hectares
Size of Treated Watershed	350 hectares
Total	442 hectares
Estimated Area Needing Major Terracing	175 hectares

I. Labor Requirements for Constructing Major Terracing per hectare:

Item	Mandays
Construction	813
Sodding Waterways & Risers	293
Gully Plugs	81
Seeding Risers	45
Repairing Terraces, Waterways, etc.	111
Total	1343

Cost for one manday to include food 400 Rupiahs

Cost for one manday to exclude food 250 Rupiahs

Labor cost per hectare with food : 1343 m/d x 400 = Rp.537,200/ha.

Labor cost per hectare without food: 1343 m/d x 250 = Rp.335,750/ha.

Total labor cost 175 ha (rp.400 m/d) @ Rp.537,200 per ha

= Rp.94,010,000

II. Materials - Estimated Cost per hectare

Bamboo materials for drop structures, brush dams, check dams, etc.	Rp. 20,000
Legume and grass seed for Risers	1,000
Grass cutting for Risers	1,000
Fertilizers	28,000
Wire for woven wire dam	10,000
Total	60,000
350 hectares x 60,000	Rp.21,000,000

III. Cost of Mechanical and Physical Structures (Pilot Program)

Item	Quantity	Unit Cost	Total Cost
Parshal Flume	2	300,000	600,000
Broad Crested Weir	1	5,500,000	5,500,000
Parshal Flume (Control Watershed)	1	2,500,000	2,500,000
		Total	8,600,000
IV. Technical Assistance (5 years)	4 Technicians	50,000 mo. ea.	12,000,000
V. Weather station attendant and Weir attendants (5 years)	2	15,000 mo. ea.	1,800,000
		Total	13,800,000

VI. Cost of Reforestation and Greening Program

Seedlings per hectare		5,000
Seeds and materials per hectare (including fertilizers)		28,000
Labor per hectare 100 m/d @ Rp. 400 per manday		40,000
	Rp.	73,000
(95 hectares x 73,000) Total	Rp.	6,935,000

VII. Cost of Integrated Forestry

Seedlings per hectare		2,500
Seed and grass cuttings per hectare		5,000
Fertilizer per hectare		21,000
Labor per hectare 100 m/d @ Rp. 400 per manday		40,000
	Rp.	68,000
80 hectares x 68,500 Total	Rp.	5,480,000

VIII. Transportation Costs

Motorcycles	2	300,000	600,000
Jeep or Small Truck	1	3,500,000	3,500,000
Gasoline, etc.			1,500,000
Bicycles	2	60,000	120,000
		Total	Rp. 5,720,000

IX. Miscellaneous Equipment

Item	Quantity	Unit Cost	Total Cost
Hand tools	2	80,000	40,000
Hand level (Abney)	2	80,000	160,000
Plane table	2	20,000	40,000
Survey Transit, Tripod, Rod, etc.	1	332,000	332,000
Warehouse and Storage Shelter	1	300,000	300,000
Platform scales (100 kg)	1	300,000	300,000
Hand scales (50 kg)	2	20,000	40,000
Measuring Tape (30 Meter)	2	20,000	40,000
Display signs	2	30,000	60,000
Instructional Material		100,000	100,000
Megaphones (Electric Amplifier)	2	40,000	80,000
	Total		Rp. 1,492,000

Budget Summary	Total Rupiah
Labor @ Rp. 400 per manday (includes food)	101,610,000
Materials for Structures	21,000,000
Mechanical Structures	8,600,000
Technical Assistance	12,000,000
Weather station and weir attendants	1,800,000
Reforestation and Greening Program (less labor)	3,135,000
Integrated Forestry Program (less labor)	2,280,000
Transportation Costs	5,720,000
Miscellaneous Equipment	1,492,000
	157,637,000
Survey, Designs and Supervision (10% of total)	15,763,700
Total Budget when farmers are paid for all labor	Rp. 173,400,700
	(US$ 417,833.01)
Labor costs when farmers donate 1/3 labor 101,610,000 x 33% =	Rp. 33,531,300
Total Budget when farmers donate 1/3 of labor	Rp. 139,869,400
	(US$ 337,034.70)

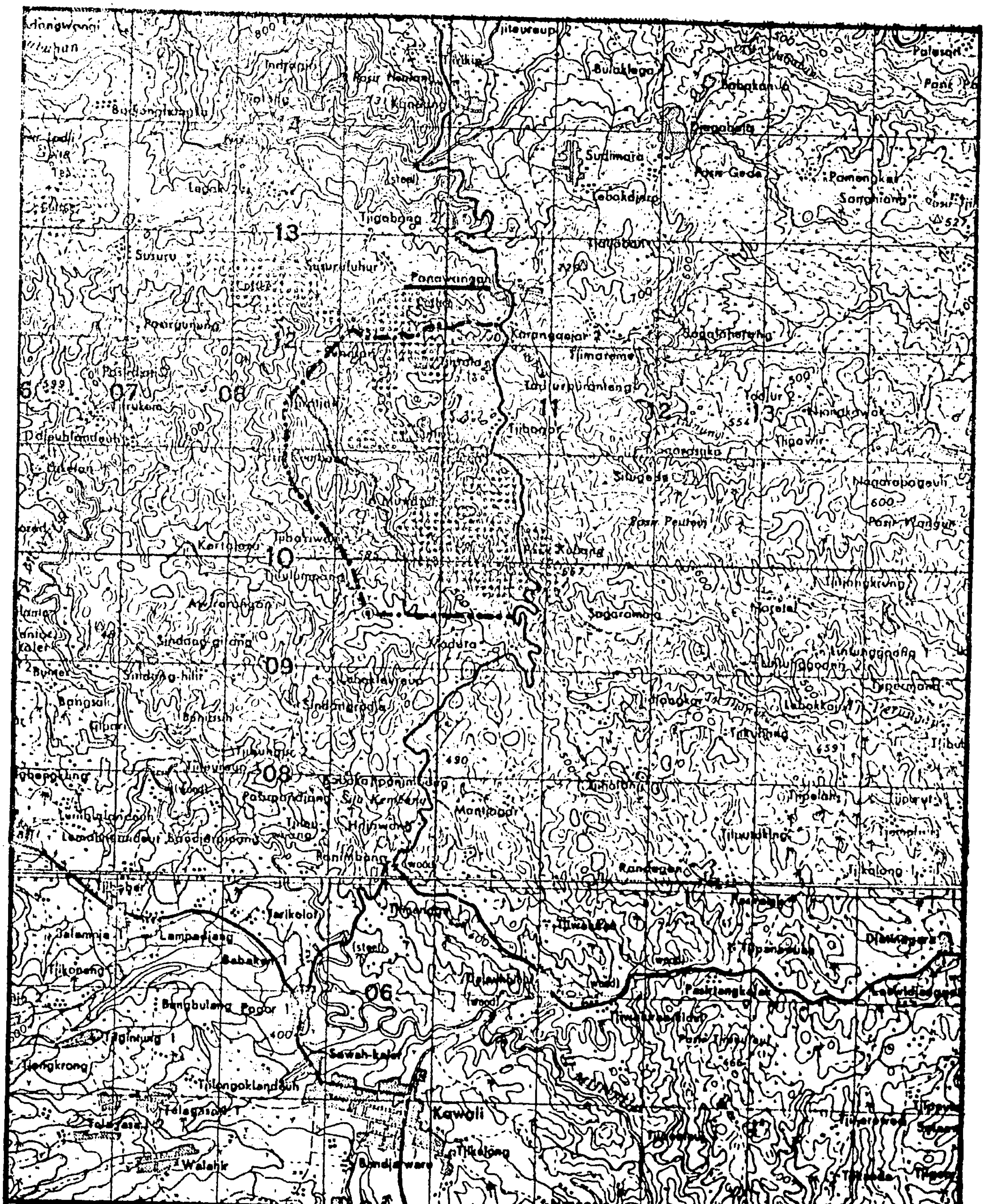
Other Pilot Conservation Watersheds

In the process of selecting the Panawangan Pilot Watershed, a number of other watersheds were considered. Four other watersheds, two in the Cikupa area and two in Wanareja area, called Malabar watershed were considered to have good potentials for applying conservation practices. These are shown on location maps. (Pages 57 and 58). These areas could benefit from such a program as is planned for the Panawangan area. Both areas have serious upstream erosion and water management problems. The reason they were not selected as pilot watersheds is a serious access road problem. If and when these areas are selected for Pilot Conservation programs it will be necessary to greatly improve the access roads. The Consultant would recommend that either of these watershed areas would make good Pilot Conservation areas. Each has its own characteristics and definite erosion and water management problems. The Malabar watersheds are in Central Java and the Cikupa watersheds are in the lower part of the Ciseel River Drainage in the Ciamis district.

The Panawangan area was selected as the Pilot Watershed because it is accessible from a major traveled highway. (Page 56)

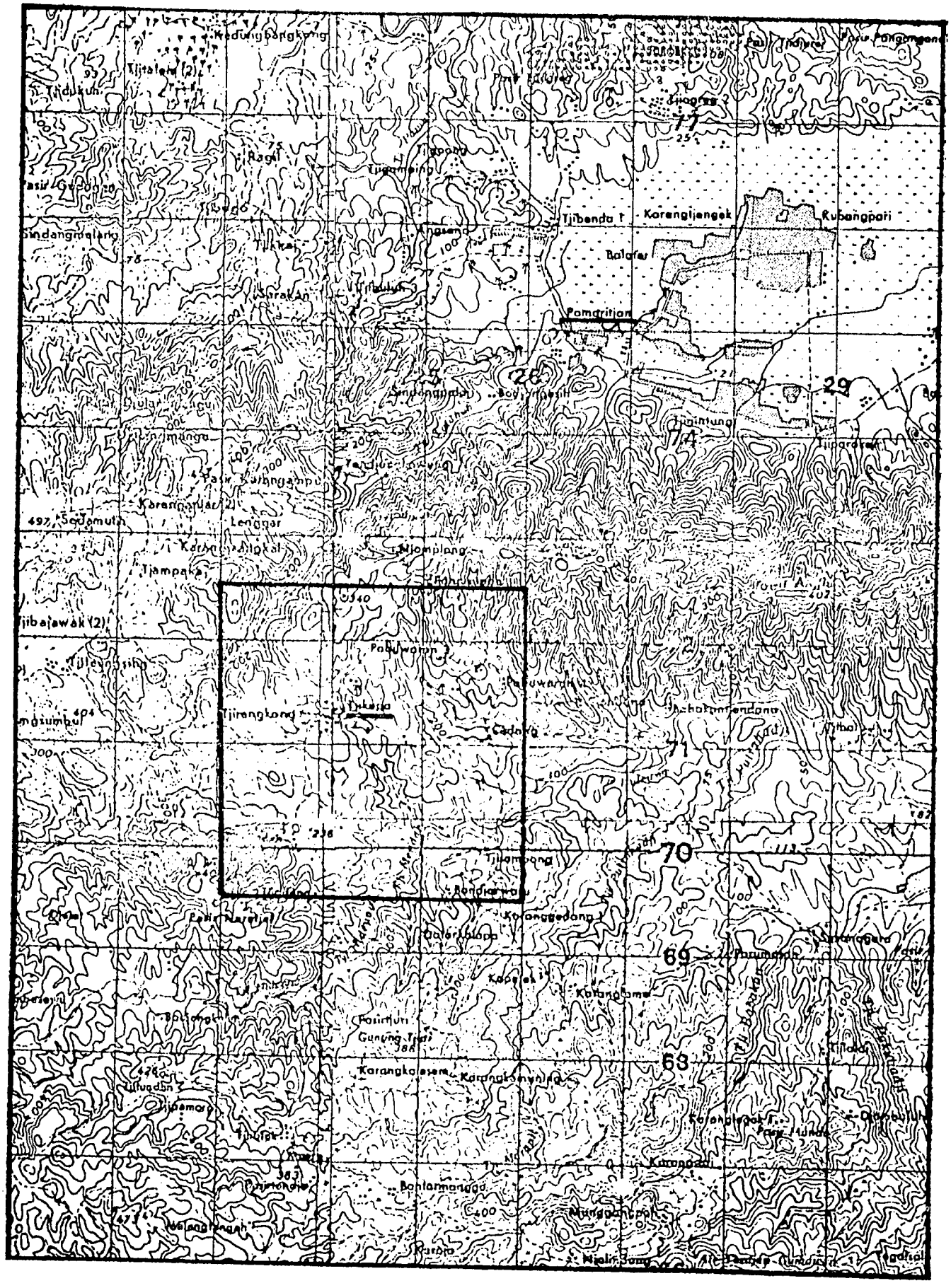
UPPER WATERSHED CONSERVATION PILOT WATERSHED PANAWANGAN AREA

SCALE 1 : 50.000



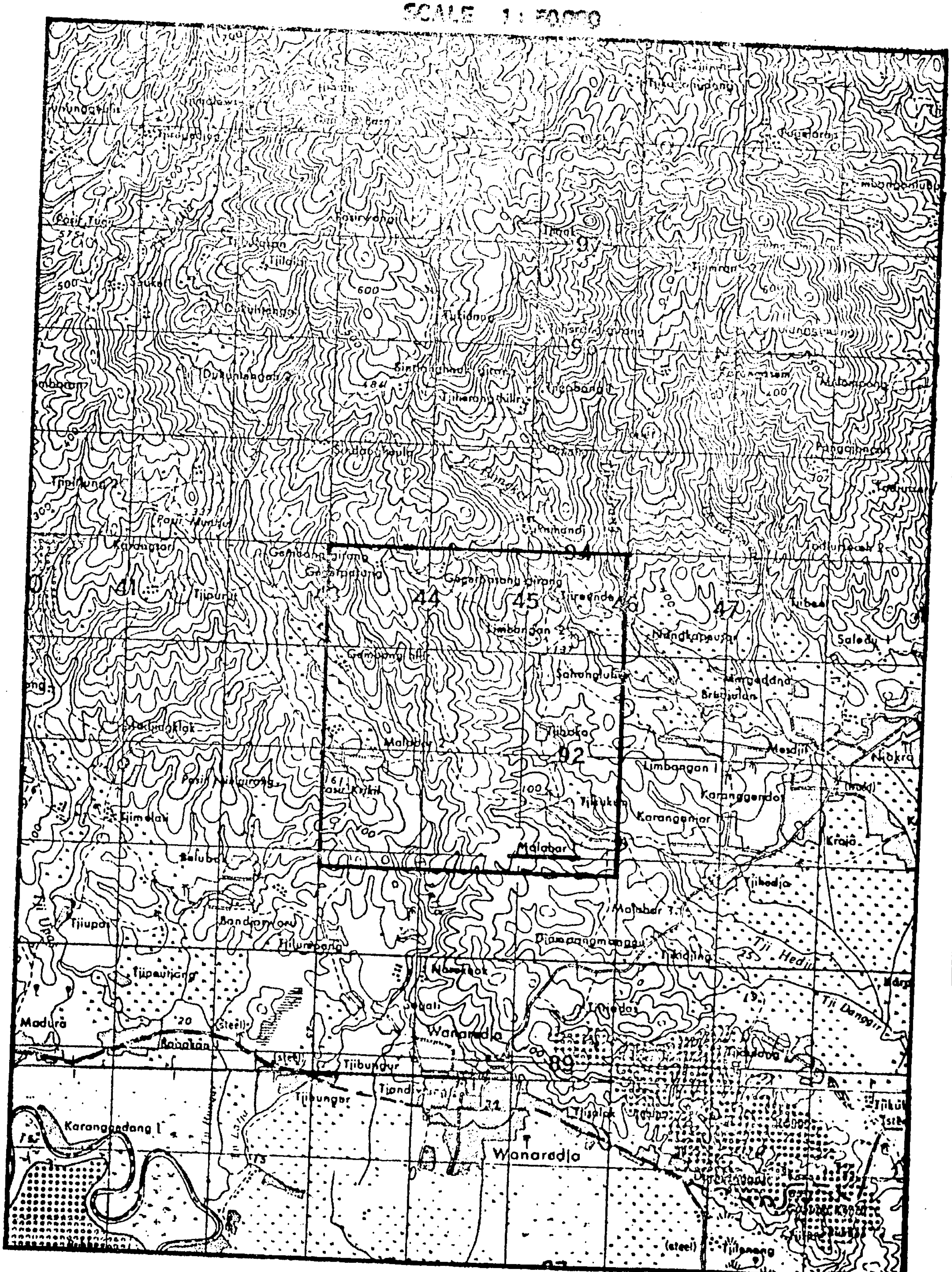
PROPOSED WATERSHED CONSERVATION PILOT WATERSHED CIKUPA AREA

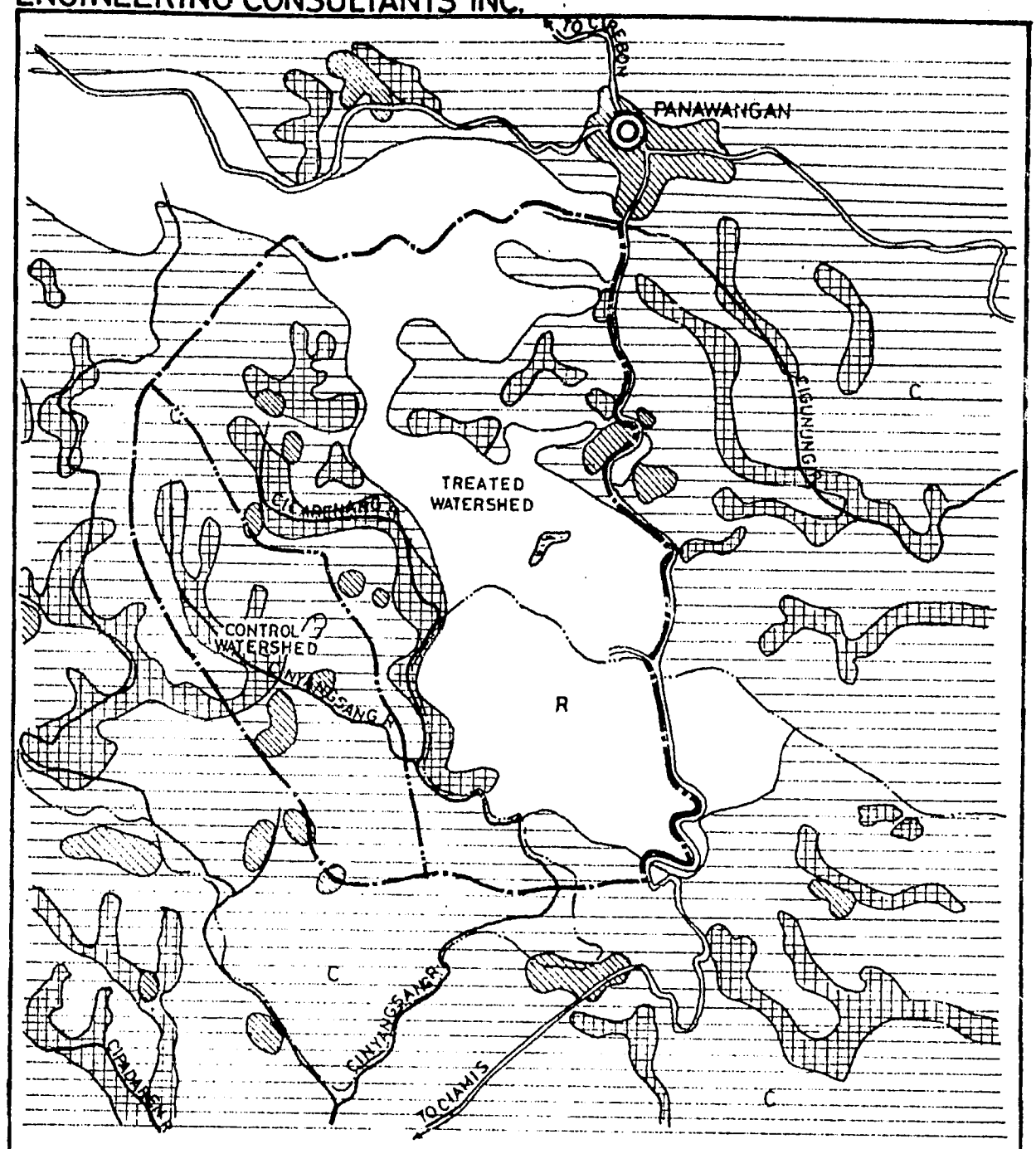
SCALE 1 : 50.000



PROPOSED WATERSHED CONSERVATION PILOT WATERSHED MALABAR AREA

SCALE 1 : 50,000





LEGEND

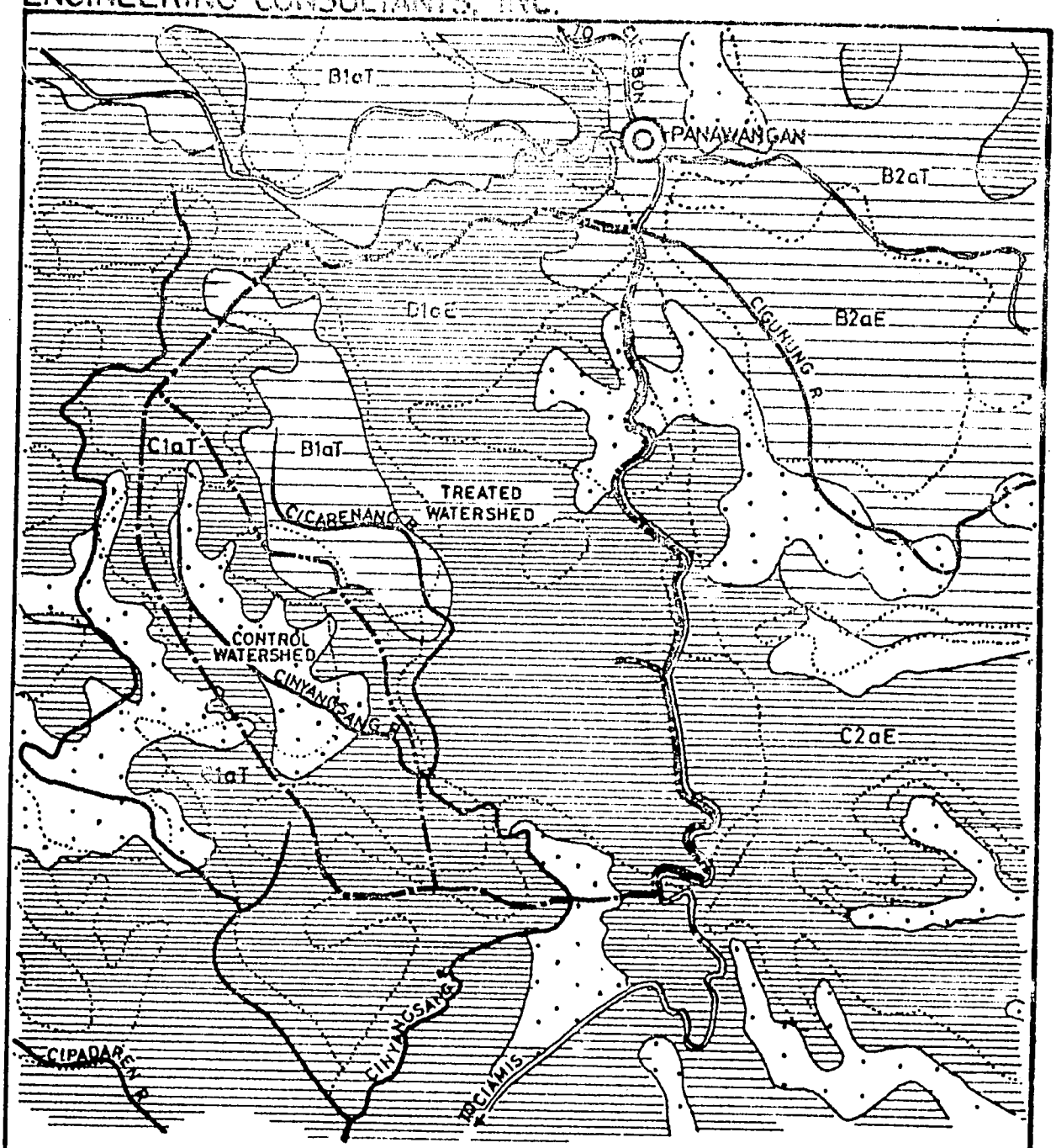
- R — DAMAGED SOIL
- C — MIXED
- VILLAGE AREA
- PLANTATION
- IRRIGATED RICE FIELDS
- SWAMPS
- ASPHALT ROAD
- AREA BOUNDARY
- CONTROL WATERSHED BOUNDARY
- RIVER
- SUB DISTRICT

1:25.000
SCALE

LAND USE

SOURCE

DIRECTORAT LANDUSE
DEPARTEMEN DALAM NEGERI



LEGEND

EROSION
- T — NO EROTION
- E — EROTED

DRAINAGE
- a — NEVER FLOODED

SOIL TEXTURE
- 1 — MEDIUM (CLAY)

EFF. SOIL DEPTH
- B — 60 _ 90 Cm.
- C — 30 _ 60 Cm.
- D — LESS THAN 30 Cm.

GRADIENT
- 0 _ 2 %
- 2 _ 15%
- 15 _ 40%
- 40 % AND OVER

- ASPHALT ROAD
- AREA BOUNDARY
- CONTROL WATERSHED BOUNDARY
- SUB DISTRICT
- RIVER

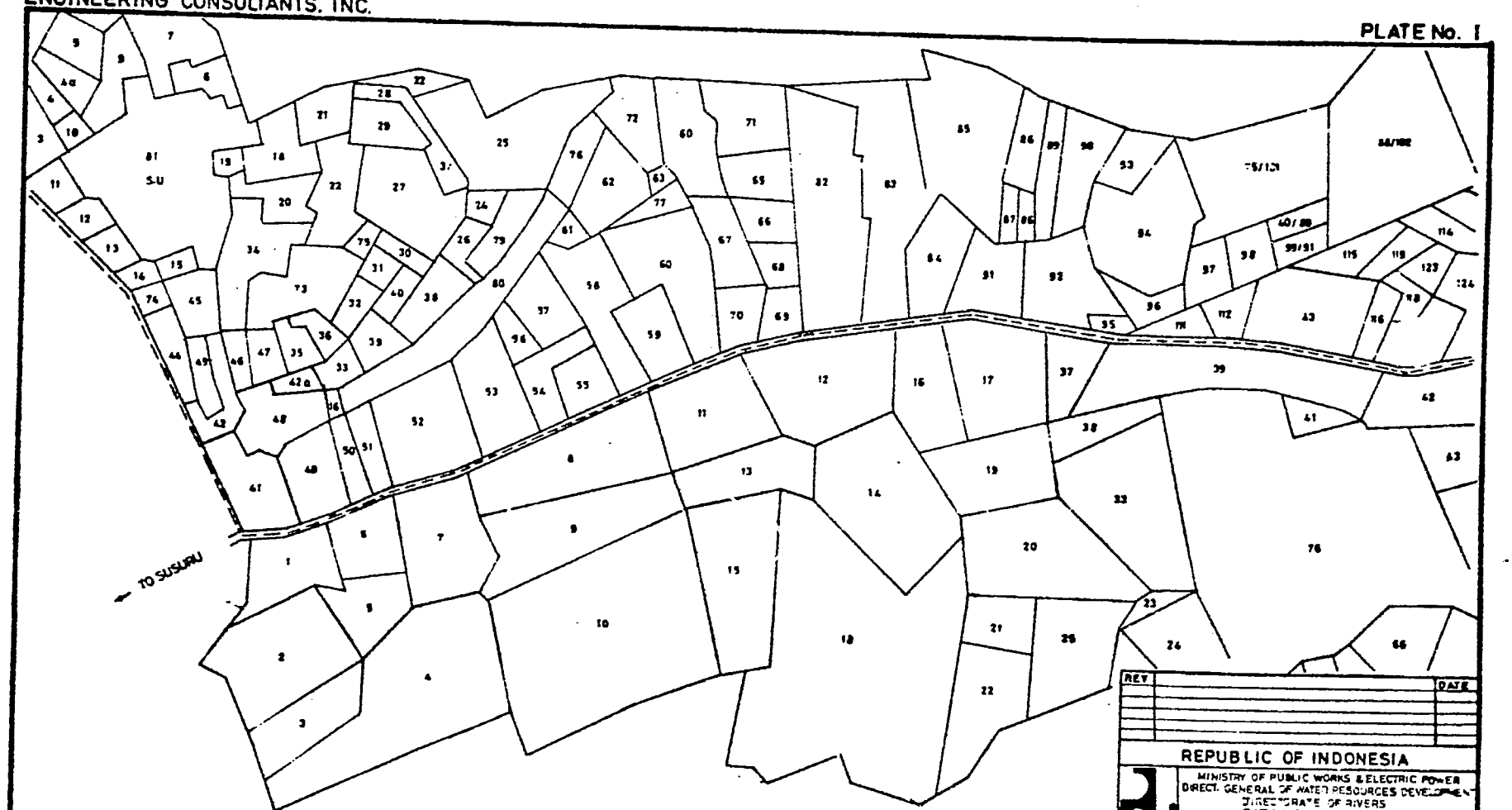
1:25.000
SCALE

LAND CAPABILITY

SOURCE
DIRECTORAT TATA GUNA TANAH
DEPARTEMEN DALAM NEGERI

ENGINEERING CONSULTANTS, INC.

PLATE No. I



REV		DATE

REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS & ELECTRIC POWER
DIRECT. GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS

CITANDUY PROJECT

PROTOTYPE
LAND OWNERSHIP
(NOT IN DEMONSTRATION AREA)

ENGINEERING CONSULTANTS, INC.
DENVER COLORADO U.S.A.

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TRACED : Dasiran	RECOMMENDED :
CHECKED :	APPROVED :
DATE : March 80 - [illegible]	DRAWING NUMBER

LEGEND

No.	COLOR CODE	SOIL CAPACITY CLASS	FACTOR	CLASS LIMIT	NOTE
1		II	Slope	Flat to Gently sloping.	
			Erosion	Medium.	
			Texture	Medium.	
			Soil Depth	Deep.	
			Drainage	Good.	
			Permeability	Medium.	
2		III	Slope	Nother sloping to sloping.	
			Erosion	Medium.	
			Texture	Medium.	
			Soil Depth	Deep.	
			Drainage	Good.	
			Permeability	Medium.	
3		IV	Slope	Heavy sloping.	
			Erosion	Medium.	
			Texture	Medium.	
			Soil Depth	Deep.	
			Drainage	Good.	
			Permeability	Medium.	
4		VI.	Slope	Steep.	
			Erosion	Heavy.	
			Texture	Medium.	
			Soil Depth	Deep.	
			Drainage	Good.	
			Permeability	Medium.	

MINISTRY OF PUBLIC WORKS & ELECTRIC POWER
DIRECT. GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVER
CITANDUY PROJECT

PROTOTYPE
LAND CAPABILITY
(NOT IN DEMONSTRATION AREA)

ENGINEERING CONSULTANTS, INC.
DENVER COLORADO U.S.A

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DATE :	D.G.W.G. No:

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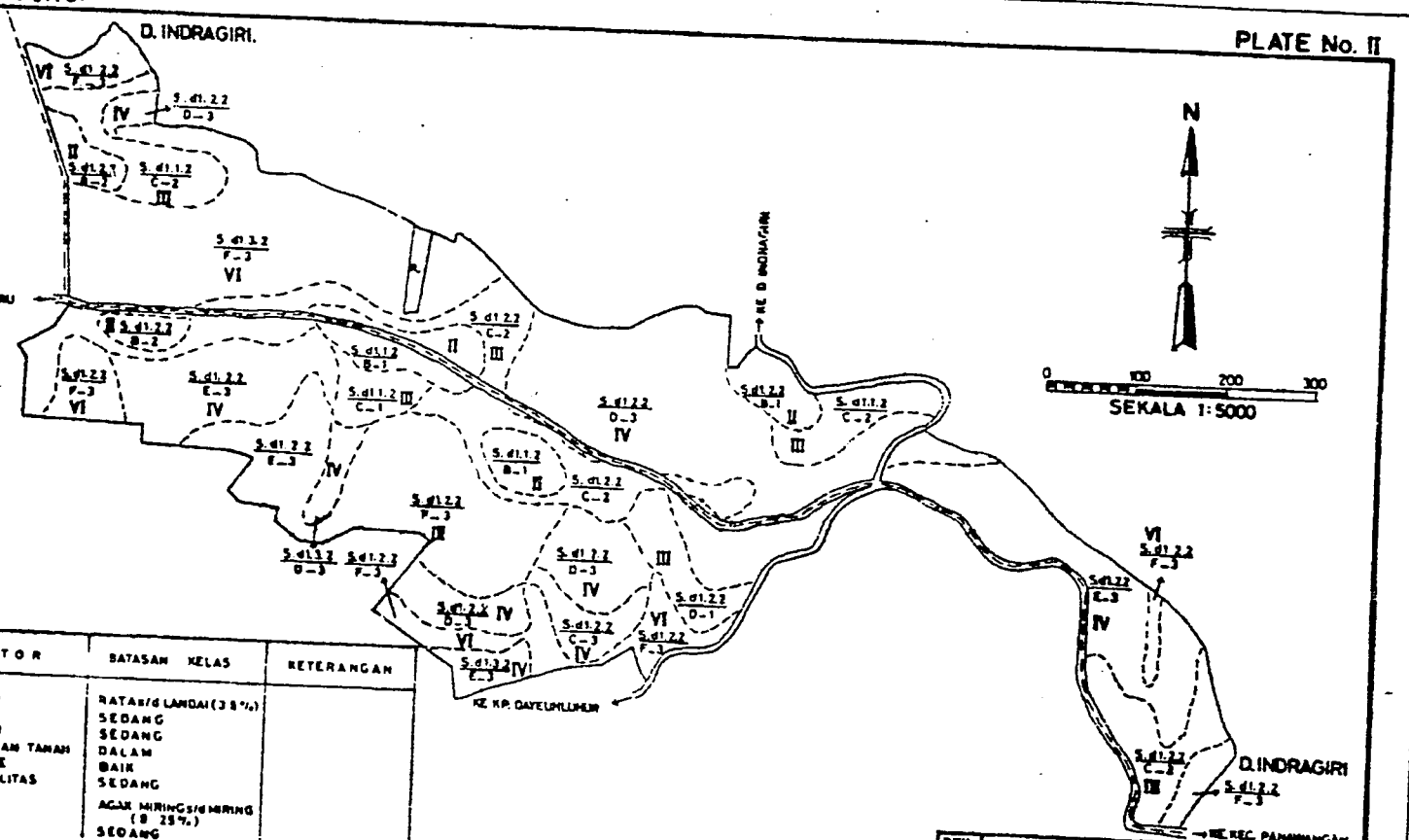
PLATE No. II



NO	KODE WARNA	KELAS KEMAMPUAN TANAH	FAKTOR	BATASAN KELAS	KETERANGAN
1.		II	LERENG	RATA s/d LANDAI (3 8 %)	
			EROSI	SEDANG	
			TEKSTUR	SEDANG	
			KEDALAMAN TANAH	DALAM	
			DRAINASE	BAIK	
			PERMEABILITAS	SEDANG	
2.		III	LERENG	AGAK MIRING s/d MIRING (8 25 %)	
			EROSI	SEDANG	
			TEKSTUR	SEDANG	
			KEDALAMAN TANAH	DALAM	
			DRAINASE	BAIK	
			PERMEABILITAS	SEDANG	
3.		IV	LERENG	SANGAT MIRING (25 40%)	
			EROSI	SEDANG	
			TEKSTUR	SEDANG	
			KEDALAMAN TANAH	DALAM	
			DRAINASE	BAIK	
			PERMEABILITAS	SEDANG	
4.		VI	LERENG	CURAM (40 65%)	
			EROSI	BERAT	
			TEKSTUR	SEDANG	
			KEDALAMAN TANAH	DALAM	
			DRAINASE	BAIK	
			PERMEABILITAS	SEDANG	

LEGENDA

JALAN

BATAS DESA

BATAS RUMUS

T.L TANAH LONGSOR

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REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS & ELECTRIC POWER
DIRECT. GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS
CITANDUY PROJECT

PROTOTYPE
LAND CAPABILITY
(NOT IN DEMONSTRATION AREA)

ENGINEERING CONSULTANTS, INC.
DENVER - COLORADO - U.S.A.

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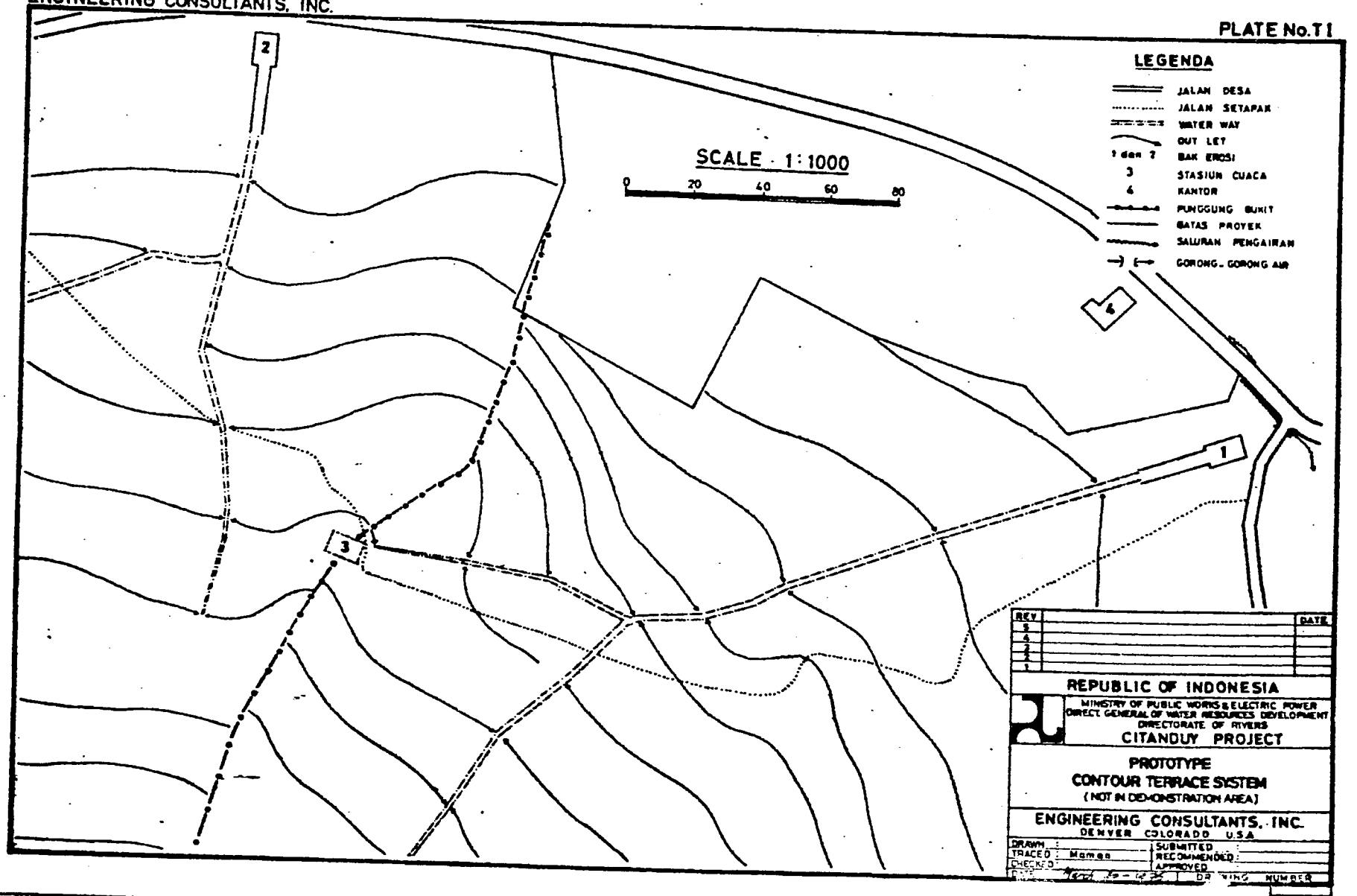
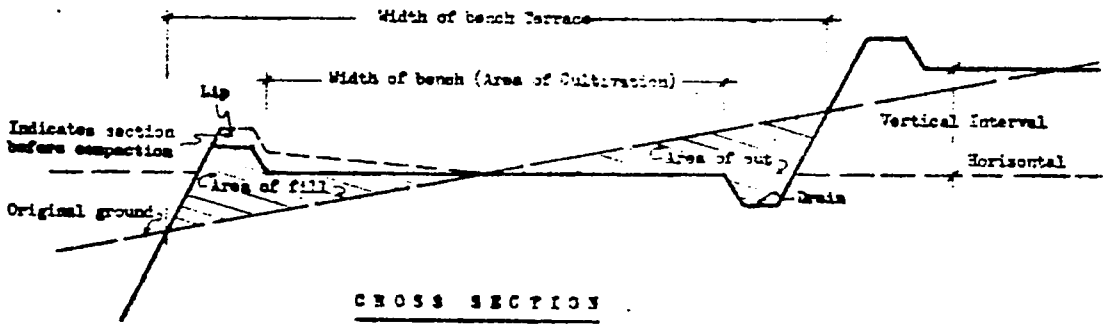
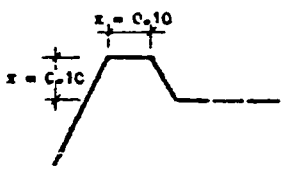
PLATE No.T1

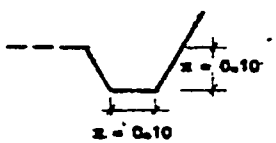




CROSS SECTION



DETAIL OF LIP



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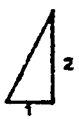

SLOPE OF RISER

NOTES:

1. For terraces of 1.25 and 1.50 meter vertical interval, dimension x·n increased to 0.15 meter.
2. All volumes are for compacted soil.
3. Terraces before settling have reverse slope.
4. Allow additional 15% of depth of fill for compaction.

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REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS & ELECTRIC POWER
DIRECT. GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS
CITANDUY PROJECT

PROTOTYPE
BACKSLOPE TERRACE
(SUGGESTED)

ENGINEERING CONSULTANTS, INC.
DENVER-COLORADO - U.S.A

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DATE	DRAWING NUMBER

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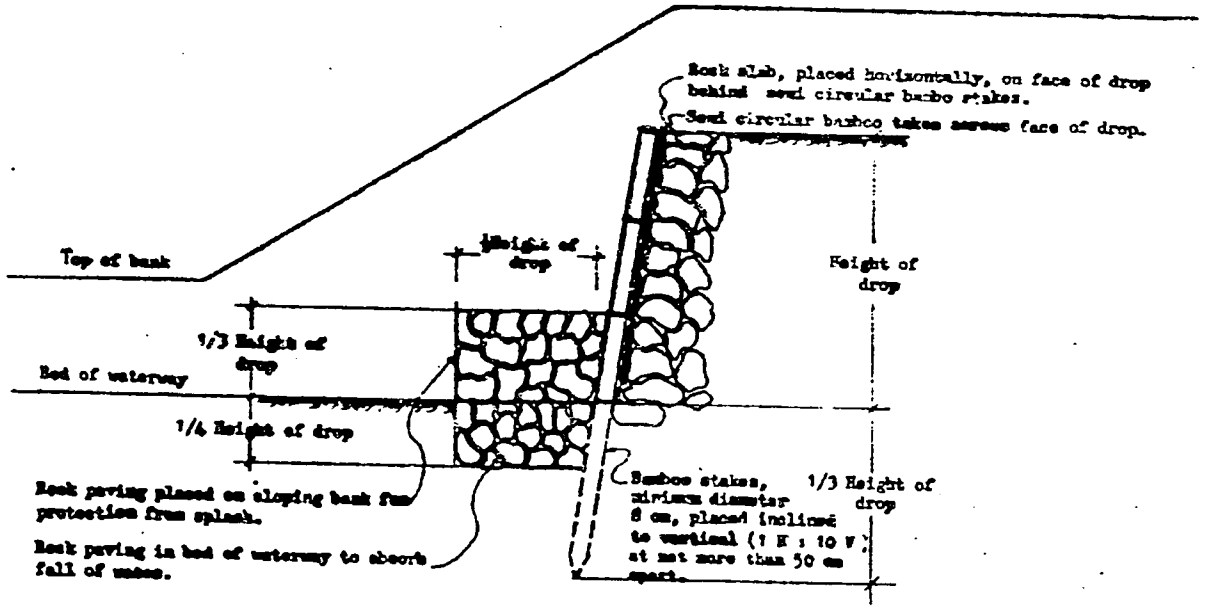
PLATE No. TIII



SCALE : 1 : 25

NOTE:

Height of drop will depend on natural conditions, but shall not exceed 1.50 meters.

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REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS AND ELECTRIC POWER
DIRECT GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS

CITANDUY PROJECT

PROTOTYPE
ROCK CHECK DAM
(SUGGESTED)

ENGINEERING CONSULTANTS, INC.
DENVER - COLORADO - U.S.A.

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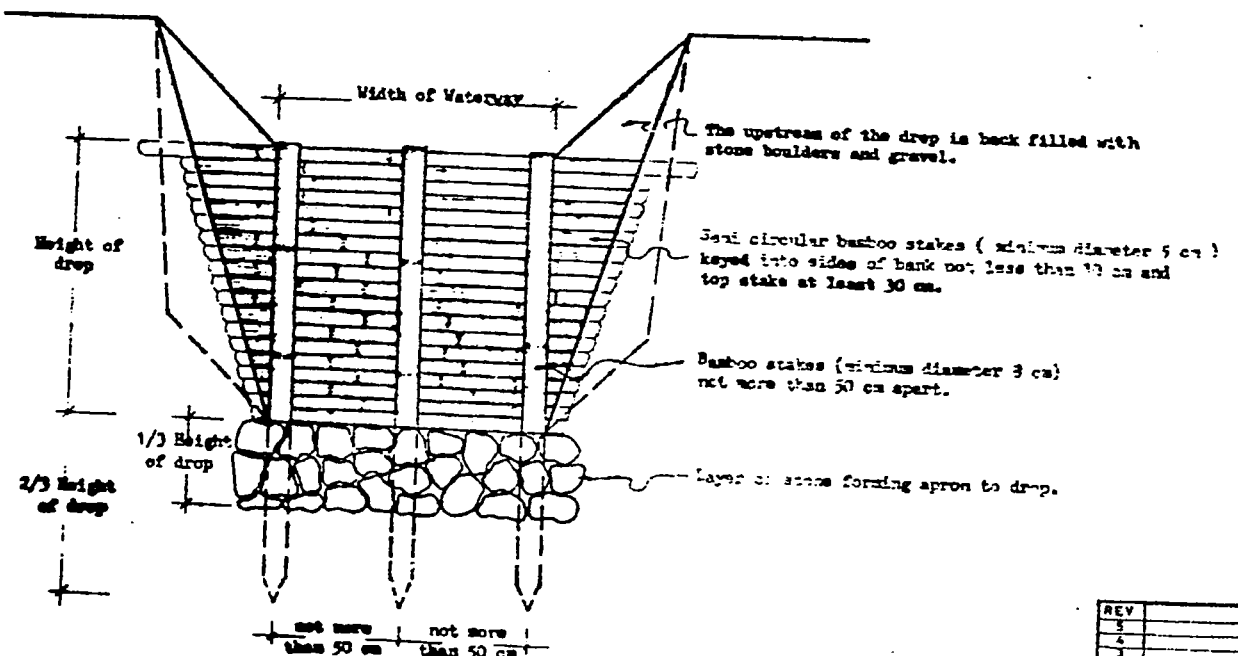
DATE:	DRAWING NUMBER

ENGINEERING CONSULTANTS, INC.

PLATE No.T IV



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REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS & ELECTRIC POWER
DIRECT GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS
CITANDUY PROJECT

PROTOTYPE
BAMBOO CHECK DAM
(SUGGESTED)

ENGINEERING CONSULTANTS, INC.
DENVER - COLORADO - USA

DRAWN :
TRACED : N. Ishiwata
CHECKED :
DATE : March 30 1973

SUBMITTED :
RECOMMENDED :
APPROVED :

ENGINEERING CONSUTANTS, INC.

PLATE No. D I

SEKALA 1:2000

0 40 80 120 160

LEGENDA:

- BATAS DESA
- JALAN
- BATAS PROYEK
- GARIS KETINGGIAN INTERVAL 1M.
- ±818 M TINGGI M DARI MUKA LAUT
- PUNGGUNG BUKIT
- DRAINAGE

REV		DATE

REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS & ELECTRIC POWER
DIRECT. GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS

CITANDUY PROJECT

PROTOTYPE
DRAINAGE DISPOSAL SYSTEM
(NOT IN DEMONSTRATION AREA)

ENGINEERING CONSULTANTS, INC.
DENVER - COLORADO - U.S.A

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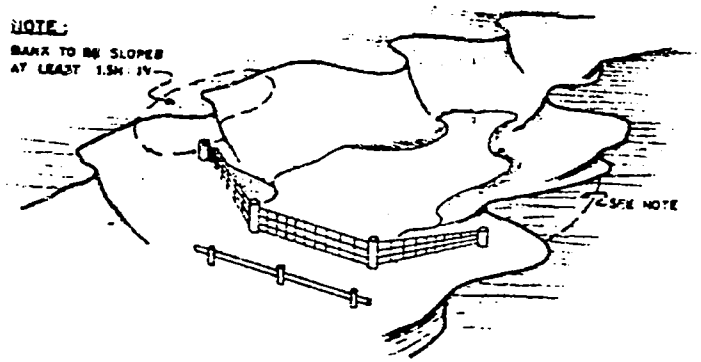
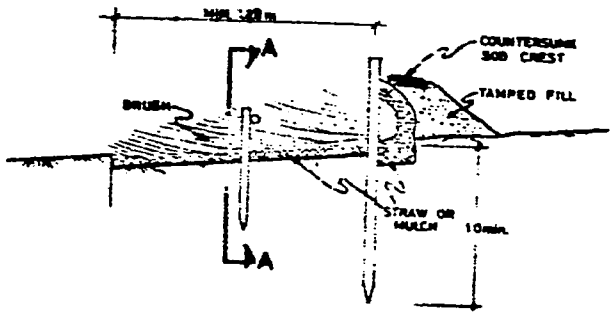
PLATE No. D II





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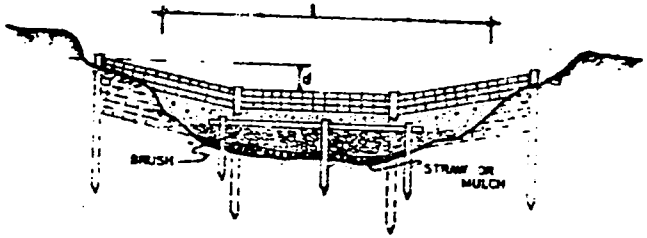

SECTION A_A

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REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS & ELECTRIC POWER
DIRECT GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS
CITANDUY PROJECT

WOVEN WIRE DAM
(SUGGESTED)

ENGINEERING CONSULTANTS, INC.
DENVER COLORADO U.S.A

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TRACED
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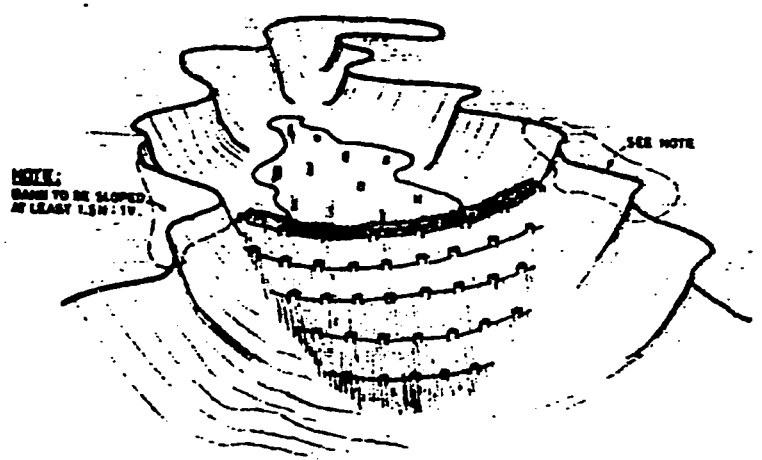
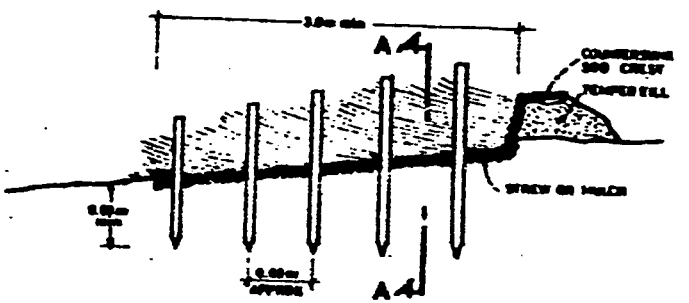
DATE
SUBMITTED
RECOMMENDED
APPROVED
DRAWING NUMBER

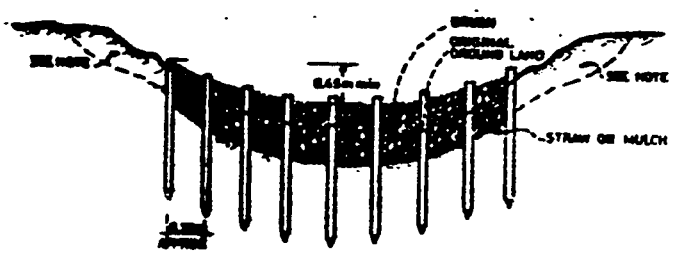
ENGINEERING CONSULTANTS, INC.

PLATE No.D III





LONGITUDINAL SECTION



SECTION A_A

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REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS & ELECTRIC POWER
DIRECT. GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS

CITANDUY PROJECT

PROTOTYPE BRUSH DAM
(SUGGESTED)

ENGINEERING CONSULTANTS, INC.
DENVER COLORADO, U.S.A

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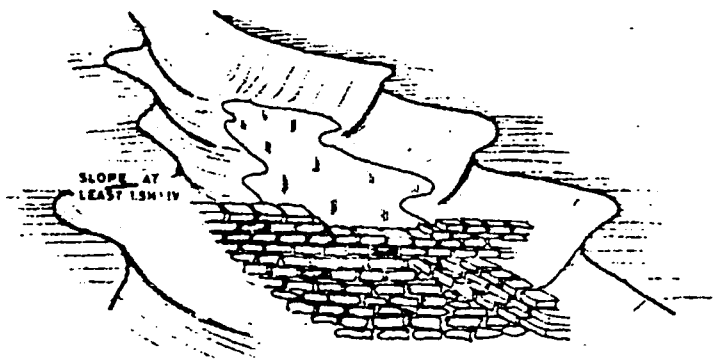
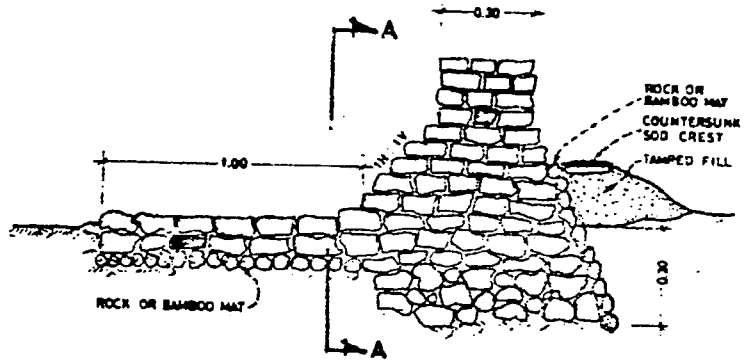
TRACED : RECOMMENDED :
CHECKED : APPROVED
DATE : DRAWING No.

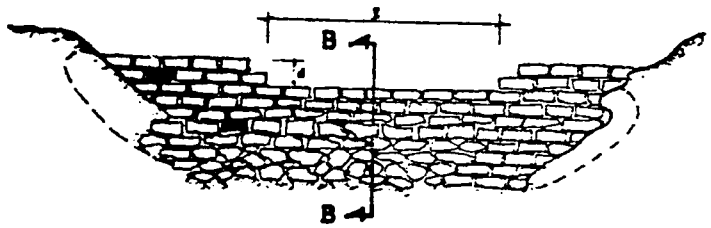
ENGINEERING CONSULTANTS, INC.

PLATE No. D IV





SECTION B_B



SECTION A_A

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REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS & ELECTRIC POWER
DIRECT. GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS
CITANDUY PROJECT

PROTOTYPE
LOOSE ROCK DAM
(SUGGESTED)

ENGINEERING CONSULTANTS, INC.
DENVER COLORADO U.S.A.

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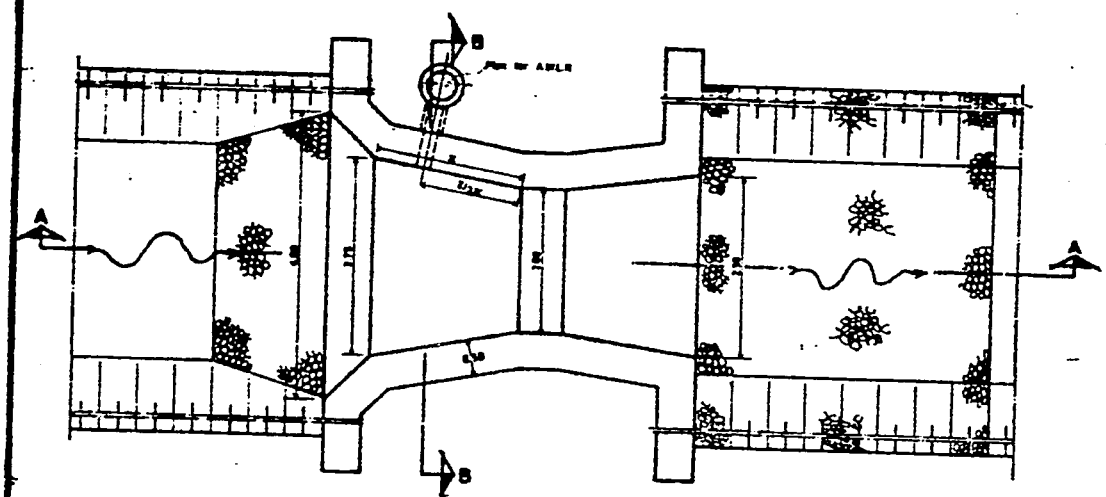
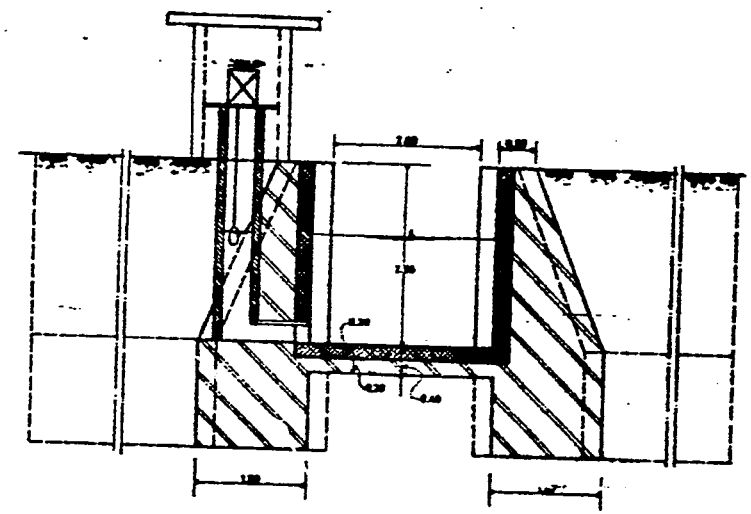
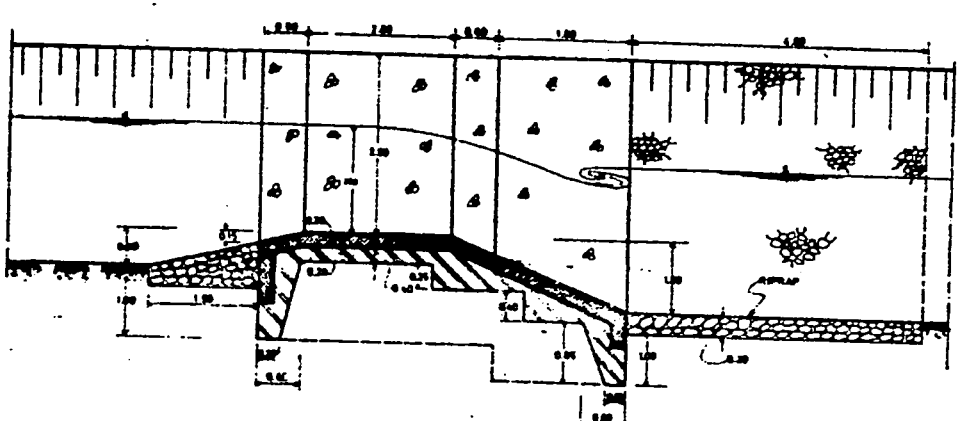
DATE		DWG. No.	



PLAN



SECTION B - B



SECTION A - A

0 1 15 2.5

SCALE
METERS

NOTES:

1. Place structure on rock or firm ground
2. Extend wing walls into the banks atleast 1 m
3. For free flow conditions $Q = 4.95\ Hd^{1.6}\ m^3/s$.
4. The estimated cost is Rp 2,500,000,-

REV		DATE
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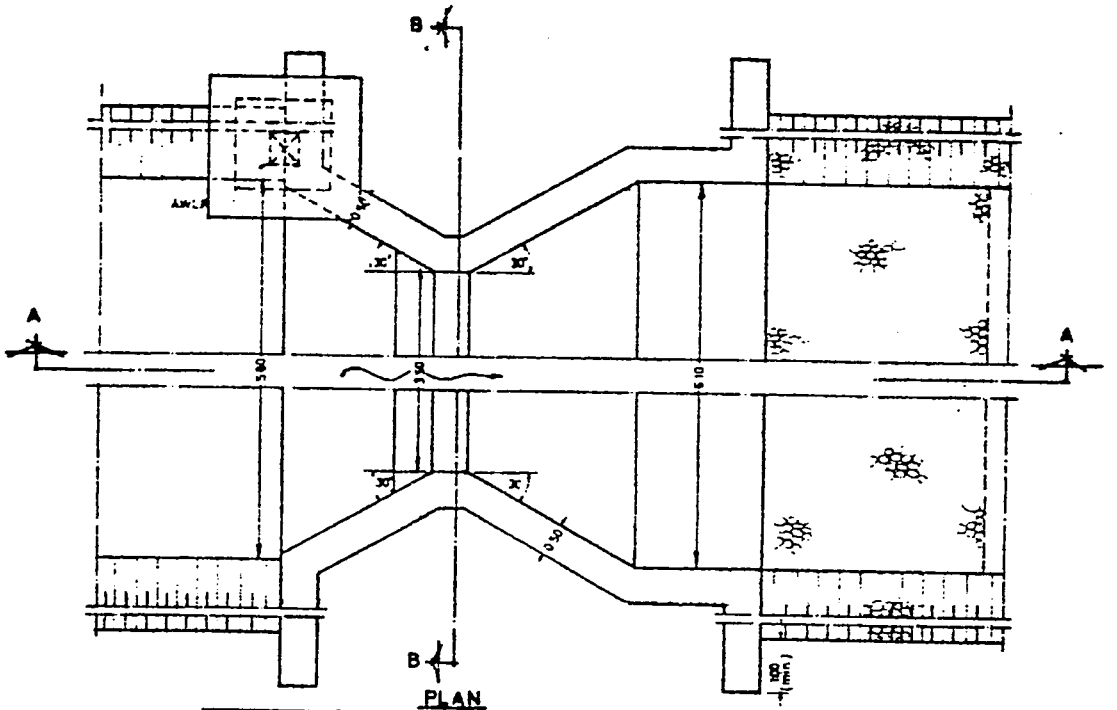
REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS & ELECTRIC POWER
DIRECT. GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS
CITANDUY PROJECT

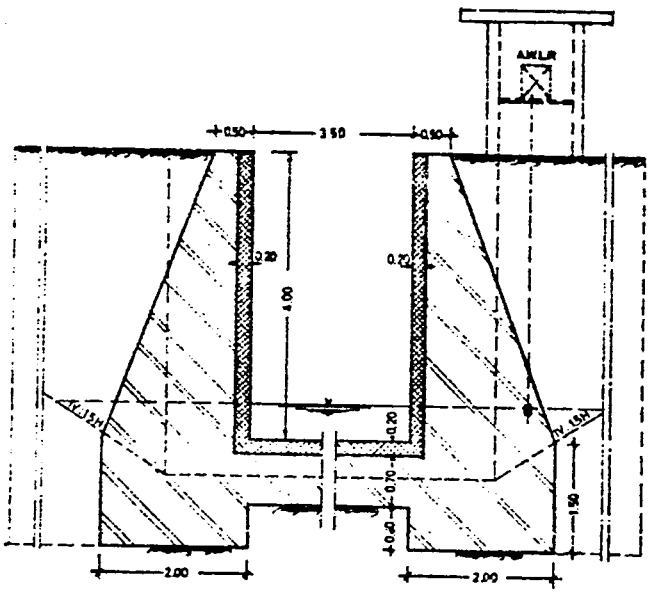
PARSHALL FLUME
CONTROL AREA
PANAWANGAN PILOT WATERSHED

ENGINEERING CONSULTANTS, INC.
DENVER COLORADO U.S.A.

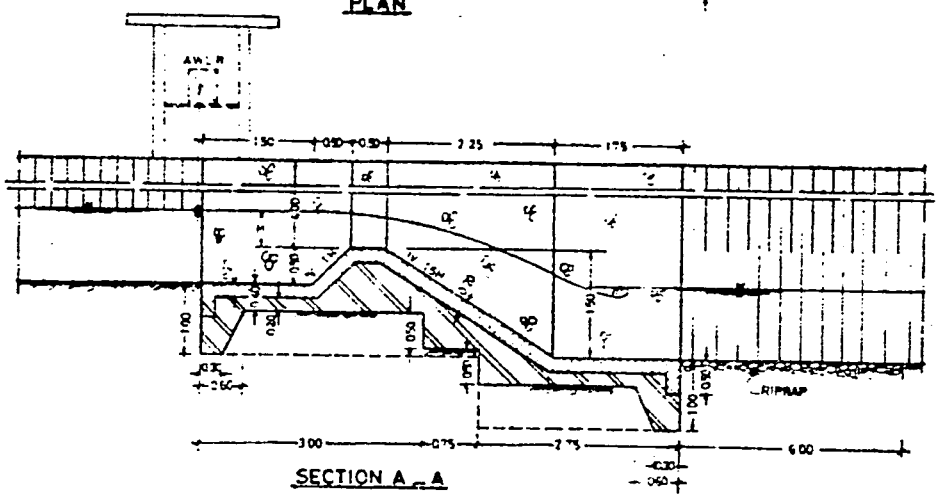
DRAWN	M. SUSWORO	SUBMITTED	S.A.R.
TRACED		RECOMMENDED	
CHECKED	S.A.R.	APPROVED	
DATE		DRAWING NUMBER	



PLAN



SECTION B_B



SECTION A_A

NOTES:

1. Place the structure on rock or firm soil.
2. Extend wing walls into bank atleast 1.00 m.
3. The flume will require calibration for discharge. However for free flow conditions suggested discharge relationship is $Q = 7H^{3/2}$.
4. The estimated cost is Rp 5,500,000.-

0 1.0 1.5 2.5

SCALE METERS

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REPUBLIC OF INDONESIA

MINISTRY OF PUBLIC WORKS & ELECTRIC POWER
DIRECT GENERAL OF WATER RESOURCES DEVELOPMENT
DIRECTORATE OF RIVERS

CITANDUY PROJECT

BROAD CRESTED WEIR
TREATED AREA
PANAWANGAN PILOT WATERSHED

ENGINEERING CONSULTANTS, INC.
DENVER, COLORADO, U.S.A.

DRAWN: Dr. Bhandari
TRACED: M. Zamani
CHECKED: A. Kumar
DATE: Oct. 22-1975
APPROVED:
DRAWING NUMBER

APPENDIX NO. I

FINAL REPORT

LAND AND WATER MANAGEMENT CONSERVATION

WATERSHED IN CITANDUY RIVER BASIN

Land and Water Management Conservation Watershed in Citanduy River Basin

It was proposed to select a watershed and implement studies designed to compare, verify, and identify improved cropping methods, varieties, terrace methods, and land use to optimize farm income compatible with proper soil use and conservation practices.

Two pilot watersheds were selected in Panawangan. Conservation practices and comparison studies will be applied to one of the watersheds. The other watershed will serve as a control to measure and compare the effects of the regular field practices now being utilized.

These watersheds were selected in consultation with the Manager of Project Citanduy, the Agricultural Extension Service, Forest Service, and Greening Program officials in Ciamis.

The objectives of the upper watershed program will be to conduct investigations and comparison watershed studies that will provide a technical basis on which future recommendations can be made for maximum crop production compatible with good soil conservation practices. Some of these objectives are listed below:

1. Statistically designed adaptive field trials will be initiated on farm units representative of the various soils, topographies, precipitation, and irrigation supplies characteristic of the Citanduy Upper Basin. Field trials will provide verifiable information on terrace systems, contour strip cropping, contour cropping, crop rotations, cropping intensity, level of production inputs, and

cost/return, and cropping systems. Information gained from these studies will be used as a basis for future recommendation.

2. To select model farm units of a group of small farmers in sub-watersheds within the Pilot Conservation Area. Terraces, check dams, brush dams, and other conservation programs will be constructed in the model farm units to train and demonstrate to all farmers proper conservation structures.

3. Water conservation and sediment control techniques will be developed through applied methods of conservation practices on model farm units. Such methods will include forestry, fertilizers, fish ponds and other conservation practices.

4. The capacity of the Government will be strengthened to progressively apply the results to other areas and to build a cadre of professional and sub-professional workers, which are capable of working directly with farmers to advise how conservation practices are to be applied.

5. To assess the effectiveness of the Pilot Conservation Program and develop effective upper watershed conservation practices for the control and management of water and sediment in all watersheds in the Citanduy Basins. Develop guidelines to help select practices suitable to particular needs of the farmer, and to apply scientific water and erosion control knowledge. To improve the life and social conditions in the villages.

6. The objective of the Pilot Program will be not only improvement of soil and water conservation and land development but also, will be concerned with socio-economic problems in rural development with objectives of increasing productivity and raising farm

incomes through modern technology, improvement of rural institutions and community development.

Implementation of Pilot Conservation Program

ECI specialists will prepare the Design Report outlining the plan for initiating comparison studies, terrace construction, and will design all water measuring structures.

Project Citanduy will supply funds and construct the weirs, water control structures, major check dams and the climatic stations and rain gages. The Project will pay for part of the labor to help farmers build terraces, check dams and water disposal systems. The Project and local government will supply fertilizer the first year of terrace construction, plus seedlings and seed of new crop varieties.

The Project will participate by providing funds to the extension service for equipment, buildings, and an additional PPL and PPS for training farmers how to control water and reduce erosion. The Project will generally control all programs associated with the pilot conservation program.

Agricultural Extension Service will provide technical training to farmers on how to plan and apply a soil and water conservation program on each farm according to the farmers land, water problem, and financial capabilities. The Extension Service will provide and train needed personnel to help the farmer carry out technical conservation plans which would include recommendations from other technical services. They will provide equipment and training centers as needed.

Agricultural services will provide cropping recommendations, fertilizer requirements, and technical plans for managing grass and/or

legumes for erosion control. Soil surveys, soil fertilizer needs, and plans for fish ponds will be provided.

Rural Banks and cooperative organizations dealing with credit and marketing will be solicited to loan money on low term interest rates to qualified farmers for improvement of agricultural lands and increase crop production.

BIMAS will be solicited to take an active role in extending credit in kind to farmers in the Pilot Watershed area.

The Forest Service Greening Program will provide technical assistance to ensure that farmers carry out these programs according to plans. Seedlings will be supplied at no cost to the farmer during the first year.

Bupati and Staff in Ciamis = The combination of a decentralized operational control of management together with a specialist technical direction staff can be achieved under the regular government organization.

The Kelurahan will be able to compile the village registers of areas and will assist the Project in taking a survey of all people who will cooperate in an erosion and water management program. A staff at this level under the guidance of the PPL and project officer will implement the plans for terracing, check dams and other erosion control measures designed for the pilot watersheds. This staff under the guidance of the Forest Service will implement the greening and reforestation program, and will arrange for the extension service and other educational media to be given to the farmer.

The Kecamatan will be responsible for the supervision of the water management and conservation program that is recommended for the Pilot Watershed by the Project. He will arrange for part payments to farmers for labor, fertilizer, planting stock, or any other type of assistance necessary to carry out the water and sediment program. The Kecamatan and his staff will formulate an annual program to carry out the design plans for the pilot watershed.

Agencies at the Kabupaten level will recruit, train, and supervise the technical personnel for the Pilot Program. These agencies under the direction of the Bupati will organize training courses, seminars, and give general and specific coordination to the Kecamatan. The Kabupaten will cooperate with the Project to arrange for surveys to be conducted on soils, land use, vegetation, geology, engineering, land capabilities, and any other physical or sociological studies that are needed to carry forward the pilot program. The Kabupaten will provide liaison with the Provincial government for technical assistance and program evaluation. He will coordinate with the Project the use of all equipment and materials made available to the water management program of the Pilot Watershed Program.

The establishment of a vegetative cover on the land in the pilot watershed is the primary means of controlling runoff and erosion. Before any program on the land can be carried out it will be essential that an understanding of the climate, soil geology , ecology , land capability, economic and social conditions of the people be inventoried. The extent of the eroded land, the land under cultivation, location of dwellings and other cultural features will be required. The interaction of each of the physical conditions and how each is related to the people problems will be coordinated by the Kabupaten and the project administrator.

APPENDIX NO. II

FINAL REPORT

CROPPING DATA REPORTED FROM SOLO PROJECT TO BE COMPARED WITH PANAWANGAN WATERSHED CONSERVATION AND DEVELOPMENT PROGRAM

Cropping Data Reported from Solo Project

Central Java

The objective of this paper is to report the data showing the beneficial effects of fertilizers, improved varieties and intercropping on the yields of rice (*Oryza sativa*), Cassava (*Manihot esculenta*), peanut (*Arachis hypogaea*), maize (*Zea mays*), and sorghum (*Sorghum vulgare*), grown on newly constructed bench terraces and on the basis of which recommendations are presented regarding improved varieties, cropping system, fertilization, crop rotations and general agronomic practices.

MATERIAL AND METHODS

Crop varieties : The following varieties were used in the demonstrations.

Cassava : Local Ngunut, 10 to 12 month variety. Planting distance 60 x 60 cm., requiring 28,000 cuttings 20 to 25 cm. long.
Mukibat cassava, 10 to 18 month duration. Planting distance 1.5 x 1.5 m., requiring 4,444 grafted cuttings. Planted in holes 0.6 x 0.6 x 0.6 m.

Rice : The improved high yielding variety, C4-63, was used for dryland rice, while Dewi Ratih an improved local variety was used for irrigated rice. Planting distance for irrigated rice 25 x 25 cm. and 25 x 15 cm. in dryland rice. Seed rate 25 to 30 kg/ha.

Maize : Local Ngunut, white, 70 day variety and two improved high yielding varieties, Bala-bala, a 70 day yellow, and Harapan, a 100 day yellow were used. Planting distance 60 x 40 cm. and seed rate 20 to 25 kg/ha.

Sorghum : UPCA S1, an improved high yielding, medium dwarf, white, 90 day variety was used. Planting distance 60 x 20 cm. and seed rate 12 to 15 kg/ha.

Peanut : Local Ngunut bunch type, 85 day variety was shelled, soaked in water overnight, mixed with top soil from an old peanut field in 1:1 ratio to ensure nodulation, and planted at 25 x 25 cm. spacing with a seed rate of 80 to 100 kg/ha.

The local varieties were supplied by the farmer, while the improved high yielding varieties were recommended by the Central Research Institute for Agriculture in Bogor, and the seeds obtained through the Agricultural Extension Service in Central Java.

Cropping system: The following two cropping systems were used in the demonstrations and based on these, recommendations have been made for crop rotations.

Sequential Planting: This is a type of mono-cropping in which one crop follows another without any two crops occuping the field at the same time.

Intercropping: This is a type of multiple cropping in which two or more crops are planted together in rows with definite spacings and grow side by side towards maturity. The crops may be harvested at the same time as in maize/peanut or one after another like in cassava/peanut.

Cropping intensity: This term refers to the number of crops grown on the same land during a year or the number of crops in a rotation divided by the number of years. For example, if one crop of rice is grown in a field in one year, the cropping intensity is 100 percent; while in a two year rotation, consisting of a crop of dryland rice, followed by cassava and then intercropping of maize/peanut, the cropping intensity is 200 percent.

Fertilizer Treatments for Demonstrations:

Sequential Planting:

Legumes: In peanuts 25 kg/ha of Urea (46% N) and 200 kg/ha of triple superphosphate (46% P_2O_5) were placed in the row under the seed at planting time. Besides the chemical fertilizers, 900 kg/ha of rotted farm-yard manure was also applied in the rows at planting time.

Non-legumes: In maize, sorghum, rice and cassava, half the Urea, all the triple superphosphate and where used all the potassium chloride (60% K_2O) were applied at planting time. While the remaining Urea was given as a side dressing after 30 to 60 days.

Intercropping: Always consisted of legume and non-legume combinations.

In the intercropping system for maize/peanut and cassava/peanut, fertilizers at the rate of 50 kg/ha of Urea and 200 kg/ha of triple superphosphate were placed under the seed or planting material of both the crops; while the remaining 100 kg/ha of Urea was given as a side dressing at 30 day old maize or 90 day old cassava.

Fertilizer treatments for farmers'fields:

A total of 87 ha were bench terraced and the crops grown on them received free fertilizers from the project during the first year. The fertilizer rates used for the different crops were based on the Bimas recommendations and the data available from the FFHC Fertilizer Programme in Central Java.

Yield calculations: In the demonstrations the plot size of each treatment depended on the area of the individual terrace, which varied from 50 to 200 m^2. The whole plot was harvested and an estimation of the yield per hectare was obtained from it.

In the farmers fields, three plots measuring 2.5 x 2.5 m. in the centre of the planted terraces were harvested, and the yield per hectare was calculated from the average of these plots.

RESULTS AND DISCUSSIONS

Sequential Planting:

Cassava: Yields of fresh cassava from two demonstrations, one following, and the other preceding dryland rice, from two plots in Unit 1 were tried. These results show that with an application of 150 kg/ha of urea and 150 kg/ha of TSP, yields of 6280 and 9046 can be obtained; while without fertilizers, the yields are very poor, being only 323 and 1055 kg/ha.

Data collected from the farmers'fields supports the results of the demonstrations, and indicate that in superficial soils of 25 to 30 cm depth, the cassava yields are 3520 to 3840 kg/ha, in soils of 50 cm depth, the yields are between 5920 to 6400 kg/ha, while in deeper soils of 50 to 90 cm, the yields tend to be much higher, from 3800 to 9160 kg/ha. These yields are 50 to 125% higher than the weighted average yield of 3.91 t/ha. for Jumantono, with the exception of the yields from the superficial soils which are about the same.

Although there is a residual effect on cassava yields of the fertilizers applied to dryland rice in the previous year, it is important to use fertilizers every year in order to maintain high yields in these eroded soils of low native fertility. An application of 150 kg/ha. of urea and 150 kg/ha. of TSP to the preceding dryland

rice crop produced a residual effect on the following cassava crop, giving a yield of 2.33 t/ha. while an additional application of the same amounts of fertilizers to the cassava crop maintained the yields at the level of 6.3 t/ha.

R i c e :

Irrigated rice: Data showing the effect of fertilizers on the yield of Dewi Ratih rice grown on newly constructed sawah terraces shows that an application of 200 kg/ha. of urea and 200 kg/ha. of TSP gave a yield of 2148 kg/ha. of stalk paddy; while the yield was only 482 kg/ha without the use of fertilizers. This yield is 41 percent lower than the weighted average yield of 3.66 t/ha for the old established sawah receiving yearly application of fertilizers.

Dryland rice: Yields of stalk paddy from two demonstrations, one preceding and the other following cassava show that with an application of 150 kg/ha of urea and 150 kg/ha of TSP, yields of 1560 and 1647 kg/ha can be obtained; while without fertilizers the yields are extremely poor, up to 137 kg/ha.

Data collected from the farmers fields indicate that in shallow soils of 30 cm depth, the yield is only 928 kg/ha, in soils 50 cm depth, the yields are between 1455 to 1712 kg/ha; while in deeper soils of 60 cm, the yields can be higher, from 1920 to 2320 kg/ha. The yields from the 50 cm soil depth compare favourable to the weighted average yield of 1.54 t/ha for the region.

The data in figure 2 shows that there is very little residual effect on dryland rice yields of fertilizers applied to the preceding cassava crop, and in order to maintain high yields it is essential to use fertilizers every year. Am application of 150 kg/ha of urea and 150 kg/ha of TSP to cassava in the previous year gave a residual effect yield of 0.13 t/ha only; while an additional application of the same amounts of fertilizers to dryland rice maintained yields of 1.65 t/ha.

Sorghum: This is comparatively a new crop in this area and is most suitable for growing during the dry period between May and August.

The plant growth for UPCA S1 variety was so stunted in the plots with no fertilizers, that no heads were formed, while in the plot without TSP the growth was poor with very small heads. The recorded yields in the other plots of the demonstration were very low as it was severely damaged by birds, being the only grain crop in the field during this dry period. It was estimated that if it had not been for the bird damage; a yield of 1000 kg/ha could have been harvested. This is supported by the results of the FFHC trial in Sringin, just outside the Kali Dumpul sub-watershed, where a yield of 1091 kg/ha was obtained by using 150 kg/ha of urea and 100 kg/ha of TSP. These yields are three times the average yield for the area.

Intercropping:

Maize and peanut: Maize and peanuts occupy a large precentage of the cultivated dryland area devoted to the production of food crops other than rice (Palawija) in Indonesia. Despite their importance, both in meeting the needs of human consumption and livestock production, these crops have not been subjected to extensive studies, specially in the field of intercropping. During the 1964-73 period in the District of Jumantono, Kali Dumpul sub-watershed, the average of irrigated rice has increased from 1.1 to 3.7 t/ha; while the average yields of maize and peanuts reflect practically no change, having stagnated at below the 0.5 t/ha level.

The highest yield was obtained when the improved 70 day maize variety Bala-bala was used in the intercropping system, giving a return of Rp. 176,400 per hectare or Rp. 2,075 per day. The intercropping of local 70 day maize with local peanut gave the next best returns of Rp. 134,700 per hectare or Rp. 1,576 per day.

Although the returns from the improved 100 day maize variety Harapan and local Ngunut peanut variety were Rp. 135,600 per hectare, which is slightly better than the local maize-local peanut combination; the return per day of Rp. 1,356 is much lower.

These results indicate that intercropping of maize and peanut gives a higher return to the farmer as compared to a monocrop in sequential planting and it can even compete favourably when improved varieties are used, with a 120 day irrigated rice yield of 3.5 t/ha of stalk paddy, representing returns of Rp. 175,000 per hectare or Rp. 1,458 per day. The best yields and returns are obtained when Bala-bala maize variety is intercropped with peanuts. In case the seed of this improved variety is not available, the combination local maize and local peanut is the next best choice.

Cassava and peanut: Cassava represents the staple food in considerable areas of Central Java, especially in the poor, subsistance farming areas of the Upper Solo River Basin. It is basically a low incentive subsistance crop which can grow on the poorest of soils, and causes severe erosion hazards on steep slopes.

The results of intercropping and fertilizer indicate that there is no difference between the yields of peanut as a mono crop in sequential planting or when grown as an intercrop with cassava. The best returns are obtained when cassava and peanuts are grown as an intercrop with the use of fertilizers.

CONCLUSIONS AND RECOMMENDATIONS

1. Crop varieties: Local varieties should be replaced by improved high yielding varieties as recommended by the Central Research Institute for Agriculture in Bogor. Unfortunately adequate seed supply of the improved varieties is not yet available at the village level. To remedy this deficiency, seed production of the improved varieties should be undertaken at the provincial level by a specialized seed agency, so as to produce about 50 packets, of the provincial seed requirements, and make it available at the village level at reasonable and controlled price.

   Encourage the expansion of the area under Mukibat cassava through demonstrations and visits of the progressive farmers to the important Mukibat cassava growing areas in East Java. In new regions like the Kali Dumpul, the taste of the Mukibat cassava is considered inferior to that of normal local cassava, but in the regions of East Java where the system of Mukibat cassava is well established no complaints about taste are reported.

2. Cropping system: Intercropping should be given preference over sequential planting, as it insures greater economic returns and better income stability for the farmer by protecting him against the risk of a total crop failure and wide price fluctuation. It confers almost the same benefits as a crop rotation with regards to its effects on the soil especially if a legume is included in the combination. The legume helps to conserve and maintain soil fertility and even though the tops are removed for fodder the fine roots with their nodules stay in the soil and on decay supply nutrients to the following crops.

In new areas, peanut seed should be inoculated before planting to insure nodulation and nitrogen fixation. This can be done by soaking the freshly shelled peanuts in water over-night and mixing with top soil from an old peanut field in a 1:1 ratio.

3. Fertilization: Potassium fertilizers are not available on the local market and are not included in the present recommendations. However, with the increased utilization of urea and TSP and the production of higher yields, potassium deficiency problems are bound to show up in the near future, when the native potassium present in the soil is depleted. This deficiency when it occurs can be corrected by applying 100 kg/ha of potassium chloride along with the urea and TSP.

4. Crop rotation: Recommendations for three and two year crop rotations take into consideration the principle crops of the area like cassava, dryland rice and peanuts, besides encouraging the introduction of newer crops like maize and sorghum. During the dry season between May and August, grain sorghum being a drought resistant crop, has great possibilities and can become a major crop supplying food both for human consumption and animal feed. However, it may be necessary to use a bird resistant variety when small fields of grain sorghum are grown.

Figure - 1

Fertilizer application rates used for the crops grown on newly constructed bench terraces in the Kali Dumpul Subwatershed

Cropping system	Fertilizer application rate kg/ha. Urea	TSP
Legumes :[1]		
Peanut	25	200
Non-Legumes:[2]	200	200
Cassava		
Rice		
Maize		
Sorghum		
Intercropping[3]	150	200
Cassava/Peanut		
Maize/Peanut		

[1] All fertilizers placed under the seed in the row at planting

[2] Half the Urea and all TSP at planting, while the remaining Urea given as a side dressing after 30 to 60 days.

[3] One third of Urea and all of TSP at planting, while the remaining Urea given as a side dressing to 30 day maize or 90 day cassava.

Figure - 2

The response of dryland paddy and cassava to fertilizer in sequential planting demonstrations on bench terraces of Unit 1 in Kali Dumpul

Dryland paddy variety C4-63, planted 13-12-73, harvested 10-5-74.
Cassava variety local Ngunut, planted 2-11-74, harvested 24-6-75.

Treatment Kg/ha.	Dryland paddy Kg/ha		Cassava Kg/ha.			
Urea-TSP-KCl	Stalk paddy	Index*	Tops	Index*	Tubers	Index*
0 - 0 - 0	137	8.8	3200	400	323	5.1
0 - 150 - 100	1647	105.6	800	100	1579	25.1
150 - 150 - 100	2942	188.6	1600	200	10805	172.1
300 - 150 - 100	1814	116.3	3200	400	12004	191.2
150 - 0 - 100	192	12.3	1600	200	3562	56.7
150 - 300 - 100	2426	155.5	1600	200	10590	168.6
150 - 150 - 0	1560	100.0	800	100	6280	100.0
150 - 150 - 200	1786	114.5	3200	400	11814	188.1

* Index based on the 150 - 150 - 0 treatment which is the closest to the Project recommendation of 200 - 200 - 0 .

Figure - 3

The response of cassava and dryland paddy to fertilizer in sequential planting demonstrations on bench terraces of Unit 1 in Kali Dumpul.

Cassava variety local Ngunut, planted 13-12-73, harvested 21-9-74.
Dryland paddy variety C4-63, planted 16-10-74, harvested 16-4-75.

Treatment Kg/ha	Cassava Kg/ha.		Dryland paddy Kg/ha.			
Urea-TSP-KCl	Tubers	Index*	Straw	Index*	Stalk paddy	Index*
0 - 0 - 0	1055	11.7	350	2.9	1	0.1
0 - 150 - 100	7988	88.3	11240	92.8	1626	98.7
300 - 150 - 100	11162	123.4	15437	127.4	1303	79.1
150 - 0 - 100	2745	30.0	12301	101.5	1481	89.9
150 - 300 - 100	7847	86.8	10510	86.7	3123	189.8
150 - 150 - 0	9046	100.0	12118	100.0	1647	100.0
150 - 150 - 200	3684	40.7	7168	59.2	3584	217.6

* Index based on the 150 - 150 - 0 treatment which is the closest to the Project recommendation of 200 - 200 - 0 .

Figure - 4

The effect of fertilizers on the yields of cassava and dryland rice in farmers fields on newly constructed bench terraces in Kali Dumpul Subwatershed.

Unit No.	Soil depth in cm	Dryland Rice Kg/ha		Fresh cassava Kg/ha.	
		Straw	Stalk paddy	Tops	Tubers
4	25	-	-	2400	3520
6	80	-	-	3728	9160
8b	50	-	-	3200	5920
8a	30	-	-	2720	3840
9	90	-	-	4480	8800
14	50	-	-	3520	6400
24a	50	5120	1455	-	-
27	60	6880	2120	-	-
55	50	3920	1600	-	-
56	50	6080	1712	-	-
16b	60	6080	1920	-	-
43	30	4320	928	-	-
17	50	6400	1600	-	-
14	40	6080	928	-	-

All plots received 100 kg/ha of urea and 200 kg/ha of TSP at planting time and 100 kg/ha of urea as a side dressing after 30 days for rice and 60 days for cassava.

Figure - 5

Effect of fertilizers on the yield of sorghum UPCA S1 variety grown on newly constructed bench terraces Unit No.1 Ngunut.

Planted 13.12.73. Harvested 15.3.74.

Fertilization kg/ha Urea-TSP-KCl.	Plot Area m^2	Field of dry grain		
		kg/plot	kg/ha	Index*
0 - 0 - 0	104	0	0	-
0 - 150 - 100	117	1.5	128	58.5
150 - 150 - 100	162	4.0	247	112.8
- 150 - 100	121	4.3	355	162.1
150 - 0 - 100	213	0.3	14	6.4
150 - 300 - 100	169	7.5	444	202.7
150 - 150 - 0	174	3.8	219	100.0
150 - 150 - 200	189	4.4	233	106.4

* Index based on the 150 - 150 - 0 treatment which is the closest to the Project recommendation of 200 - 200 - 0 .

The check and zero TSP treatment had very poor growth and practically no heads; while the yields in the other plots was severely affected by birds.

Figure - 6

Effect of inter-cropping and fertilizers on the yields of maize and peanuts

Cropping System	Days	Urea-TSP kg/ha	Maize yield t/ha Tops	Maize yield t/ha Grain	Peanut yield t/ha Tops	Peanut yield t/ha Shelled	Value[2] Rp/ha
SEQUENTIAL							
1a. Local peanut	85	0-0	-	-	2.15	0.18	27,000
b. Local peanut	85	25-200	-	-	3.71	0.76	114,000
2a. Local maize	70	0-0	1.85	0.098	-	-	5,880
b. Local maize	70	200-200	3.45	1.03	-	-	61,800
INTERCROPPING[1]							
1a. Local maize with Local peanut	70 85	0-0	0.69	0.01	2.33	0.23	35,100
1b. Local maize with Local peanut	70 85	150-200	3.34	1.02	3.59	0.49	134,700
2a. Bala-bala maize with Local peanut	70 85	0-0	0.68	0.03	2.75	0.20	31,800
2b. Bala-bala maize with Local peanut	70 85	150-200	3.75	1.69	3.64	0.50	176,400
3a. Harapan maize with Local peanut	100 85	0-0	0.31	nil	1.85	0.24	35,000
3b. Harapan maize with Local peanut	100 85	150-200	8.80	0.96	3.45	0.52	135,600

[1] Urea 50 kg/ha and all TSP applied at planting time to both maize and peanut, while the remaining 100 kg/ha of urea was given as a side dressing only to 30 day maize.

[2] Value calculated at Rp. 60 per kg/ of maize and Rp. 150 per kg. of shelled peanut. Value of tops not taken into account as they are normally fed to livestock or used in list of payment in harvesting.

Figure - 7

Effect of intercropping and fertilizers on the yields of cassava and peanuts in farmers fields on newly constructed bench terraces.

Cropping System	Unit[3] No.	Days	Urea - TSP kg/ha	Cassava yield t/ha Tops	Cassava yield t/ha Tubers	Peanut yield t/ha Tops	Peanut yield t/ha Shelled	Value[2] Rp/ha
SEQUENTIAL								
Local peanut	4	85	0-0	-	-	1.11	0.09	13,500
			25-200	-	-	2.45	0.30	45,500
	6	85	0-0	-	-	2.15	0.14	21,000
			25-200	-	-	3.19	0.78	117,000
	7	85	0-0	-	-	1.95	0.13	19,500
			25-260	-	-	3.45	0.56	84,000
INTERCROPPING								
Local cassava with Local peanut	4	270	0-0	0-8	0-32	1.05	0.10	18,200
		85	150-200	1.6	4.80	1.96	0.28	90,000
	6	270	0-0	1.6	0.80	2.01	0.12	26,000
		85	150-200	3.2	7.20	3.92	0.88	204,000
	7	270	0-0	1.6	0.48	1.75	0.13	24,300
		85	150-200	3.8	6.80	3.46	0.51	144,500

1 Urea 50 kg/ha and all TSP applied at planting time to both cassava and peanut, while the remaining 100 kg/ha of urea was given as a side dressing only to 90 day cassava.

2 Value calculated at Rp. 10 per kg of fresh cassava and Rp.150 per kg of shelled peanut. Value of tops not taken into account as they are normally fed to livestock or used in lieu of payment in harvesting in case of peanuts.

3 Unit No.4 soil less than 25 cm in depth consisting of C Horizon, Unit No.6 soil between 75 to 100 cm in depth consisting of B horizon, while Unit No.7 soil between 50 to 75 cm in depth consisting of B horizon and taken as representative of an average soil of the area.

Figure - 8

The yields of Mukibat cassava and local cassava when intercropped with peanuts

Planting date: 14.10.74 Harvested: Peanut - 6.1.75 and Cassava 27.9.75.

Cropping system	Planting distance (m)	Fresh cassava yield kg/plant tops	Fresh cassava yield kg/plant tubers	Fresh cassava yield t/ha tops	Fresh cassava yield t/ha tubers	Peanut yield t/ha tops	Peanut yield t/ha shelled	Value Rp/ha
Local cassava with Local peanuts	0.60 x 0.60 0.25 x 0.25	0.14	0.26	3.9	7.2	3.8	0.56	156,000
Local cassava with Local peanuts	1.50 x 1.50 0.25 x 0.25	1.25	2.48	5.6	11.1	5.4	0.46	180,000
Mukibat cassava with Local peanut	1.50 x 1.50 0.25 x 0.25	14.5	15.5	64.0	68.9	5.4	0.47	518,500

Both cassava and peanut received urea 50 kg/ha and TSP 200 kg/ha at planting time, while after 85 days when the peanuts were harvested, 100 kg/ha of urea was given as a side dressing to cassava.

Value calculated at Rp. 10. per kg of fresh local cassava, Rp.7 per kg for fresh Mukibat cassava and Rp. 150 per kg of shelled peanut. Value of tops not taken into account. The tops of peanuts and the leafy tender tops of cassava can be used as fodder, while in the case of mukibat cassava about 80 percent of the tops consists of woody material, which can be used for firewood after drying.

Figure - 9

Field of fresh cassava tubers obtained by the Mukibat system, for different growing periods and plant spacing, as reported by seven authors.

Authors	Growing period (months)	Plant spacing (m x m)	Yield of Fresh tubers			
			reported	calculated		
			kg/plant	t/ha	t/ha/yr	Ave/t/ha/yr
Koesmadi (1953)	13	3.0 x 3.0*	58	64	59	
	10	3.0 x 3.0*	54	60	70	
	10	3.0 x 3.0*	61	68	75	97
	9	3.0 x 3.0*	93	100	133	
	11	3.0 x 3.0*	123	137	150	
Kurniaatmadja (1969)	12 - 13	2.0 x 2.0	35	88	84	
	12 - 13	2.5 x 2.5	50	80	77	81
	12 - 13	3.0 x 3.0	75	83	80	
Taufik Budiman (1972)	12 - 15	2.5 x 3.0	100	133	106	106
Anonymous (1973)	12	3.0 x 3.0*	104	115	115	115
Purwohadi Wijoyo (1973)	8 - 9	1.5 x 2.0	20 - 25	75	100	
	18	2.0 x 3.0	50 -100	125	83	91
Subur Djatiwalujo (1973)	10 - 12	2.0 x 2.0	25 - 30	69	75	75
Syekhfani (1973)	8 - 9	2.0 x 2.0	25 - 40	81	108	108
et al (1975) K.Dumpul	11.5	1.5 x 1.5	15.5	69	72	72

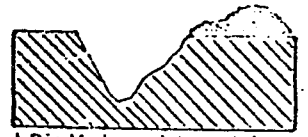
* Estimated maximum.

APPENDIX NO. III

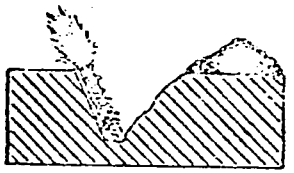
FINAL REPORT

TREE PLANTING INSTRUCTIONS

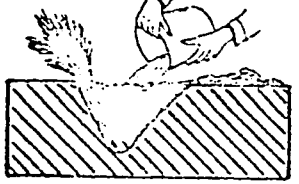
HEELING IN



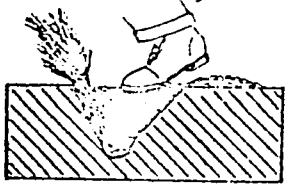
1. Dig V-shaped trench in a moist shady place.



2. Break bundles and spread out evenly.

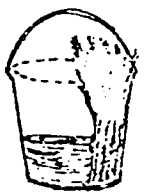


3. Fill in loose soil and water well.



4. Complete filling in soil and firm with feet.

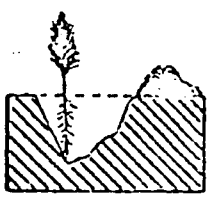
HANDLING SEEDLINGS IN FIELD



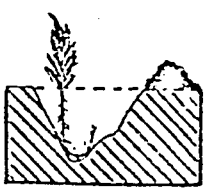
Correct
In bucket with sufficient water to cover roots.

Incorrect
in hand–roots dry out.

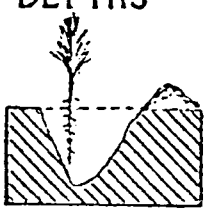
CORRECT AND INCORRECT DEPTHS



Correct
At same depth or ½" deeper than seedling grew in nursery.

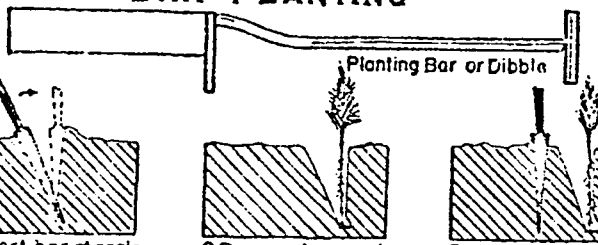


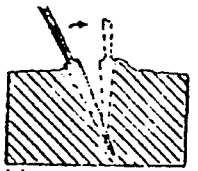
Incorrect
Too deep and roots bent.



Incorrect
Too shallow and roots exposed.

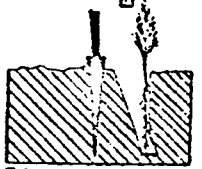
BAR PLANTING



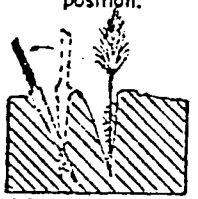


1. Insert bar at angle shown and push forward foupright position.

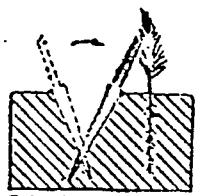
2. Remove bar and place seedling at *correct* depth.



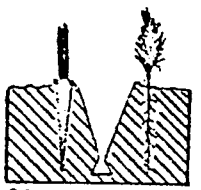
3. Insert bar 2 inches toward planter from seedling.



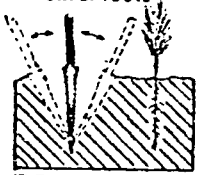
4. Pull handle of bar toward planter firming soil at bottom of roots.



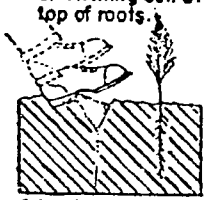
5. Push handle of bar forward from planter firming soil at top of roots.



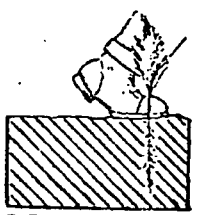
6. Insert bar 2 inches from last hole.



7. Push forward then pull backward filling hole.

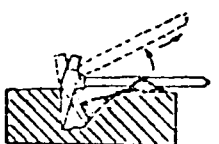


8. Fill in last hole by stamping with heel.



9. Firm soil around seedling with the feet.

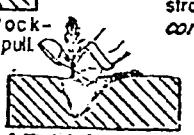
MATTOCK PLANTING



1. Insert mattock–lift handle & pull.

2. Place seedling along straight side at *correct* depth.

3. Fill in and pack soil to bottom of roots.



4. Finish filling in soil and firm with heel.

5. Firm around seedling with the feet.

APPENDIX NO. IV

FINAL REPORT

COST ESTIMATES FROM SOLO PROJECT

FOR COMPARISON WITH PANAWANGAN UPPER WATERSHED

Cost Estimates From Solo Project

The cost estimates are based on a manday of 7 hours at a cost of Rp. 600 per manday, including supervision and overhead.

Grass Strips:

Land preparation

Hand ploughing

3 mandays for 1 hectare — Rp. 1,800

Width of strip 4 - 5 meters.

Contour planted hedges:

Narrow furrow 100 m - 2 m/d	Rp. 1,200
Plant material per 100 m	Rp. 200
Planting 100 m - 0.5 manday	Rp. 300
Cost per 100 m	Rp. 1,700

Major Terraces:

Width 50 - 60 cm.

height 50 c

Output 9 m/md.	Rp. 600
Cost per 100 m	Rp. 6,600

Narrow Base Terraces

Width approx 30 cm.

Height approx 27 cm.

Output:

1 /md = 30 meters 1 x 600 cost/nh	Rp. 600
3 /md for 100 meters	Rp. 1,800

Contour Bank sloping:

3/md 100 meters	Rp. 1,800

Contour Trenches or furrows:

Depth 40 cm

Width 100 cm

Output

100 m continuous trenches	3/md	Rp. 1,800
100 m staggered trenches	$2\frac{1}{2}$/md	Rp. 1,500

Water Courses

Grassing of mulched strips per ha.	Rp.100,000

APPENDIX NO. V

FINAL REPORT

SUMMARY FINDINGS FROM SOLO CONSERVATION PROJECT AS APPLIED TO PANAWANGAN UPPER WATERSHED

Summary Findings From Solo Conservation Project as Applied to Panawangan Program

A summary of some of the findings from the Solo Project in Central Java will give a rough idea of what can be expected when a conservation and water management program is applied in the Panawangan Pilot Watersheds.

Bench terracing, which is a highly labor intensive practice of soil conservation required 1,343 man days to construct on land having a grand slope of 30 - 40% slope. Gullies had a definite pattern of erosion. The investment cost at the 1974-1975 prices was about Rp. 220,000 per ha of gross area treated. This is equivalent to $ 530 US.

This cost includes the subsidized cost of fertilizers which was distributed free to the farmers the first year. In special cases free seed and planting stock were also included. Under the erosion conditions encountered, the net return for family labor and land was about Rp. 10,000. This figure includes only the income derived from the annual food crop cultivation. It does not include income that may have been derived from livestock or trees. It is estimated that in 25 years this gross income would be reduced to approximately Rp. 1,500 if the erosion was not stopped.

With conservation practices applied to the land and using improved cropping practices and improved varieties the net return will be increased 15 times or about Rp. 150,000 per ha of gross area treated. In terms of investment, bench terracing is also profitable. If we use a discount rate of 15% over a 30 year period the cost benefit ratio is 2.5 to 1, at which rate the capital can be recovered in approximately seven years time. The internal rate of return would be approximately 23% which is a profitable return on investment.

Because of the erosion conditions in the Panawangan Pilot watershed, returns of this magnitude, or greater, can be expected. The soil conditions in Panawangan have a higher capability and capacity to react favorably to conservation treatments than in the Solo Project. This will not only provide greater benefits to the farmer but also to the community.

These increased benefits should have an impact on the rural labor employment which should rise as the intensity of cultivation increases. Over a 30 year period this should not only absorb the natural increase in population but help in the present rural under-employment at Panawangan. Increased crop yields should also stimulate a greater market economy and educational program. This in turn would raise the standard of living in the villages.

It should be emphasized that these calculations have been made on the assumptions that the terraces will be properly maintained, and that, better cropping practices, fertilizer applications, and increased livestock production will be used to maintain a high standard of farming. The local government in the Ciamis District will have to be aware of farmers'needs and develop ways of stimulating improved conservation practices as they are developed by research and experience.

APPENDIX NO. VI

FINAL REPORT

LIST OF HOME GARDEN PLANTS FOR JAVA

LIST OF HOME GARDEN PLANTS IN JAVA

(Indonesian and botanical names and edible parts).

Amaranthaceae		(leafy vegetables)
Bayam itik	*Amaranthus blitus* L.	
Bayam salasih	*A. hybridus* L.	
Bayam duri	*A. spinosus* L.	
Bayam gelatik	*A tricolor* L.	
Bayam merah	*Altermanthera amoena* Vosa	
Brojo	*Gelosia argentea* L.	
Anacardiaceae		
Jambu monyet,	*Anacardium occidentale* L.	(fruit and nut)
Gandariah,	*Bonea meorophylla* Griff	(leafy tree)
Kayu jaran,	*Lannea grandis* (Dennest) Engl.	(leafy tree)
Binglu or Kemang	*Mangifera caesia* Jack	(leafy tree)
Mangga,	*M. indica* L.	(fruit tree)
Kedondong,	*Spondias cytherea* Som.	(fruit tree)
Bangkoang,	*Mangifera foetida* Lour	(fruit tree)
Kweni dan Kebembem	*M. odorata*	(fruit tree)
Araceae		
Sueng or Walur,	*Amorphophallus campanulatus* Bl.	(root vegetable)
Keladi or Talas,	*Colocasia esculanta* L.	(root vegetable)
Bentul,	*Kanthosoma violaceum* Schott	(root vegetable)

Araliaceae		
Daun mangkok,	Nothopanax scutellarium Merr	(leafy)
Klanting or Sahang,	Scheffara aromatica Harms	(leave & fruit)
Borang or Gorang,	Trevesia sundaica Mig	(leaf & fruit)
Basellaceae		
Gendola,	Basella rubra L	(leafy climber)
Bombaceae		
Durian,	Durio zibethinus Murr	(fruit tree)
Cannaceae		
Ganyong,	Canna edulis Ker.	(root vegetable)
Carraceae		
Papaya,	Carica papaya L	(fruit & leaves)
Chenopodiaceae		
Alur,	Suaeda matitima Dumort	(leaves)
Bit,	Beta vulgaris	(root vegetable)
Combrelaceae		
Dani,	Quiscualis indica L	(leaves, flowers & fruit)
Compositae		
Ulam raja,	Cosmos caudatus H.B.K.	(leaves)
Beluntas,	Pluchea indica Less	(leaves)
Daun getang,	Spilanthes acmella Murr	(leaves)
Jotang,	Spilanthes ocymifolia A.H. Moore	(leaves)
Slada,	Lactuca sativa	(leaves)

Convolvulaceae

Ubi jalar or ketela,	Ipomoea batatas Pior	(root & leaves)
Kangkung,	Ipomoea reptans Pior	(leaves)

Cruciferae

Petsai,	Brassica pekinensis L	(leaves)
Sawi,	B. chinensis L	(leaves)
Sesawi, Sesawi jabung and sawi ijo,	B. juncea Coss	(leaves & flowers)
Kubis,	Brassica olearacea var capitate	(Head)
Kubis kembang	Brassica olearacea var botrytis	(curd)
Lobak, Rades	Rephanus sativus L	(radish)

Cucurbitaceae

Beligu or kundur,	Benincasa hispida Cogn	(fruit)
Semangka,	Citrullus lanatus Thunb,Mansf	(fruit)
Melun or Blewah,	Cucumis melo L	(fruit)
Timun or Bonteng,	Cucumis sativus L	(fruit)
Krai, Blewah,	Cucumis melo var momordica	(fruit)
Waluh or Labu bulat,	Cucurbita moschata Duch	(fruit & leave)
Labu panjang,	Cucurbita pepo L	(fruit)
Labu air,	Lagenaria siceraria Mol.Standl	(fruit)
Oyong or petola,	Luffa acutangula Roxb	(fruit)
Belustru,	Luffa cylindrica M. Roem	(fruit)
Paria,	Momordica charantia L	(fruit)
Labusiam, Jepan	Sechium edule	(fruit)

Dioscorace

Ubi aung and gembili,	Dioscorea aculeata L	(root vegetable)
Ubi kelapa or ubi manis,	Dioscorea alata L	(root vegetable)
Ubi Singapura,	Dioscorea bulbifera L	(root vegetable)
Gadung,	Dioscorea hispida Dennst	(root vegetable)
Ubi pasir,	Dioscorea pentaphylla L	(root vegetable)

Euphorbiaceae		
Ketela pohon,	Manihot esculenta	(root & leave)
Buni,	Antidesma bunius Spreng	(fruit)
Menteng,	Baccaurea recemosa Muell	(fruit)
Cerme,	Phyllanthus acidus Skeels	(fruit)
Kimalaka,	Phyllanthus emblica L	(fruit)
Guttiferae		
Manggis,	Garcinia mangostana L	(fruit)
Gnetaceae		
Mlinjo or Balinjo	Gnetum anemon L	(fruit, leaf & flowers)
Graminae		
Bambu duri	Bambusa spinosa Bl	(root sprouts)
Bambu kuning	Bambusa vulagaris Schrad	(root sprouts)
Labiateae		
Kentang Jawa	Coleus teberosus Benth	(root)
Leguminosae		
Kacang tanah	Arachis hypogaea L	(root nuts)
Gude	Cajamus cajan Ni Usp	(pod)
Kacang parang	Canavalia ensiformis, A.D.A.	(pod tree)
Menting	Cassia occidentalia L	(pod tree)
Senting	Cassia laevigata Wild	(pod tree)
Ketepang	Cassia tora L	(pod tree)
Kara-kara or Kacangbado	Dolichos lablab	(pod)
Kedelai	Glisine soja	(pod)
Petai selong	Leucaena glaunca Benth	(pod tree)

Kara benguk	Mucuna pruriens var utilis	(pod climber)
Bengkung	Pachyrhisus bulbosus Kurs	(root climber)
Petai or Pete	Parkia speciosa Hort ex Hasck	(pod tree)
Kacang uci	Phaseolus calcaratus Roxb	(pod climber)
Kakara or Koro	Phaseolus lunathus L	(pod climber)
Kacang hijau	Phaseolus radiatus L	(pod herb)
Kacang merah	Phaseolus vulgaris L	(pod)
Jering or Jengkol	Phithecolobium lobatum Benth	(pod tree)
Kacang belimbing	Psophocarpus tetragonolobus DDC	(pod tree)
Turi	Sesbania grandiflora Pers	(flower)
Kacang panjang	Vigna sinensis Savi	(pod herb)
Kacang babi	Vicia faba	(pod herb)
Kacang kapri	Pisum arvense, P. sativum	(pod)
Kara wedus	Dolichos lablab	(pod climber)

Liliaceae

Bawang merah	Allium ascalonicum L	(root bulb)
Bawang bakung	A. fistulosum L	(leaf stalk)
Kucai	A. odorum L	(leaf stalk)
Bawang putih	A. satium L	(root bulb)

Moraceae

Sukun	Artocarpus communis G. Forst	(fruit tree)
Nangka	A. integra Merr	(fruit tree)
Cempedak	A. Champeden Spreng	(fruit tree)

Moringaceae

Kelor	Moringa cleifere Lam	(fruit & leaf tree)

Musaceae

Pisang	Musa paradisiaca L	(fruit)

Palmae		
Kelapa,	Cocos nucifera L	(coconut)
Salak,	Salacca edulis Reinw	(fruit shrub)
Passifloraceae		
Markisa,	Passiflora quadrangularis L	(fruit climber)
Buah negeri,	P. edulis Sims	(fruit climber)
Portulaceae		
Gelang,	Portulaca cleracea L	(leaf herb)
Solanaceae		
Lombok,	Causium annum L	(chillies or hot pepper)
Gengek bodas,	C. frutescens L	(small hot pepper)
Tomat,	Lycopersicon esculentum L	(tomato)
Terong,	Solanum melongera L	(eggplant)
Ranti,	Solanum nigrum L	(herb)
Kentang,	Solanum tuberosum	(potato)
Zinziberaceae		
Lengkuas	Alpinia galauca Sw	(root sprouts)
Kunyit	Qurcuma longa L	(herb)
Umbelliferae		
Ketumbar or koriander,	Coriandrum sativum L	(herb)
Seledri	Apium graveolens L	(herb)
Wortel	Daucus carota L	(carrot)
Bromeliaceae		
Nenas,	Ananas comosus Mer	(pineapple)

Annonaceae		
Sirsak,	Annona muricata L	(fruit tree)
Buah nona,	A. reticulata L	(fruit tree)
Srikaya,	A. squamosa L	(fruit tree)
Lauraceae		
Adpokat,	Persea americana Mill	(Avocado tree)
Meliaceae		
Duku,	Lansium domesticum Lorr	(fruit tree)
Myrtaceae		
Jambu air,	Eugenia aquaea Burm F	(fruit tree)
Jambu Semarang	E. javanica Lam	(fruit tree)
Jambu bol,	E. malacoensis L	(fruit tree)
Gowok,	E polycephala Mig	(fruit tree)
Juwet,	E. cumini (L) Merr	(fruit tree)
Jambu biji,	Psidium guajava Burm F.	(guava)
Oxalidaceae		
Blimbing manis,	Averrhoa carambola L	(fruit tree)
Blimbing wuluh,	A. belimbi L	(fruit tree)
Punicaceae		
Delima,	Punica granatum L	(Pomegranate)
Rutaceae (Citrus)		
Jeruk siem/ jeruk keprok,	Citrus reticulata Blanca	(Mandarin)
Jeruk manis,	C. sinensis Osbeck	(Sweet orange)
Jeruk nipis,	C. aurantifolia Swingle	(Lime)
Jeruk Bali/Besar,	C. grandis Osbeck	(Pomelo)

Sapindaceae		
Rambutan,	*Nephelium lappaceum* L	(fruit tree)
Kapulasan,	*N. mutabile* Bl.	(fruit tree)
Klengkong or Lengkeng,	*N. longan* L	(Chinese lychee tree)
Sapotoceae		
Sawo,	*Achras sapota* L	(Sapota tree)

APPENDIX NO. VII

FINAL REPORT

RECOMMENDED PLANT SPECIES UPLAND WATERSHEDS

Recommended Plant Species Upland Watersheds

Hedge Species:

Some of the better hedge species to be planted on the edge of terraces and gullies.

> Leucaena glauca (Lantoro). A legume, wood is used for fuel and for charcoal.
>
> Sesbania grandiflora (turi). Good browsing legume, wood for fuel, bark for medicine.a good erosion plant.
>
> Acacia vilosa. A legume with a wide range of adaptability on soils of all altitudes. Good for green manure. Wood used for fuel and charcoal. Acacia decurrens and A.elata used for shade in Java.

above are popular trees used widely on sloping lands in upper watersheds and will grow from sea level to 1500 m.

> Leguminous creepers. Centrosema pubescens, cajanus cajan, tephrosis, calopogonium mucunoides, Desmodium ovalifolium, Cilitoria Ternatea, Pueraria phaseoloides.

A number of suitable trees are available for improving land stability and fertility, for the eradication of alang-alang (Imperata cylindrica) and to provide forest and other products. The following tree species are only some that should be suitable for planting in the Pilot area.

> Acacia auricauliformis. A legume, very rapid growth on poor soils, wood is good for fuel and charcoal.

Acacia decurrens. A legume, best at higher elevations, very rapid growth on poor soils, used for fuel and top quality charcoal. At 5 years of age may attain a height of 20 m and a diameter of 30 cm. good producer of nitrogen. High in tannin.

Acacia vilosa. A shrub used for green manure. A legume and good producer of nitrogen. 3-4 m in height is planted on contours between main crops. Can be inocculated with Laccifer Lacea to produce shellac. Can be propagated by seeds.

Albizzia Chinensis. A legume best grown 200-900 m elevation. Height 35 m and a diameter of 150 cm. Leaves may fall during dry season. Wood is used for packing boxes, matches and for filler in paper.

Albizzia falcata. Is a tall ever green shade tree. Legume, on good sites will attain a height of 3 m and a diameter of 53 cm in ten years. Easy to plant and a good soil builder. Grown from seed. Leaves used for feed, wood used lumber, packing and matches. Tree susceptable to wood borer at 7 to 9 years. It has rapid growth but rather short lived.

Anacardium Occidentale. Cashew, Jambumete. Will grow on poor eroded soils, and does well on drier sites. Wood has no value. Bark used for medicine, the stem contains gum used for high quality glue. The fruit is edible and is used in some medicines, the nuts are edible and contain oil (acajou) used for cooking. Tree comes into production in 3-4 years. cashew nut shell liquid (CNSL) can be recovered as by-product from cracking nut.

Artocarpus integra. Jack tree, nangka. Produces an edible fruit in about 10 years. Wood used for lumber, leaves for cattle feed.

Carica Papaya. Papaw, begins to bear fruit at 6 to 8 months. edible leaves used for salads and medicine and tenderising meat, seeds are used also for medicine.

Durio zibethinus. Grows from sea level to 1000 m elevation, wood used for cheap lumber, fruit has strong odour but is sweet, well liked, sold in markets. Seeds can be cooked or fried.

Eugenia aromatica. Clove, cengkeh. Grows best on fertile soil and short dry season. Needs wide spacing, may reach 20 meters in height and 40 cm in diameter. Flowers used for spice, medicine, and flavouring cigarettes. Leaves steam distilled for oil, about 1 percent aetheric. Also used for vanilline. Clove contains about 18 percent oleum caryophyilli.

Leucaena glauca. Wild tamarind, pete selong. Legume, shrub or tree 2 to 10 meters high grows well in upper watersheds. Is interplanted in new plantations. Used as green manure, leaves and twigs used as cattle and chicken feed. Peas and young pods are edible. Wood is hard and used for fuel, good erosion plant with a strong dense root system.

Magnifera indica. Mango, mangga. Well adapted up to 1000 m elevation. Wood is very durable, grown for fruit, best trees are grafted. Bark is used for dyeing fabrics and drugs.

Manilkara kauki. Sawo, used mostly in gardens. Fruit edible. Wood is very durable, strong, good for carving and timbers and tools.

Melacuca leucadendra. Kayu putih. Wood very hard and heavy, and durable in sea water. Used for houses and posts. Easy to split and is used for fuel. Leaves are steam distilled for oil (cineol) which contain about 60%.

Scleichera oleosa. Grows mostly below 600 m. Height 15-40 m and 60 to 175 cm. Some times interplanted with teak. Wood is hard and heavy used for fuel and charcoal, bearings for use under water. Young leaves edible. Bark contains tannin 11 to 14%. Seeds contains oil used for soap and medicine. Trees are inocculated with Laccifer laces for the production of shellac.

Sesbania grandiflora. Turi, legume, light crown, sometimes planted in rice fields. Leaves may be fed to chicken, wood for fuel, bark for medicine and flowers are edible. Produces about 35 tons per hectare of leaves.

Tamarindus indica. Tamarind tree. A legume, planted for shade, wood is durable and heavy, used for charcoal. The flesh of the fruit is very sour and is used for spice in food.

APPENDIX VIII

FINAL REPORT

GLOSSARY

GLOSSARY

Back Slope Terrace	- Is constructed with a very steep back slope, two to one or steeper, which is kept planted to grass. It can be used as a graded or level terrace. The earth to build the ridge may be taken from the lower side or from the lower and upper sides of the ridge. Taking earth from the lower side of the ridge will reduce the slope of the land between terraces. The backslope must be maintained in grass, trees, weeds, and burrowing animals must be controlled. The area in grass on the backslope will reduce the area of the field available for crop production.
Bench Terrace	- Is a steplike terrace on the contour with a wide level bench between steep risers (steep slope to next terrace platform). It is adapted to steeper slopes. The riser is kept planted to grass.
Broad Base Terrace (Mangum Terrace)	- Is constructed with a base 6 to 8 meters and a height of 30 to 38 centimeters. During construction one third of the soil is moved uphill and two thirds of the soil is moved downhill. It consists of a ridge with the ditch above it.

Buffer Strips	- Established strips of perennial grass or other erosion resisting vegetation, usually on the contour in cultivated fields, to reduce runoff and erosion.
Contour	- Is an imaginary line that passes through points of equal elevation on the ground surface. The difference between the contour lines is the contour interval. Contour lines are close together on steep slopes and farther apart on flat slopes. Contour lines point upstream in crossing a valley or stream. The steepest land slope is at right angles to a contour line. Uniform slopes have contour lines spaced uniformly. A closed contour line which has no other contours within, represents either a summit or a depression.
Contour Cropping	- Refers to any tillage practice of land, applied across the slope on the level (on contour). Contour cropping disregards straight lines and follows the curved contour lines whenever necessary to stay on the level. It is most effective in reducing erosion on deep permeable soils and on gentler slopes of 2 to 6% which are less than 90 meters long, where erosion losses may be reduced 50% by contour strip cropping,

while on slopes of 18 to 24% contour cropping without supplementary practices reduces erosion losses only about 10 percent.

Diversion Terrace or Ditch - Used to divert runoff at the head of a gully before other control measures are installed within the gully itself. The diversion ditch will divert runoff to some point for safe disposal.

Erodible (soil) - Soil susceptible to erosion.

Fine-Textured Soil - Roughly, clayey soil containing 35 percent or more of clay.

Graded Channel Terrace - Is designed to intercept and divert runoff at nonerosive velocities. It is constructed with the channel having a slight grade so that the runoff from the area above moves along the channel to an outlet. The primary function of the terrace is for erosion control.

Grass Waterways - Are natural or constructed outlets or waterways protected by grass cover. They serve as safe outlets for runoff water from contour rows, terraces, and diversions. Natural drainageways make the best locations for waterways.

Greening Program	- The forest extension service supplies seed, tree seedlings, fertilizers, and technical assistance to farmers who plant trees and a permanent grass or legume on their land.
Gully Erosion	- Concentrated water runoff from slopes that increase in volume and velocity to cut deep gullies in the land surface.
Integrated Forestry	- Growing a mixture of trees, grass, and animals.
Land Capability	- A grouping of kinds of soil into special units, subclasses, and classes according to their capability for intensive use and the treatments required for sustained use.
Land-use Planning	- The development of plans for the uses of land that will best serve the general welfare, together with formulation of ways and means for achieving such uses.
Level Terrace	- Is constructed with the channel level and ends of the terrace blocked to store runoff in the terrace until it infiltrates into the soil. If it used for erosion control and moisture conservation. Its use is limited to areas with moderate rainfall and permeable soil.

Mineral Soil	- A general term for a soil composed mostly of mineral matter, in contrast to an organic matter.
Narrow Base Terrace	- Sometimes known as a bund has a width of 1 to 2 meters and a height of 60 centimeters. These should be approximately on the contour with a slight grade of not more than 1%.
Plane Table	- A plane table consists of a board attached to a tripod so that it can be leveled and rotated on a vertical axis. It is used as a drafting table for plotting map details and contour lines in the field.
Plantation Forest	- Is a forest if indigenous or exotic trees which is planted and maintained for the production of forest crops.
Production Forest	- Is a forest which is managed and used for perpetual production of forest crops.
Protection Forest	- Is a forest that is maintained to protect the watershed, prevent erosion, and regulate water flow.
Rill Erosion	- Accelerated erosion by water which produces small but well-defined channels. The channels may be straight lined but frequently join in crisscross

patterns. This is incipient form of erosion which may lead to sheet and gully erosion.

Riser - Is the steep slope that separates the bench terraces. The riser is kept planted to grass.

Runoff - The surface flow of water from an area; or the total volume of surface flow during a specified time.

Slope - The incline of the surface of a soil. It is usually expressed in percentage of slope, which equals the number of feet of fall per 100 feet of horizontal distance (perpendicular as percentage of base, or the tangent of the angle of slope; a slope of 100 percent is one of 45 degrees).

Soil Texture - The relative proportions of the various size groups of individual soil grains in a mass of soil. Specifically, texture refers to the proportions of clay, silt, and sand.

Strip Cropping - Is the practice of alternating contour strips of sod and clean tilled crops. (Row crops). The sod strips help slow runoff and filter out eroded soil.

Strip widths should be governed by the percent slope and should vary from up to 30 meters on 2 to 6% slopes to 18 meters or less on 18% slopes and above.

Terrace - Is a broad surface channel or embankment constructed across the sloping lands, on contour lines at specific intervals. For the control of runoff or soil erosion, or both. The terrace intercepts surplus runoff to retard it for infiltration or to divert the flow to an outlet at nenerosive velocity. Most terraces are designed with gradual slopes to lead water off safely into grass waterways or other suitable outlets. The number and spacing of terraces depend on the soil type, slope, and cropping practices.

Tillage - The operation of implements (to include the cangkul) through the soil to prepare seedbeds and rootbeds.

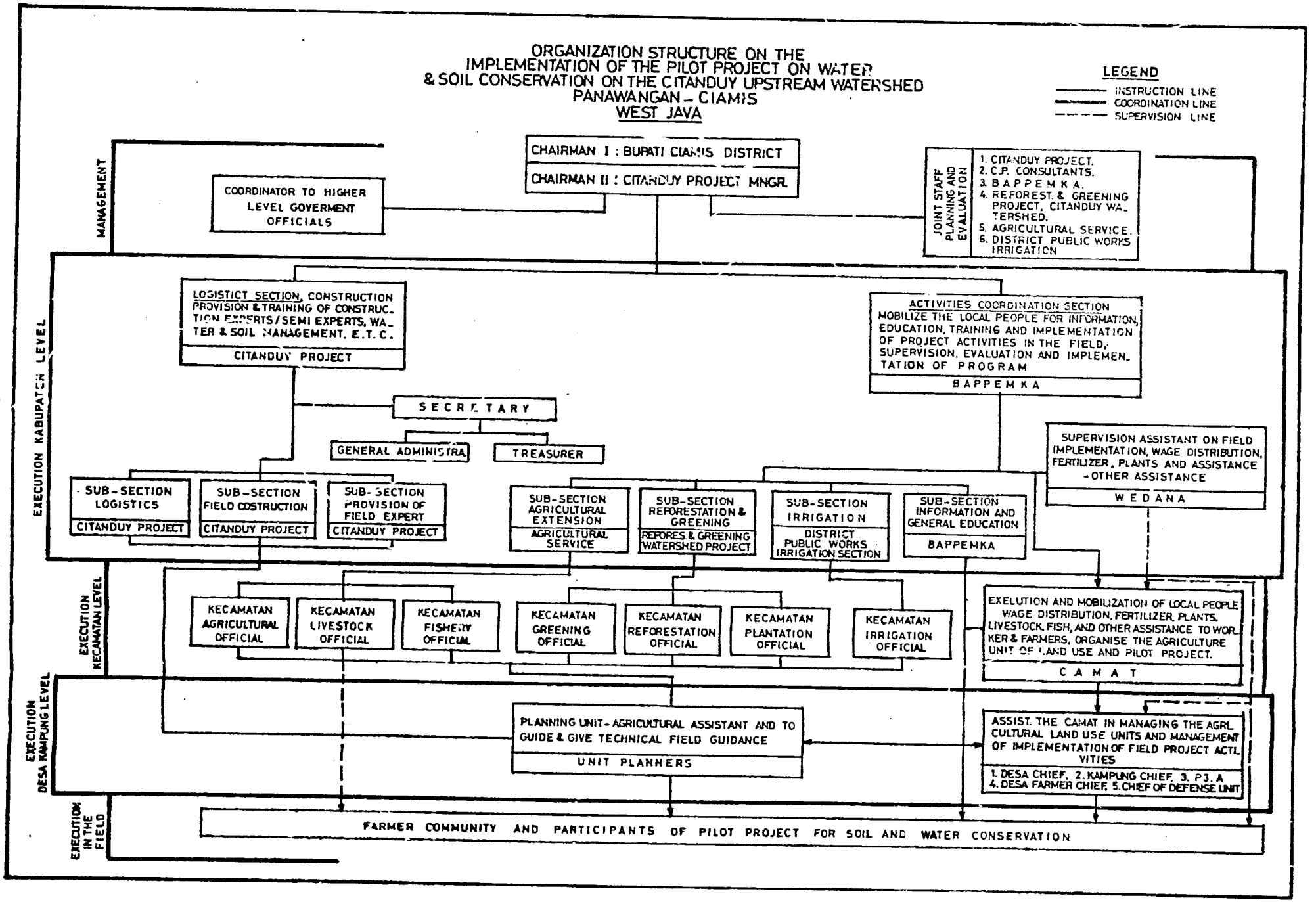
Topography - The shape of the ground surface, such as hills, mountains, or plains. Steep topography indicates steep slopes or hilly land; flat topography indicates flat land with minor undulations and gentle slopes.

Topographic Map	- Is a small scale representation of the topography of an area. It may show natural features such as trees and streams, and artificial features such as lakes, buildings, and roads.
Topsoil	- Is a general term applied to the surface portion of the soil, including the average plow depth (15 centimeters) or the A horizon, where this is deeper than the plow depth. It cannot be precisely defined as to depth or productivity except in reference to a particular soil type.
Upland Soils	- High ground; ground elevated above the lowlands along rivers or between hills.
Watershed	- The tern is used for the topographic boundary separating one drainage basin from another. In some countries, watershed refers to the total area above a given point on a stream that contributes water to the flow at that point. Synonyms are "drainage basin" or "catchment Basin."

APPENDIX IX

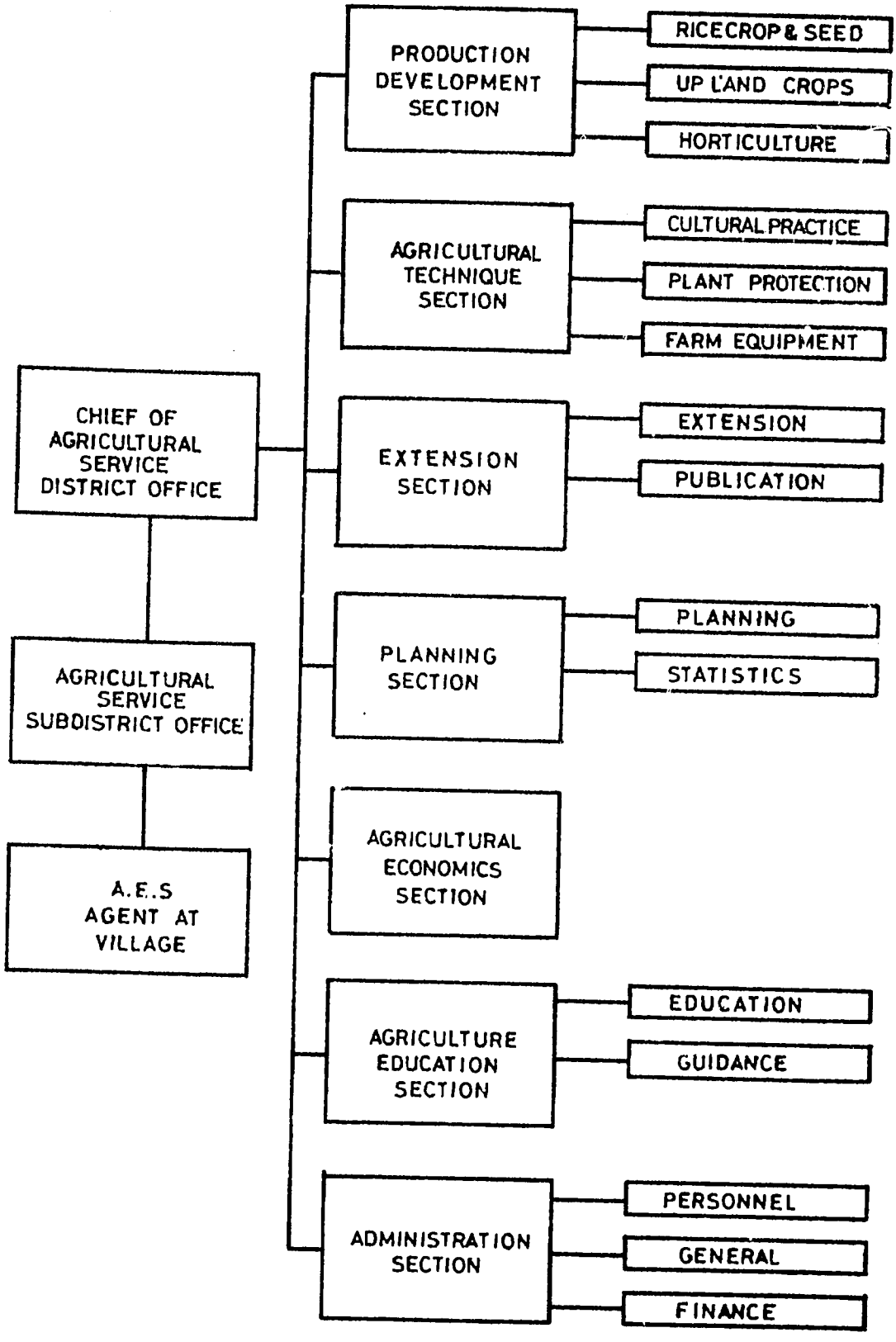
FINAL REPORT

ORGANIZATIONAL CHARTS


ORGANIZATION STRUCTURE ON THE IMPLEMENTATION OF THE PILOT PROJECT ON WATER & SOIL CONSERVATION ON THE CITANDUY UPSTREAM WATERSHED PANAWANGAN – CIAMIS WEST JAVA
LEGEND
INSTRUCTION LINE
COORDINATION LINE
SUPERVISION LINE
MANAGEMENT
CHAIRMAN I : BUPATI CIAMIS DISTRICT
CHAIRMAN II : CITANDUY PROJECT MNGR.
COORDINATOR TO HIGHER LEVEL GOVERMENT OFFICIALS
JOINT STAFF PLANNING AND EVALUATION
1. CITANDUY PROJECT.
2. C.P. CONSULTANTS.
3. B A P P E M K A.
4. REFOREST. & GREENING PROJECT, CITANDUY WATERSHED.
5. AGRICULTURAL SERVICE.
6. DISTRICT PUBLIC WORKS IRRIGATION
EXECUTION KABUPATEN LEVEL
LOGISTICT SECTION, CONSTRUCTION PROVISION & TRAINING OF CONSTRUCTION EXPERTS/SEMI EXPERTS, WATER & SOIL MANAGEMENT. E.T.C.
CITANDUY PROJECT
ACTIVITIES COORDINATION SECTION
MOBILIZE THE LOCAL PEOPLE FOR INFORMATION, EDUCATION, TRAINING AND IMPLEMENTATION OF PROJECT ACTIVITIES IN THE FIELD, SUPERVISION, EVALUATION AND IMPLEMENTATION OF PROGRAM
BAPPEMKA
SECRETARY
GENERAL ADMINISTRA
TREASURER
SUPERVISION ASSISTANT ON FIELD IMPLEMENTATION, WAGE DISTRIBUTION, FERTILIZER, PLANTS AND ASSISTANCE – OTHER ASSISTANCE
W E D A N A
SUB-SECTION LOGISTICS
CITANDUY PROJECT
SUB-SECTION FIELD COSTRUCTION
CITANDUY PROJECT
SUB-SECTION PROVISION OF FIELD EXPERT
CITANDUY PROJECT
SUB-SECTION AGRICULTURAL EXTENSION
AGRICULTURAL SERVICE
SUB-SECTION REFORESTATION & GREENING
REFORES. & GREENING WATERSHED PROJECT
SUB-SECTION IRRIGATION
DISTRICT PUBLIC WORKS IRRIGATION SECTION
SUB-SECTION INFORMATION AND GENERAL EDUCATION
BAPPEMKA
EXECUTION KECAMATAN LEVEL
KECAMATAN AGRICULTURAL OFFICIAL
KECAMATAN LIVESTOCK OFFICIAL
KECAMATAN FISHERY OFFICIAL
KECAMATAN GREENING OFFICIAL
KECAMATAN REFORESTATION OFFICIAL
KECAMATAN PLANTATION OFFICIAL
KECAMATAN IRRIGATION OFFICIAL
EXELUTION AND MOBILIZATION OF LOCAL PEOPLE WAGE DISTRIBUTION, FERTILIZER, PLANTS, LIVESTOCK, FISH, AND OTHER ASSISTANCE TO WORKER & FARMERS, ORGANISE THE AGRICULTURE UNIT OF LAND USE AND PILOT PROJECT.
C A M A T
EXECUTION DESA KAMPUNG LEVEL
PLANNING UNIT – AGRICULTURAL ASSISTANT AND TO GUIDE & GIVE TECHNICAL FIELD GUIDANCE
UNIT PLANNERS
ASSIST. THE CAMAT IN MANAGING THE AGRICULTURAL LAND USE UNITS AND MANAGEMENT OF IMPLEMENTATION OF FIELD PROJECT ACTIVITIES
1. DESA CHIEF, 2. KAMPUNG CHIEF, 3. P3. A
4. DESA FARMER CHIEF, 5. CHIEF OF DEFENSE UNIT
EXECUTION IN THE FIELD
FARMER COMMUNITY AND PARTICIPANTS OF PILOT PROJECT FOR SOIL AND WATER CONSERVATION

-LTF-

AGRICULTURAL SERVICE ORGANIZATION
CIAMIS DISTRICT



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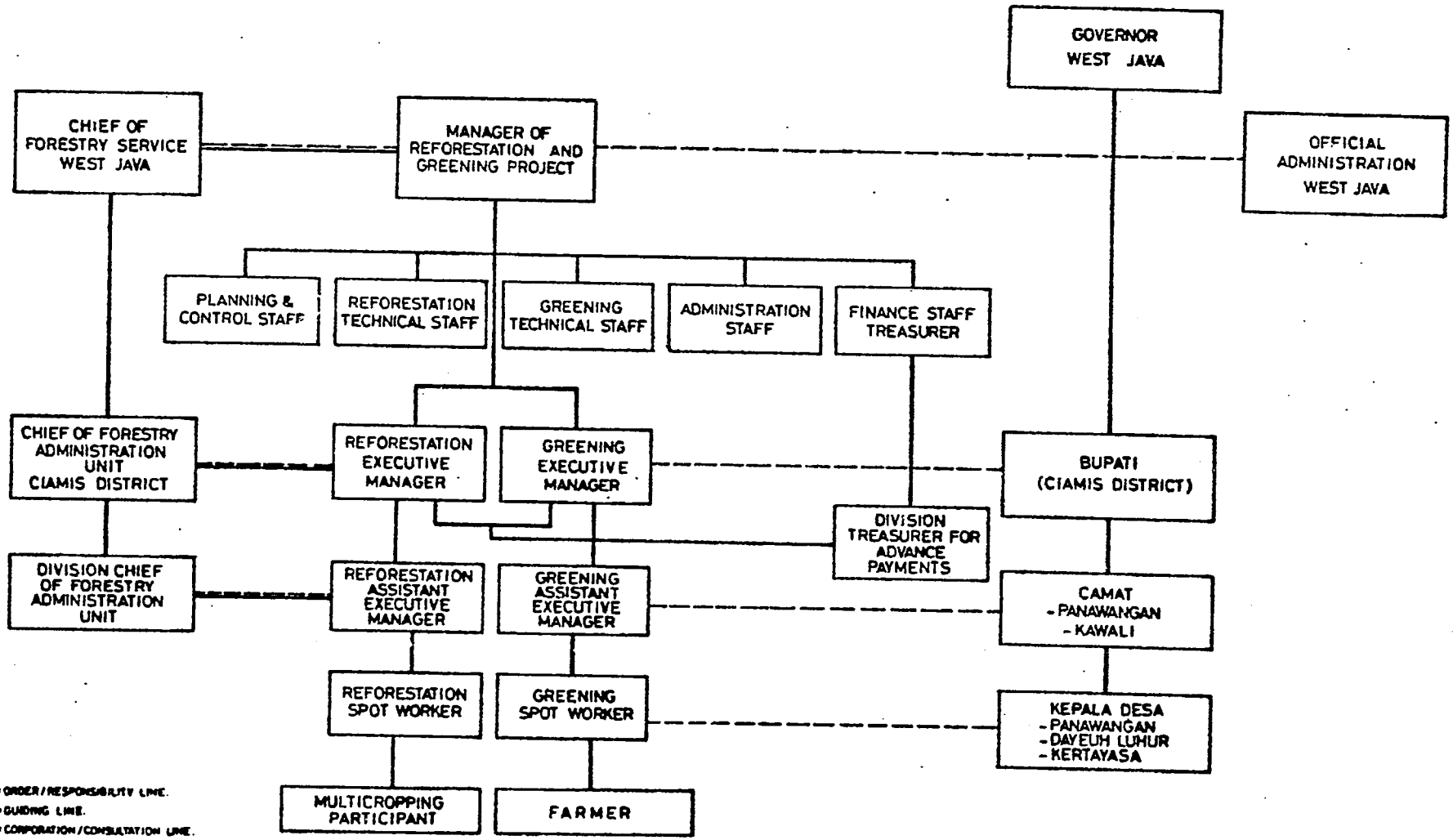
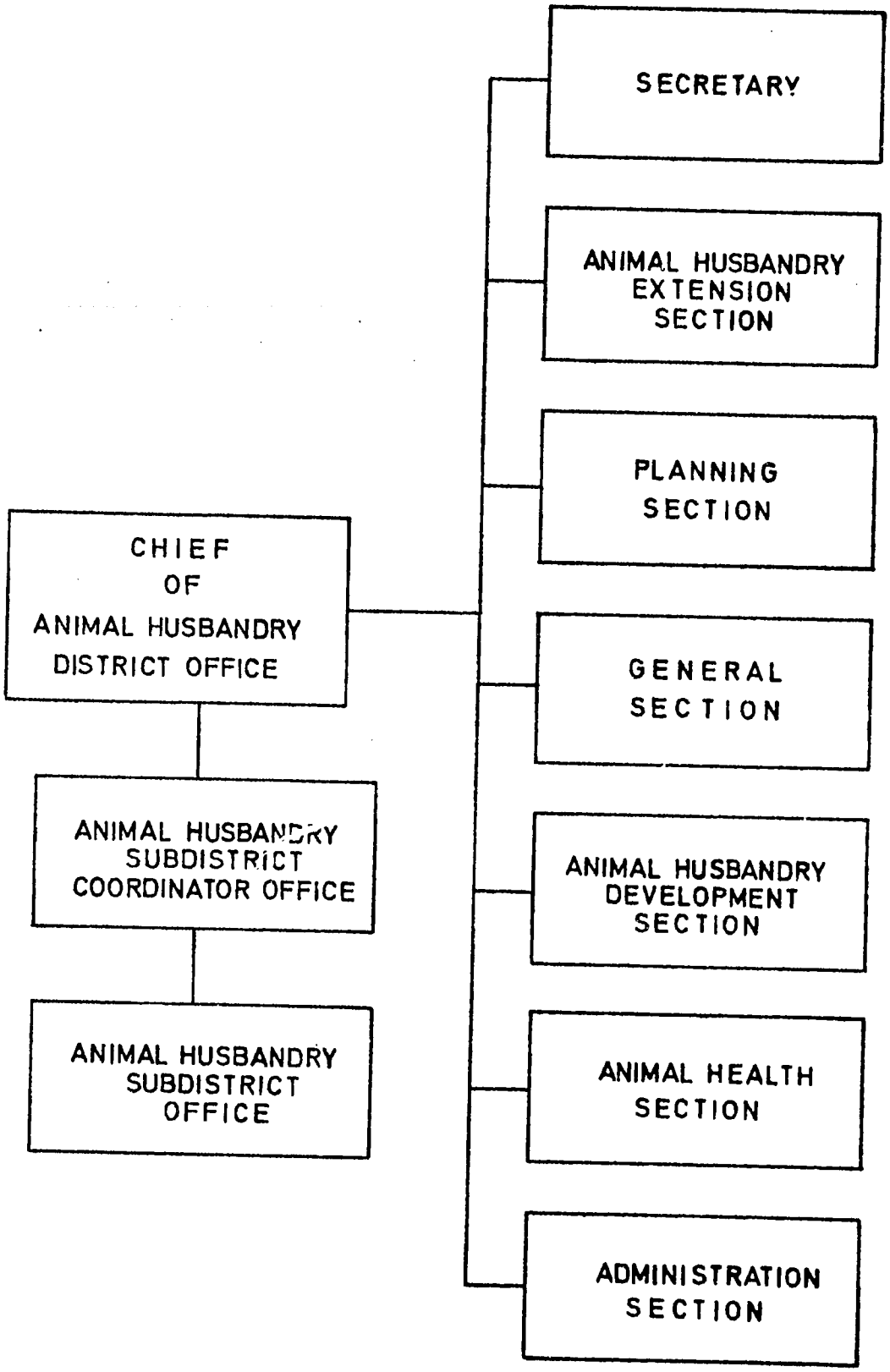
ORGANIZATION CHART OF REFORESTATION & GREENING PROJECT CITANDUY WATERSHED



ANIMAL HUSBANDRY SERVICE ORGANIZATION
CIAMIS DISTRICT



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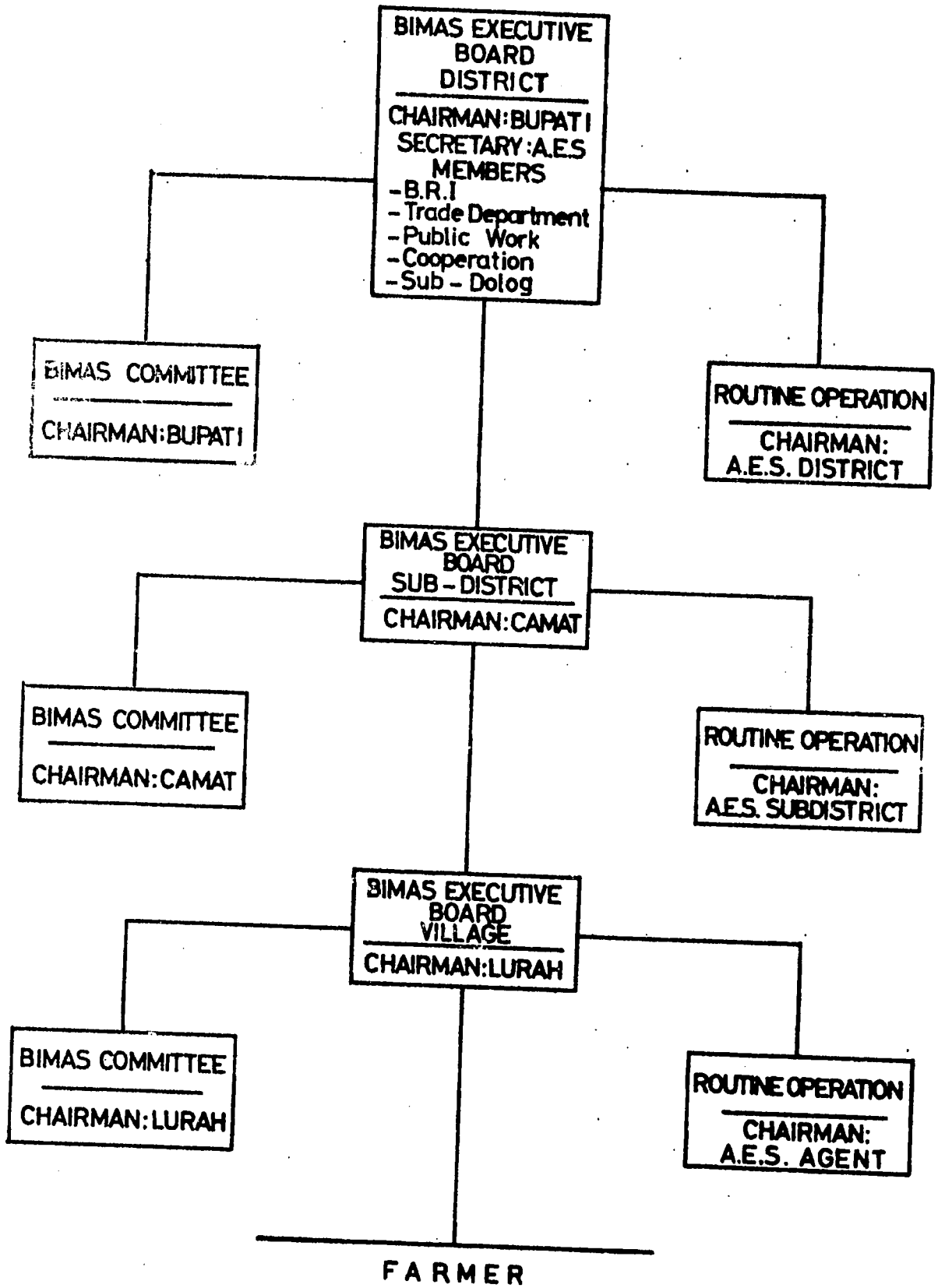
ORGANIZATION CHART
BIMAS-INMAS



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