No. 2

THE REPUBLIC OF COLOMBIA

THE FEASIBILITY STUDY ON THE ARIARI RIVER BASIN INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT

ANNEX (Ⅱ)

ANNEX I : IRRIGATION AND DRAINAGE
ANNEX J : LAND CONSERVATION AND DISASTER PREVENTION
ANNEX K : RURAL INFRASTRUCTURE
ANNEX L : PROJECT COST ESTIMATION
ANNEX M : PROJECT IMPLEMENTATION (INCLUDE ORGANIZATION)
ANNEX N : PROJECT EVALUATION
ANNEX O : OTHERS

NOVEMBER 1989

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

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ANNEX I : IRRIGATION AND DRAINAGE

I.1 INTRODUCTION

I.1.1 General

Irrigation and drainage is one of the significant elements for the agricultural development and an adequate irrigation and drainage system is necessary for the purpose of increasing the agricultural productivity. When an irrigation and drainage system is planned, the most effective system must be considered. Especially, in the area where a lot of effective rainfall can be expected, the consideration of comparison between with system and without system is required.

In the project area of the Ariari River Basin Integrated Agricultural Development Project (here in after "the Project"), an annual rainfall of 2,500 mm to 3,500 mm can be expected and it is difficult to make an optimum irrigation and drainage system considering the cost and benefit. Of course depending on the cropping pattern and agricultural management plan, the irrigation method should be changed. Therefore, the flexibility of the system must be considered in accordance with the agricultural development strategy in the project area. In this study, at first the necessity of the system will be considered, and then the optimum system will be planned and finally the optimum facilities will be designed for the Project.

I.1.2 Objective of The Study

The objective of the study is to understand the existing conditions of irrigation and drainage and to find out an optimum irrigation and drainage system for the project area.

Considering the effective rainfall in the project area, the necessity of an irrigation system is not so high. However, it would be necessary to provide an irrigation system not only for the expansion of paddy rice production but also for the developed agriculture, and the installation of an irrigation system will have one of the large impacts on the development of the project area.

On the other hand, a field drainage system would be necessary for rising the agricultural production and considering the existing conditions, the establishment of field drainage system may be one of the big subjects in the project area.

I.1.3 Summary of The Study

(1) Irrigation

1) Existing Condition

Mainly paddy field of approximately 1,400 ha area have been irrigated and a few of the upland crops are also irrigated in the dry season (1,900 ha of paddy rice has been irrigated in the rainy season). The gravity system is applied and water is drawn from small streams (caños) using small diversion works. The water shortage in the dry season is one of the big restrictions for the expansion of irrigation.

2) Irrigation Plan

Crop water requirement was estimated by the Penman Method and effective rainfall was considered for irrigation water requirement.

Feasibility of the terminal pumping irrigation system for tree crop in the upper zone was studied and it was found out that the terminal pumping system is not feasible considering the facilities cost for this system.

Feasibility study of the irrigation system for pasture was carried out and was found that it is infeasible to irrigate to pasture.

Alternative study on water use plan was carried out with the consideration of land use plan, proposed cropping pattern, effective use of water resources and marketing etc. and approximately 23,815 ha of irrigation area was determined as shown below.

Double Cropping of Paddy	15,070 ha
Double Cropping of Paddy and Others	4,815 ha
Perennial Crops	3,930 ha

Considering the project benefit and cost for 2,5,10 year return period, the optimum design year was studied and 5 year return period was selected as the design year and the scale of facilities for the project were designed considering this 5 year return period. The maximum system capacity for the 5 year return period is 36.725 ㎥/s.

3) Facility Plan

Based on the irrigation plan, required facilities were found out and preliminary design was carried out.

The alternative study on the sight and type of diversion works was carried out and the lowest sight and head works of floating type were selected.

The alternative study on the route of irrigation system was carried out and the dimensions of the facilities were determined as shown below:

Canal		
Main Canal	Design Discharge	Length
Concrete Lining Canal	5.0 - 36.8 ㎥/s	65 km
Unlined Canal	0.0 - 5.0 ㎥/s	40 km
Secondary Canal		
Unlined Canal	0.0 - 5.0 ㎥/s	103 km
Diversion works		
Diversion Weir	Height 3.0 m Length 210 m	
	Concrete Floating Type	
Intake Works	5.0x2.6 m 5 unit	
Settling Basin	45x50x3 m	
Related Structures		
Drop works	356 unit	
Siphon	161 unit	
Waste Way	64 unit	
Division Works	222 unit	
Bridge	138 unit	

Terminal field irrigation facilities was studied and the facilities are summarized below:

Tertiary Canal	1,000m/200ha
Stop Log	16 unit/200ha
Division Box	2 unit/200ha
Culvert	6 unit/200ha
On-farm Road	3,000m/200ha
Inlet	1 unit/200ha

4) Consideration of Other Water Source

Dam construction of Upper part in the Guape River and installation of pumping system to supplement for irrigation water in the dry season were considered. From the rough cost estimation, dam or pumping system to supplement for irrigation water is not feasible in the existing condition comparing with the expansion of irrigation area.

(2) Drainage

1) Existing Condition

The poor drainage area caused by soil texture can be observed in the project area. However, considering the land use (paddy or pasture), this poor drainage is not a serious problem for the agricultural development.

Existing drainage system in the study area is established naturally using small stream (caño) by gravity and small ditches are used in a few fields. Inundation occurs one or two times in every year but most of the water flow out to caño within 24 hours except at the middle part of caño Venado and low land of Puerto Avichure.

2) Drainage System Plan

In principle, the existing caños will be used as the main drainage canal, so that the prevailing drainage system will not be changed except for some parts of the lower place which have poor drainage condition.

In this study, the allowable inundation period of field is 24 hours for paddy field and 4 hours for upland and the drainage improvement plan was formulated and the design size of the facil-

ities were determinated using the peak flood discharge of 4 or 5 year return period which is the criteria normally used in Colombia.

From the result of the study, it is confirmed that 5 km of improvement of caño section is required at Puerto Avichure and improvement of the flowing capacity of culvert at cano Venado is required.

(3) Recommendation

Considering the implementation of The Project and rising the development level in the project area, the following subjects will be recommended.

- Hydraulic Model Test of Diversion Works
- Establishment of Organization of Water Use
- Establishment of Deliberate Agricultural Management
- Drainage Improvement of Poor Drainage Land

I.2 IRRIGATION

I.2.1 Existing Condition

(1) Existing Method

Since an annual rainfall of 2,500 - 3,500 mm can be expected in the study area, the irrigation is not always necessary for crop cultivation except for paddy rice. However, in the dry season (especially January and February), 20 days of continuous drought days can also be expected, and it is one of the big restrictions for the agricultural management in the study area. In the existing condition, the seeds are sown after first rainfall for first semester except in the field which has irrigation system. A few small scale irrigation system can be found out in the study area but most of the farmers manage the crop cultivation without irrigation.

Approximately 2,000 ha of farm land, which belongs to about 40 farmers, have been irrigated with small scale irrigation system in the study area, and most of them are paddy field with the cultivation history of average 5 or 6 years, the oldest one was cultivated for about 15 years. Mainly ponding irrigation has been used and furrow irrigation is used in a few areas for upland crops.

Irrigation water is introduced from small streams (caños) with diversion works and temporary ridge is constructed at the paddy field every semester for ponding irrigation. The depth of ponding irrigation is about 10 - 20 cm and flowing irrigation is used for paddy fields through all the seasons. On the other hand, furrow irrigation is used for the upland crops in dry season but the irrigation area is very little and was just started a few years ago.

About 10 - 150 ha (mostly 20 - 40 ha) of irrigation area is estimated for each diversion works and operation and maintenance is carried out individually. In the drought year, the problem of water shortage will be expected and it is necessary to establish an organization of water use system.

(2) Existing Facilities

About 20 diversion works were constructed in the study area and most of them are made of log or gravel and some of them are made of concrete. All of them have been made in these 15 years and some of them made of log and gravel are constructed every year.

Each one has a 50 - 200 m of head race and introduce water to field. Most of these head races are consisted of earth canal and a few of them are made by concrete. These canal are not operated by gate system but stop log.

Location and dimensions are summarized in Fig. I-2-1.

(3) Existing Problems

Existing problems of irrigation agriculture are summarized below:

a) Water shortage in the dry season

Irrigation area, crops and cultivation plan are restricted by water shortage in the dry season and it is necessary to use other water source for the expansion of irrigation agriculture.

b) Lack of organization of water use

There is no organization of water use in the project area and it is difficult to take enough water to field at the lower side in dry season, when there is other water user at the upper side of the same caño. Therefore, it is necessary to establish an organization of water use for rural effective water use.

c) Shortage of available funds

From the result of field investigation it was understand that most of the farmers are planning for an irrigation system for their farm land and change the crops and agricultural management. However, in the existing condition, it is difficult to implement these plan because of shortage of available funds.

I.2.2 Irrigation Plan

(1) Basic Concept

Considering the history of irrigation agriculture in the project area, it may be difficult to improve the irrigation system to full development level in one time. Constructing a dam at the upper part of the Guape River and installation of pumping system in the project area can be considered for irrigating the whole farm land of the project area. However, time is necessary for the step by step development of the country, and considering the development level for the first step, gravitational irrigation system using diversion works on the Guape River is recognized as the most adequate system.

Based on this concept mentioned above, the irrigation plan was studied by applying the gravitational system. It is determined that the irrigation water will be introduced from diversion works at the Guape River to the project area but considerations on the dam and pumping station is described considering next step of development in the future. Therefore, irrigation system was studied with restriction by water discharge volume of the Guape River in this step.

Considering the annual rainfall of 2,500 mm , gravitational irrigation system is used till the terminal point of the water course and pumping system is not used for field irrigation. Concerning this subject, comparison between with and without terminal pumping irrigation system is studied in this section.

(2) Crop Water Requirement

1) General

Water requirement was calculated in the following manner;

- Calculation of Potential Evapotranspiration
- Calculation of Crop Water Requirement
- Calculation of Irrigation Water Requirement

From the monthly calculation, the sufficient effective rainfall

can be expected in the study area and irrigation will be required only in December and January except for paddy rice. However, about 20 days of continuous drought days can also be expected every year, and irrigation system will be necessary for rising the crop quality and for intensive agriculture. Furthermore, it is important to make an optimum economic system plan and irrigation water requirement will be calculated in consideration of the monthly effective rainfall.

2) Potential Evapotranspiration

Potential evapotranspiration was calculated by the Penman Method, which is recommended by HIMAT, in accordance with "Guidelines for Predicting Crop Water Requirements (FAO,1977)". Considering the meteorological and topographic conditions, the calculation was executed for the lower, middle and upper zones based on meteorological data of the Puerto Limon (255 m.a.s.l.), La Holanda (360 m.a.s.l.) and Mesetas (620 m.a.s.l.) stations. The result is shown in Table I-2-1 and Fig.I-2-2. The annual potential evapotranspiration for lower, middle and upper zones were estimated as 1,234 mm, 1,166 mm and 1,110 mm respectively.

3) Crop Water Requirements

Crop water requirement was estimated in accordance with the guideline of FAO and the field investigation. Based on the cropping pattern described in ANNEX F, the crop coefficient of development stage for each crop had been estimated and monthly crop water requirement was calculated.

$$ETC=Kc*ETP$$

where ETC : Crop Water Requirement (mm/month)
Kc : Crop Coefficient
ETP : Evapotranspiration (mm/month)

The results of calculation for the proposed crops for each zone are shown in Table I-2-4.

When the effective rainfall is considered, crop water requirements can be reduced. The crop water requirements with consideration of

the effective rainfall for 2,5,10 and 20 year return period are shown in Table I-2-5.

4) Irrigation Efficiency

The irrigation efficiency was obtained as shown below, which was calculated on the basis of FAO' guideline, and taking into account of physical conditions of the study area and previous records.

For paddy field : 42 % (distribution efficiency : 70 %
Field application efficiency : 60 %)

For fields other than paddy :
35 % (distribution efficiency : 70 %
Field application efficiency : 50 %)

Intake rate was tested at 12 points in this study (the locations of test point are shown in Fig. I-2-1) and the result is shown in Table I-2-6, I-2-7 and Fig. I-2-3.

5) Irrigation Water Requirement

Considering the cropping pattern and irrigation area, irrigation water requirement will be calculated. Irrigation area will be determined after the alternative study of irrigation plan. Therefore, irrigation water requirements will be discussed in section (5) of this chapter.

(3) Comparison between With and Without Pumping System for Field Irrigation System of Tree Crop in The Upper Zone

1) General

In the upper zone, there is an area of 430 ha which requires pumping system for field irrigation because of soil and topographic conditions. Land slope of this area is steep and tree crops are grown as the main crop. Further more, an annual rainfall of 3,500 mm can be expected in the upper zone and irrigation is not always necessary in this area. Therefore, the consideration of feasibility of pumping system will be necessary for introducing the field irrigation system.

The comparison will be carried out in the following manner.

- Estimation of benefit of with irrigation system
- Estimation of cost of terminal pumping irrigation system

In this study, these items were analyzed for Papaya which is one of the main crops in upper zone.

2) Estimation of Benefit of With Irrigation System

From the result of field survey, 20 ton/ha of yield of Papaya is estimated in the existing condition. On the other hand, with irrigation system, a proposed yield of 22 ton/ha can be expected. The net return in both the cases can be expected as follows;

	Without Irrigation	With Irrigation
Unit Yield (ton/ha)	20.0	22.0
Farm-gate Price (Col$/ton)	40,000	40,000
Gross Return (Col$/ha)	800,000	880,000
Production Cost (Col$/ha)	220,070	220,070
Net Return (Col$/ha)	579,930	659,930

Therefore a net return of Col$ 80,000/ha of difference can be expected.

3) Estimation of Cost of Terminal Pumping Irrigation System

a) Facilities Cost

Considering the soil and topographic conditions, it is proposed that one unit of the field irrigation system is composed of a portable pump, pipes and sprinklers. Approximately two (2) ha of irrigation area is covered by this unit in one time of three or four hours of operation with 10 to 12 mm/hour of irrigation density. About one week of irrigation interval may be applied, and therefore, 30 to 40 ha of irrigation area can be covered by this unit. This units of the field irrigation system are summarized below:

Portable Pump : Discharge 1,200 l/min Diameter 125 mm Head 30 m
Pipe : Diameter 100 mm (2000 pieces/10m)
Spray Gun : 4 unit
Sprinkler : 60 set

The cost of this unit was estimated as approximately Col$ 20 million and, considering 15 years of durable years, about Col$ 45,000/ha/year of facilities cost was estimated.

b) Operation and Maintenance Cost

This operation is required only for dry season (about 100 days from December to March) and four or five laborers will be necessary for each unit if moving time is considered as considered as one hour. And also an average of 0.3 liter/sec/ha of irrigation water is required for these four months. Maintenance cost can be estimated as 5% of the facility cost. Operation and maintenance cost was estimated as shown below:

Labor Cost	(Col$/ha)	27,000
Energy Cost	(Col$/ha)	34,000
Maintenance Cost	(Col$/ha)	3,000
Sub-Total	(Col$/ha)	64,000

c) Total Cost

Total cost was estimated as Col$ 109,000 /ha and the construction cost of the main facilities is excluded in this estimation.

4) Feasibility of Field Pumping Irrigation System

From the result of calculation, the benefit cost ratio(B/C) was estimated as 0.73. Therefore, it is infeasible to introduce the field pumping irrigation system to tree crop in upper zone.

(4) Comparison between With and Without Irrigation System for Pasture

1) General

The development strategy for livestock in this project is to re-

duce the area of pasture and to maintain the present production by the improvement of grass cultivation. Considering the irrigation plan, as 2,500mm - 3,500mm of rainfall is observed in Ariari basin, it is difficult to expect a high increase of pasture yield by introducing the irrigation system. Therefore, it is necessary to make a feasibility study on the introducing of irrigation system for pasture.

This study will be carried out as following manner.

- Estimation of difference of production between with and without irrigation.
- Estimation of irrigation cost.
- Comparison of cost and benefit.

2) Estimation of Difference of Production between With and Without Irrigation

According to information from ICA ("EVALUACION DE PASTOS PARA SUELOS TROPICALES ACIDOS BAJO PASTOREO"), following data was obtained about the live weight gain of the livestock.

Case	Dry season (110 days)	Rainy season (255 days)
2 head/ha	503 g/day/head	548 g/day/head
3 head/ha	362 g/day/head	506 g/day/head
(mean 2.5)	(433 g/day/head)	(527g/day/head)

This data is obtained from the result of investigation in the experimental farm and this can not be adjusted directly to actual farm. Therefore, the weight gain rate of this data is used for the estimation.

In the case of with irrigation, all seasons can be assumed as rainy season since water is readily available for the crop. Therefore, about 5% of increase of weight gain is expected with irrigation. As 260 kg/ha/year is proposed in this project, approximately 13 kg/ha/year of increase of weight gain (it means approximately an increase of Col$ 3,000 /ha/year of gross return) is expected by introducing irrigation.

3) Estimation of Irrigation Cost

Depending on the type of irrigation system , the irrigation cost will vary. And in the case of pumping system, Col$ 106,000/ha /year of irrigation cost is expected. Otherwise, if gravitational irrigation system is applied in stead of pumping system, almost same labor cost as the pumping system will be required. It means that at least about Col$ 24,000 /ha/year will be necessary to operate the irrigation system.

4) Comparison between Cost and Benefit

Comparing the benefit of irrigation with irrigation cost for pasture, the cost will be more than ten times of the benefit. Therefore, it can be said that the irrigation for pasture in this project is infeasible.

(5) Alternative Study of Irrigation Plan

1) General

Depending on the irrigation plan, the value of peak water requirement varies and it is necessary to adjust the dimensions of irrigation facilities with the consideration of peak water requirement. Therefore, depending on the irrigation plan, the cost and benefit of the irrigation will vary.

According to the land use plans described in ANNEX E, the costs and benefits were estimated approximately for each land use plan. And, Alternative study was carried out in the following manner.

- Estimation of production benefit for each land use plan
- Estimation of system cost for each land use plan
- Comparison of cost and benefit ratio between each land use plan

Estimation of production benefits and comparison between each plan is studied in ANNEX 0 and facilities cost of the systems are estimated in this section.

2) Estimation of System Costs for each Land Use Plan

System costs are estimated by the following manner:

- Estimation of irrigation water requirement for each plan
- Planning of preliminary layout of irrigation canal route
- Estimation of system costs for each land use plan

The Irrigation area of each land use plan is shown in Table I-2-8 and I-2-9. Based on these land use plan, the water requirement for each land use plan was calculated as shown in Table I-2-10 and I-2-11 and the peak water requirements are summarized below:

Peak Water Requirements (m³/s)

Return Period	Plan I-1	Plan I-2	Plan II-1	Plan II-2
1/2	42.084	35.583	35.739	27.040
1/5	43.180	36.725	36.896	28.224
1/10	43.723	37.293	37.467	28.813
1/20	44.115	37.705	37.885	29.252

These difference of the water requirements is caused by the change in cropping pattern and the irrigation area for each semester is not changed. Therefore, the irrigation system including facilities does not vary depending on the these land use plan but the capacities must be different. In this study, the peak water requirements for the 5 year return period will be used. Proposed irrigation system for the alternative study is shown in Fig.I-2-4.

Based on the design discharge, the cost of irrigation system was estimated roughly. The estimation is summarized below:

The Cost of Irrigation System (million Col$)

	Plan I-1	Plan I-2	Plan II-1	Plan II-2
Diversion Works	1,543	1,377	1,377	1,162
Canal System	11,450	10,588	10,588	9,145
Total	12,993	11,965	11,965	10,307

3) Comparison between Each Land Use Plan

From the result of the economic analysis on these plan in ANNEX N, following internal rate of return was obtained and it can be said the Plan I-2 is most optimum in these plans.

Financial Internal Rate of Return (%)

Plan I-1	Plan I-2	Plan II-1	Plan II-2
24.5	25.8	23.7	23.1

(6) Determination of Design Year

1) General

The design discharge is determined by considering the cost and benefit of the system for each return period. The difference of the discharges are not so high but the most economic system must be studied, because these construction cost will be paid by the farmers. The 2,5 and 10 year return period was considered for design year in the study and the analysis was carried out in the following manner.

- Estimation of benefit with system for each return period
- Estimation of total cost of system for each return period
- Comparison between systems with each return period

2) Estimation of Production Value with System for Each Return Period

The benefit with system for each return period was estimated as follows:

- Calculation of total expectation of water insufficiency with system for each return period and each proposed crop

- Estimation of the difference of total production value between the systems for each return period

a) Calculation of Total Expectation of Water Insufficiency with System for Each Return Period and Each Proposed Crop

Considering effective rainfall, the water insufficiency rate was calculated using the following formula.

$$Wi=Ti/Tw*100$$

where Wi : the water insufficiency rate (%)
Ti : total water insufficiency with consideration of effective rainfall (mm/year)
Tw : total water requirement without consideration of effective rainfall (mm/year)

This value was calculated for 2,5,10 and 20 year return periods using the data from Table I-2-5.

The probability(Pn) of which water insufficiency rate(Wi) for an n year return period, can be calculated as Pn=1/N and the expectation of water insufficiency rate can be calculated as follows;

$$Er=Wi*Pn$$

where Er : expectation of water insufficiency rate

The total expectations of water insufficiency rate for each proposed crops of each zone are shown in Table I-2-12.

b) Estimation of The Difference of Total Production Value between the Systems for Each Return Period

The production value with system for each return period were calculated using following formula:

$$Bi=Bp*Ar*(1-Ter)+Be*Ar*Ter$$

where Bi : Production Value of each Crop with system (Col$/year)
Bp : Proposed production value of crop with system (Col$/year)
Be : Existing production value of crop without system (Col$/year)

Ar : Proposed cultivated area (ha)
Ter : Total expectation of water insufficiency with system

The result of calculation is shown in Table I-2-13 and I-2-14, and the total production value for each case is summarized below:

Total Benefit with System for
Different Return Periods (million Col$)

2 year	5 year	10 year
19,223	19,245	19,250

3) Estimation of Total Cost With System for Each Return Period

The irrigation systems were designed preliminarily and the construction costs were estimated for the peak discharge of 2,5 and 10 year return periods. Irrigation area and canal length are independent from return period; A few dimensions are influenced by the difference of design discharge. The dimensions of the main structure and construction costs are summarized below:

Total Constrction Costs of Irrigation System (Col$)

	for 1/2	for 1/5	for 1/10
Diversion Works	1,348	1,377	1,391
Canal System	10,436	10,588	10,637
Total	11,784	11,965	12,028

Operation and maintenance costs does not vary with system for each return period. Therefore, these elements are not considered in this study.

4) Comparison between the Systems for Each Return Period

The internal rate of return for each return period is analyzed in ANNEX N and the following result was obtained. The result shows that the design discharge of 5 year return period should be the most effective.

Internal Rate of Return for Each Return Period (%)

System for 1/2	System for 1/5	System for 1/10
25.7	25.8	25.7

I.2.3 Facility Plan

(1) Alternative Study of Diversion Works

1) Site of Diversion works

Through the field study and discussion with Colombian personnel concerned, the following three sites have been proposed for comparison. These sites have been picked up mainly by considering the river and topographic conditions. (See Fig. I-2-4)

- Site A : right downstream from Angostura Bridge
- Site B : approximately 5.3 km upperstream from Lejanias
- Site C : approximately 4.6 km downstream from Lejanias

a) Topography and Geology

The features of these selected sites are summarized in Table I-2-15.

- Site A

Topography :

The valley of this site is of V-shaped and approximately 35 m in width in the river bed. Gradient of left bank is found so steep with a slope of 1:1. On the other hand, the right bank is found relatively gentle with 1:1.9 slope. There is a heavy river discharge through the narrow river bed.

Geology :

The site consists of metamorphic rocks basement, colluvial sediments and recent river sediments.

Metamorphic rocks are principally phyllite and partially green

and black schists. These rocks are hard with clear schistosity, gentle flooding, fracture and joints.

Colluvial sediments are found in both the banks. The left bank sediments are formed by fall of weathering zone of the metamorphic rocks depositing angular fragments. The right bank sediments are so heterogeneous consisting of boulders, sand, silt and clay. This sediment is formed by mud flow coming from branch and is found unstable.

Terraces and colluvial sediments have an extensive distribution along the right bank toward the downstream of this site.

Geological profile and boring logs of this site are shown in the Fig. I-2-6 respectively.

- Site B

Topography :

This site is located at the opening part of the gorge and has approximately 140 m width of river bed. The land slope is 1:14 in the left bank and 1:8.6 in the right bank. Fluvial terraces have an extensive distribution on both the banks with gentle inclination towards the river. Recent river bed is extensively distributed between the terraces of both banks. The principal river terrace is found in the left side and a secondary river course, coming from a tributary is found, in the right side.

The recent fluvial sediment hills show waved topography both the river courses.

Geology :

Recent river sediments are extensively distributed on the river bed consisting of large boulders (2 m of diameter at the maximum), gravel and sand. Ancient river sediments of some fine grain underlay the sediments mentioned above. Moreover, sedimentary rocks such as sandstone are interbedded with a thickness varying between 2.5 and 5 m. These sedimentary beds have no continuous distribution due to fluvial erosion caused by old river

courses.

Geological profile and boring logs of this site are shown in Fig. I-2-6 and, respectively.

- Site C

Topography :

This site corresponds to the part of the relatively narrow river course. The river width is approximately 245 m. Steep wall of branch mountain range is located at the left bank. Horizontal fluvial terraces are found at 4, 6 and 10 m from the actual river bottom. The river bed exhibits with irregular old river terrace.

Geology :

Recent river sediments are extensively distributed and fine ancient river sediments underlie the previous sediments. Sedimentary rocks show outcrops of wall at the left bank and foot of fluvial terraces located approximately 170 m upper stream from the site. These rocks are hard and massive, and show low permeability. Regarding to structural aspects, these sedimentary rocks show nearly horizontal bedding and little fracture.

Geological profile and boring logs of this site are shown in Fig. I-2-6 respectively.

b) Comparison of Diversion Site

Parameters to be employed in selecting the optimum site among the said three sites for the installation of diversion works are mentioned below:

1. Downstream sector from the site C where the lands will be irrigated by gravity shall be eliminated for the comparison study, because the costs and benefits to be estimated in this sector are equal.

2. Lands located at the upperstream side of the Site C will be

supplied with water by the pumping station. In accordance with Pre F/S, this area might be irrigated by pumping irrigation system, but this system is infeasible from the result of comparison study discussed in section I.2.2. However, it is better to consider the pumping station for making the same condition as the other sites and there is some possibility to introduce the pumping irrigation system depending on the change in the economical condition in the future.

3. The dimensions of structures such as water intake works, diversion works etc. shall be designed based on the condition that the maximum water intake volume is 36.7 m³/s as proposed in the irrigation plan. On the basis of these dimensions, the costs for each sub-structure shall be estimated.

4. The size of the pumps will be designed in accordance with the topographic condition and the operation and maintenance cost of these pumps is to be estimated subject to the Project life being 50 years.

Based on the conditions above mentioned, preliminary design of diversion facilities was considered and the dimensions of these facilities area shown in Table I-2-16.

The benefit of each case is exactly the same, and only the total yearly costs were considered. The cost estimation is shown in Table I-2-17 and the result is summarized below:

Comparison of Total Yearly Cost of Diversion Works (million Col$)

Site A	Site B	Site C
646	565	319

The total yearly cost of Site C is most economical and this cost includes the operation and maintenance cost of pumping station. Therefore, Site C must be selected for the site of diversion works.

2) Comparison of Diversion Structures

Following two diversion systems were proposed (See Fig.I-2-7):

Type A : Water is introduced with diversion weir

Type B : Water is introduced without diversion weir

The comparison of these two types of diversion system is shown in Table I-2-18. The type A is applied, considering the stability of water intake and maintenance cost of diversion system.

3) Preliminary Design of Diversion System

a) Design Conditions

Design conditions are summarized below:

Water Discharge : 36.725 m³/s
Flood Discharge (20 year return period) : 460 m³/s
Elevation of Top of Diversion Weir : 596.5 (m.a.s.l)
High Water Level : 597.7 (m.a.s.l)
Maximum Water Depth : 1.2 m

$$H=(Q/C\times B)^{2/3}=(460/1.70\times 210)^{2/3}=1.18 \fallingdotseq 1.2$$

where Q : Flood Discharge
C : Overflow Coefficient
B : Length of Weir 210 m

b) Length of fore Apron

The length of fore apron was calculated considering the conditions mentioned below:

- Required Length for The Protection from Erosion by Overflow Water

Fixed Weir Part : $L_1 = 0.6\times C\times\sqrt{(D)}$
Movable Weir Part : $L_2 = 0.9\times C\times\sqrt{(D)}$

where L_1 , L_2 : Required Length of Fore Apron (m)
C : Bligh's Coefficient (sand, Gravel : 9)
D : Difference of Elevation between Top of Weir and Lower End of Fore Apron (3.6m)

- Required Length for The Protection from Piping Caused by Water Head

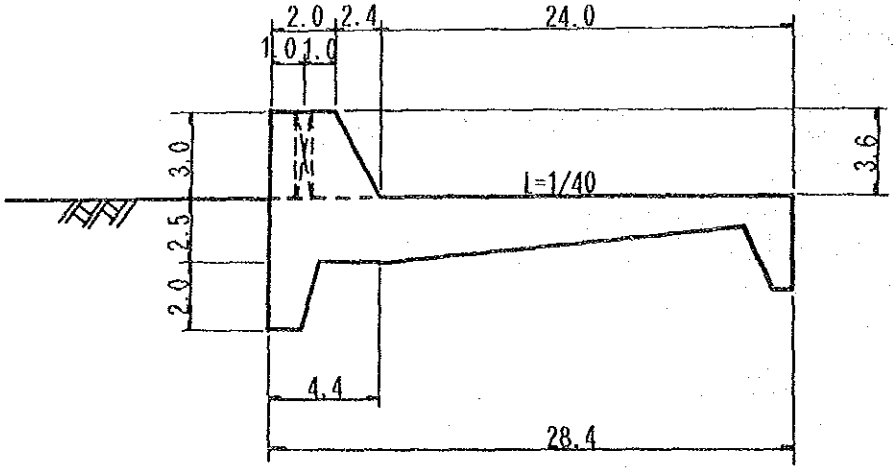
$$L_3 \geqq C \times \Delta H$$

where L_3 : Creep Length (m)
C : Bligh's Coefficient (sand, Gravel : 9)
ΔH : Maximum Water Head (3.6m)

Each length was calculated as shown below:

$$L_1 = 0.6 \times 9 \times \sqrt{(3.6)} = 10.25 \fallingdotseq 10.5 \text{ m}$$
$$L_2 = 0.9 \times 9 \times \sqrt{(3.6)} = 15.37 \fallingdotseq 15.5 \text{ m}$$
$$L_3 \geqq 9 \times 3.6 = 32.4 \text{ m}$$

The weir section was determined as shown below:



The creep length (L_0) of the section is calculated as shown below:

$$L_0 = 2.5 + 2.0 \times 2 + 28.4 = 34.9 \text{ m} > L_1 , L_2 , L_3$$

Therefore, the length of fore apron is determined as shown below:

Fixed Weir Part : 24.0 m
Movable Weir Part : 27.4 m

c) Dimensions of Facilities

The dimensions of diversion facilities are determined as shown below:

Length of Diversion Weir : 210.0 m
Fixed Weir
Type : Floating Type
Length : 187.0 m
Height : 3.0 m
Top Width : 2.0 m
Longitudinal Slope of The Lower Part : 1:0.8
Length of Fore Apron : 24.0 m
Thickness of Fore Apron : Max. 2.5 m , Min. 1.0 m
Length of Riprap : 15.0 m
Scouring Sluice
Number of Gates : 2
Width of Span and Height of Gate : 10m× 3.0m
Length of Rear Apron : 37.5 m
Length of Fore Apron : 27.4 m
Length of Riprap : 15.0 m
Height of Guide Wall : 1.0 m
Intake Works
Number of Gates : 5
Width of Gate : 5.0 m
Height of Gate : 2.6 m
Sand Settling Basin
Width of Basin : 2.6 m
Length of Basin : 45.0 m
Effective Water Depth : 3.0 m
Flow Velocity in The Basin : 0.3 m/s

(2) Alternative Study of Canal System

Although the basic concept of planning a canal system is to minimize the incidental structures such as siphon, bridge, drops, etc. as far as possible, it is estimated that a great number of large scale drop works are required for the project in view of the land slope which is as significant as more than 1%. Furthermore, because of many caños which run in parallel with each other

throughout the area, crossing structures are also required to distribute the irrigation water all over the area.

The following two alternatives were studied to delineate a proposed course for the main canal, bearing the afore-mentioned aspects in mind.

Plan I : Several main canals were designed in parallel with the caños so that the number of crossing points of secondary canals with caños may be minimized. In this case the main canal was designed longer, but the number of crossing points becomes fewer. There was no substantial change in the drainage system .(See Fig.I-2-8)

Plan II: The number of main canals was designed as few as possible, while more secondary canals were disposed along the contour line. The total length of main canal was less, but the number of secondary canals crossing with the caños is more. Improvement works of drainage in field are required.(See Fig.I-2-9)

For both the plans, there is no big differences for the lower part from the principal road and therefore, it is enough to compare only for the upper part in the study area.

The summary of comparison between both the plans is shown in Table I-2-19 and, considering the construction cost, the plan II was taken for this project.

(3) Irrigation Canal Facility Plan

1) Designed Discharge

The designed discharge is determined as shown in Fig.I-2-12 and Tables I-2-21, I-2-22, considering the topographic condition, allowable flow velocity and location of west way,

2) Irrigation Canal

a) Comparison of Energy Dissipation Method

Drop type and chute type of energy dissipation methods are proposed in the study area. Drop type is applied considering the reason mentioned below.

- Canal scale of chute type will be smaller than that of drop type, but water discharge (3～7 m/s) of chute is higher than that of drop type. Therefore, it is necessary to design the structure considering high water velocity in the case of chute type, and the system of drop type is more economicalthan that of chute.

- In the case of chute type, some of problems on the safety water management can be expected.

Construction costs of the systems of these types are shown in Table I-2-20.

b) lining

Concrete lining is designed as 10 cm considering the canal scale, efficiency of construction and maintenance. Under drain is also designed considering the up lift.

c) Canal Side Slope

Considering the soil condition and canal scale, canal side slope is determined as shown below.

Designed Discharge	≧ 1.0	㎥/s	1:1.5
Designed Discharge	< 1.0	㎥/s	1:1.0

3) Canal Section

Canal section is designed based on the most effective cross-section.

4) Hydraulic Design Condition

a) Flow Velocity

Flow velocity was calculated based on the Manning's Formula,

$$V = 1/n \times R^{2/3} \times I^{1/2}$$
$$Q = A \times V$$

where V : Flow Velocity (m/s)
n : Coefficient of Roughness
R : Hydraulic Mean Depth (m)
I : Logitudinal Slope
Q : Discharge (m^3/s)
A : Area of Flow Section (m^2)

b) Allowable Flow Velocity

Following allowable flow velocity is applied:

- Maximum Allowable Flow :	Concrete Lined Canal	Vmax=1.5 m/s
	Unlined Canal	Vmax=0.6 m/s
- Minimum Allowable Flow :		Vmin=0.4 m/s

c) Coefficient of roughness

Following coefficient of roughness is used:

Concrete Lined Canal	$n_1 = 0.015$
Unlined Canal	$n_2 = 0.025$

d) Freeboard

Freeboard is considered based on the following formula:

$$Fb = 0.05 \times h + V^2/2g + 0.1$$

where Fb : Freeboard (m)
h : Water Depth (m)
g : Gravitational Acceleration (m/s^2)

5) Standard Canal Section

Standard canal section was designed as shown in Fig.I-2-10 and I-2-11. The canal length is summarized below:

Canal Type	Canal Length (km)
C-a	40.5
C-b	5.7
C-c	18.7
Sub Total	64.9
So-a	63.9
So-b	79.2
Sub Total	143.1
Total	208.0

Dimensions of Main and Secondary canals are shown in Table I-2-21 and Table I-1-22.

(4) Related Structure

1) Drops

Drops were designed with water cushion considering number of designed discharge and effective energy dissipation. Preliminary design of drops and dimensions of structure are shown in Fig.I-2-14 and number of drops is summarized below:

Type 1	32 units	Type 2	65 units
Type 3	88 units	Type 4	21 units
Type 5	14 units	Type 6	17 units
Type 7	11 units	Type 8	17 units
Type 9	14 units	Type 10	1 unit
Type 11	21 units	Type 12	9 units
Type 13	19 units	Type 14	20 units
Type 15	1 unit	Type 16	5 units
Type 17	1 unit	Total	346 units

2) Siphon

Siphon is considered where the irrigation canal will be crossing with the caños. Following two types of siphon were designed depending on discharge volume.

- Box Culvert Type : Designed discharge over 2.5 ㎥/s, 50 units

- Pipe Culvert Type : Designed discharge under 2.5㎥/s, 111 units

Flow velocity of inside of the siphon was applied as over 1.5 times of that of open canal considering the prevention of sedimentation. Preliminary design of siphons are shown in Table I-2-14.

3) Waste Way

Waste way is planned at the changing point of canal section and where large siphon is expected, considering the safety and maintenance of irrigation canal. And the terminal waste way work is designed at the terminal point of secondary canal. Preliminary design of waste way works is shown in Fig.I-2-14 and the number of works is summarized below:

Type 1	8 units	Type 2	1 unit
Type 3	2 units	Type 4	3 units
Type 5	14 units	Type 6	7 units
Type 7	29 units	Total	64 units

4) Division Works

Following two types of division works are designed at diversion point.

- Longitudinal Separation Works : 6 units

  In case of distribution discharge is more than 1.0㎥/s

- Gate-controlled Division Works : 222 units

  In case of distribution discharge is less than 1.0㎥/s

Parshall flume, spillway and waste way are considered in Jet flow division works. Preliminary design of division works is shown in Fig I-2-14.

5) Bridge

Bridge is planned at the point where the irrigation canal is crossing with the existing road. The following width of bridges is applied depending on the road class.

- National Road : Width of Bridge 8.0 m, 3 units
- Departmental Road : Width of Bridge 6.0 m, 28 units
- Others : Width of Bridge 4.0 m, 107 units

Preliminary design of bridges is shown in Fig.I-2-14

(5) Field Irrigation Facility Plan

Ponding irrigation for paddy rice and furrow irrigation for the other crops are used for the field irrigation system. Considering the field terminal system, the standard lot was drawn as shown in Fig.I-2-15. The facilities of irrigation system in the standard lot are summarized below:

Tertiary Canal	1,000m/200ha
Branch Canal	5,000m/200ha
Stop Log	16 units/200ha
Division Box	2 units/200ha
Culvert	6 units/200ha
On-farm Road	3,000m/200ha
Inlet	1 unit/200ha (Including Secondary Canal)

I.2.4 Consideration of Other Water Source

(1) General

Considering the full-development stage in the future, it is necessary to develop the water resources for the expansion of irrigation agriculture. In the existing condition, the water discharge volume of the Guape River is not always sufficient when the whole project area is to be irrigated. Therefore, following possibilities is considered to develop the water resources.

- Construction of the dam at upper stream of the Guape River
- Construction of pumping station at Puerto Caldas

(2) Construction of Dam at The Upper Stream of the Guape River

1) Potentiality of Water Resources

An annual rainfall of 3,500 - 5,000 mm can be expected in the Guape River basin and approximately 70% of them flows down as surface water runoff. It means that approximately 3 million m³/km² (about 0.1 m³/s/km²) of annual runoff can be expected. 63% of annual runoff flows down in the rainy season and the remaining 37% in the dry season. Therefore, it is possible to store surplus runoff water in the rainy season to supplement for water supply in the dry season.

On the other hand, considering the topographic condition in the catchment area, there are a lot of V-shaped valleys and good dam sites can be found out at anywhere. The condition of forest is not so bad and there are a lot of uncivilized areas. Therefore, the potentiality of water resources is high and it is possible to supply enough water in the dry season with dam construction.

2) Estimation of Dam Construction Cost

Dam construction cost was estimated roughly based on the similar project in Colombia. The relationship between water storage volume and construction cost is shown in Fig.I-2-16.

3) Relationship between Water Storage Volume and Supplementary Water

From the view point of supplementary water supply, required water storage volume varies depending on the condition of water supply. However, depending on the condition of water demand, supplementary water can be changed with same water storage volume. For example, same water storage volume is required in the case of 2 ㎥/s of supplementary water for 5 days and in the case of 1 ㎥/s of supplementary water for 10 days. The relationship between water storage volume and supplementary water volume is shown in Fig.I-2-17.

4) Feasibility of Dam Construction

The water storage volume of dam will be determined from the considera tion of water supply plan. There is approximately 30,000 ha of farm land suitable for paddy rice in the project area and about 60㎥/s of water requirement is estimated in January when all of this area is irrigated. Considering the water discharge of the Guape River, about 4 ㎥/s of supplementary water will be required for a month and approximately 10 million ㎥ of required storage volume is estimated. In this case, the dam construction cost is estimated as Col$ 24 billion.

In the case of reducing the paddy cultivation area to 25,000 ha, the estimated water requirement will be about 50 ㎥/s and approximately 4 million ㎥ of storage volume will be required the and dam construction cost is estimated as Col$ 14 billion. In order to compare the project cost in the development plan the relationship between paddy field area and construction cost are summarized below:

Area of Paddy 1st	2nd	Water Requirement	Irrigation System Cost	Dam Construction	Total Cost
(ha)	(ha)	(m3/s)	(billion Col$)		
18,990	15,070	37	12	0	12
25,000	25,000	50	14	14	28
30,000	30,000	60	16	24	40

In the present condition, it can be said that the dam construction

for irrigation is not feasible comparing increase of irrigated area and system cost.

(3) Construction of Pump Station at Puerto Caldas

1) Potentiality of Water Resources

Puerto Caldas which is right down from the confluence of the Ariari River with the Guape River has approximately 3,000 km² of catchment area and about 90 m³/s of mean water discharge is expected in the dry season. Over 3,000 mm of annual rainfall is observed in the upper basin of the Ariari River, and therefore, it can be said that there is enough water to supplement for irrigation water requirement in the dry season.

However, the water route of the Ariari River is not stable and is always changing and bank erosion is one of the big problems on river side. Considering the river condition, it is difficult to construct the pump station around Puerto Caldas.

2) Preliminary Layout of Pumping System

The purpose of this pumping system is supplement water for irrigation in the dry season. This system consists of inlet, settling basin, pump station, discharge basin, head race and other related structure and facilities. The preliminary layout of pumping system is shown in Fig.I-2-18.

3) Cost Estimation of Pumping Station

Considering the supplementary water volume, the design discharge of pumping system will be 23 m³/s for 30,000 ha of paddy field and 13 m³/s for 25,000 ha. The dimensions of pumping facilities are summarized below:

Peak Discharge (m3/s)	23	13
Discharge Head (m)	15	15
Number of Pumps (unit)	5	5
Pump Diameter (mm)	1,500	1,200
Generating power (Ps/unit)	1,300	750

The related structures and facilities are designed roughly as shown in Fig.I-2-19 and these construction and facilities cost are estimated as shown below.

Cost of Pumping System (million Col$)

Peak Discharge	23 m3/s	13 m3/s
Pump station		
Equipment	5,500	3,800
Civil Works	500	500
Others	600	400
Sub-total	6,600	4,700
Head Race	2,000	1,500
Total	8,600	6,200

Considering 50 years of project life, operation and maintenance cost must be estimated. Replacement of equipment also must be calculated, considering the durable period as 20 years.

Total cost of Pumping System (million Col$)

Peak Discharge	23 m3/s	13 m3/s
System Cost	8,600	6,200
O/M Cost	4,400	2,400
Replacement Cost	11,000	7,400
Total Cost	24,000	16,000

The total cost of facilities concerned with irrigation is summarized below:

Area of Paddy 1st	Area of Paddy 2nd	Water Requirement	Irrigation System Cost	Pumping System Cost	Total Cost
(ha)	(ha)	(m3/s)	(billion Col$)		
18,990	15,070	37	12	0	12
25,000	25,000	50	12	16	28
30,000	30,000	60	12	24	36

4) Feasibility of Pumping System

Comparing the increase of irrigated area and system cost, the installation of pump station is infeasible for supplement of irrigation water.

(4) Another alternative of Pump Station

The maximum design discharge of irrigation system is 36.725 ㎥/s and irrigation facilities of the upper part of this system are designed using this discharge. It is possible to reduce the maximum design discharge with the combination of gravity system and pumping system at Puerto Caldas. For example, when the pumping system of 10 ㎥/s capacity is installed, the maximum design discharge becomes 26.725 ㎥/s and the dimensions of all the related structures of the upper part are reduced. The relationship between the costs of pumping system and irrigation system and the distribution of water volume must be studied this section.

The maximum water requirement is fixed as 36.725 ㎥/s and the maximum required capacity of pumping system is 23.600 ㎥/s, considering topographic condition and land use plan. The relationship between cost and water distribution is shown in Fig.I-2-20. This figure shows that the most optimum irrigation system is the system without pumping system.

I.3 DRAINAGE

I.3.1 Existing Condition

(1) Existing Drainage System

The existing drainage system in the study area consists of natural caños and drained water is discharged to caño by gravity. Small ditches can be observed in the fields and finally these ditches are connected to caños. There is no systematic or pumping drainage.

The caños flow down from the upper zone to the lower zone in parallel with the Guape and Ariari Rivers and finally connect to these rivers. The following caños mainly performs as the trunk drainage canal and the location of these caños are illustrated in Fig.I-3-1.

- Caño Urichare
- Caño Guanayas
- Caño Venado
- Caño Mucuya
- Caño Sardinata
- Caño Tapao
- Caño Upin

(2) Existing Problem

No serious problem of drainage is encountered in the upper zone of the study area, as lands have enough slope to drain the water. On the other hand, there are poor drainage areas in the middle and lower zones of the study area.

The situation of these areas is as follows:

- Lands located along caños where overflow occurs frequently due to their small section covered with weeds or bushes.

- Lands where the rain water is collected and remains in the lower area due to thin density of caños and waved ground surface.

These poor drainage lands are not used for crop production and livestock farming, but being left as natural forest, small ponds or swamps. The duration of flood in caños is usually from 1 to 2 days.

In the poor drainage lands, land use is restricted and it is necessary to improve drainage for the high intensive land use.

I.3.2 Drainage System Plan

(1) Principles

In the study area there are a lot of caños flowing down in parallel with the Guape and Ariari Rivers and these caños will be the main drainage canals in principle. Poor drainage areas in the study area can be classified in the following manner according to their features.

a) The inundated areas in flooding time caused by insufficient flow capacity of caños.

b) The inundated areas in depressed places caused by topographic undulation.

c) The areas with high groundwater level which influences the growth of crop.

The poor drainage in the inundated areas will be improved by rehabilitation works of caños and installation of new drainage canals. Rehabilitation works including underdrain will be required for the locations of high groundwater level.

The drainage plan for surface water is to be established in the first stage of this project. And, considering the condition of inundation in the study area, maximum 24 hours rainfall will be adjusted for the drainage plan.

The existing caños will be used as drainage canal of the project, so that the prevailing drainage system will not be changed expect for some parts of the lower zone which present poor drainage; new drainage canal will be considered for these parts. In relation to the Caño Urichare which has extensive catchment area outside the study area, new drainage system to connect the caño with the Guape River will be considered in and around Lejanias, if a great amount of rehabilitation works of the caño will be required within the

study area as a result of estimation on water discharge volume.

The following canos will be used as trunk drainage canals or the project.

- Caño Urichare
- Caño Guanayas
- Caño Venado
- Caño Mucuya
- Caño Sardinata
- Caño Tapao
- Caño Upin

The drainage system is illustrated in Fig.I-3-2.

In Colombia, the drainage system to be applied to farmland is designed with 4 to 5 year return period. In this project, the allowable inundation period of fields are 24 hours for paddy fields and 4 hours for upland field and the drainage improvement plan was formulated in the following manner.

- Calculation of inundation period at the check points for the flood of 2,5,10 and 20 year return period, the considering flow capacity.

- Check each inundation period with consideration of land use.

- Check the flow capacity of check points.

- Formulate the plan of drainage improvement if necessary.

(2) Calculation of The Inundation Period at The Check Points

The flood discharge is estimated by the Rational Method using the 24 hour rainfall. Depending on the catchment area, the duration of inundation varies. Based on the result of hydrologic study, the flood discharge of each check point was estimated and is summarized in Table I-3-1.

The inundation period at the check points were estimated considering the flood discharge and flow capacity of caños and the check points. The calculation was carried out using one minute of time step and the example of calculation is shown in Fig.I-3-3. These results are summarized in Table I-3-2.

(3) Check Each Inundation Period with Consideration of Land Use

Considering the land use, the inundation period at every point was checked. Table I-3-2 shows that the flow capacity of the existing drainage canal at Puert Abichule is not sufficient in accordance with the criteria, and it is necessary to improve the flow section of existing drainage canal.

And also these results show that every check point has a sufficient capacity except the culvert of Caño Venado.

(4) Formulation of the Plan of Drainage Improvement

From the result of checking the inundation period and flow capacity of check point, the following works of drainage improvement are required.

a) About 5 km of improvement works of existing drainage at Puert Abichule

In the existing condition, the flowing capacity of existing drainage canal is estimated as approximately 2.5 ㎥/s and 6 hours of inundation period can be expected (the flow capacity of Caño Chule is estimated as approximately 14 ㎥/s). Therefore, for the purpose of reducing the inundation period from 6 hours to within 4 hours, the existing drainage canal and the existing culvert at end of this canal must be improved. As designed discharge of 6 ㎥/s will be required.

b) Rehabilitation Works of Drainage Culvert at Cano Venado

There are three drainage culverts and the total existing flowing capacity of these drainage culverts is estimated as approximately 9 ㎥/s of and about 10.5 hours of inundation period is expected with this capacity. The rehabilitation works of these culverts must be required in order to reduce the inundation period. Approximately 32 m3/s of design discharge is expected.

The drainage plan is shown in Fig. I-3-4.

I.3.3 Drainage Facility Plan

(1) Rehabilitation Works of Existing Drainage Canal and Culvert at Puert Avichule

The design conditions are as follows:

Design Discharge	6.0 m3/s
Design Hydraulic Gradient	1/2000
Length	5 km
Design Load	1.0 ton/m2

Considering these conditions, the standard section and drainage culvert is designed preliminarily as shown in Fig.I-3-5 and Fig.I-3-6.

(2) Rehabilitation Works of Drainage Culvert at Cano Venado

The design conditions are as follow;

Design Discharge	10.5 m3/s
Design Hydraulic Gradient	1/1500
Design Load	1.0 ton/m2

These three drainage culvert was designed in same condition as Fig.I-3-6

I.4 RECOMMENDATION

Considering the implementation of project and rising the development level in the project area, the following subjects will be recommended.

- Hydraulic Model Test of Diversion Works

The water route is not stable in the existing site of diversion works and it is quite difficult to determine the dimensions of structures only from the result of hydraulic calculation. Therefore, it is necessary to make a hydraulic model test for the determination of dimensions for diversion works.

- Establishment of an Organization of Water Use

An organization of water use will be required for the effective water use. At the first time, it is expected that too much volume of water is taken out easily in the upper part and there is not enough water for the lower part in the canal. It is necessary to carry out the operation and maintenance of the irrigation system for the effective water distribution and, for this purpose, an organization of water use must be established.

- Establishment of Deliberate Agricultural Management

In the existing condition, seeds are sown only after the first rainfall in the dry season. After the construction of the project, it is possible to establish the deliberate agricultural management using the irrigation system. Therefore, the agricultural strategy with the consideration of irrigation system must be studied.

- Drainage Improvement of Poor Drainage Land

After the establishment of irrigation system, it is necessary to improve the drainage for increasing the agricultural productivity. If drainage capacity becomes too high, more irrigation water will be required. Therefore, it is necessary to make an adequate plan of drainage improvement.

TABLES

Table I-2-1 Evapotranspiration of The Ariari Project Area

(mm/month)

AREA	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
Lower Zone	132.3	118.0	111.8	91.7	92.0	79.0	85.6	91.3	100.3	105.8	106.7	119.3	1233.7
Middle Zone	110.8	103.6	107.6	98.1	88.5	78.0	82.7	92.4	97.0	102.3	100.7	104.6	1166.3
Upper Zone	108.9	97.7	105.4	87.0	83.9	74.5	82.6	88.7	90.0	92.0	87.3	111.4	1109.5

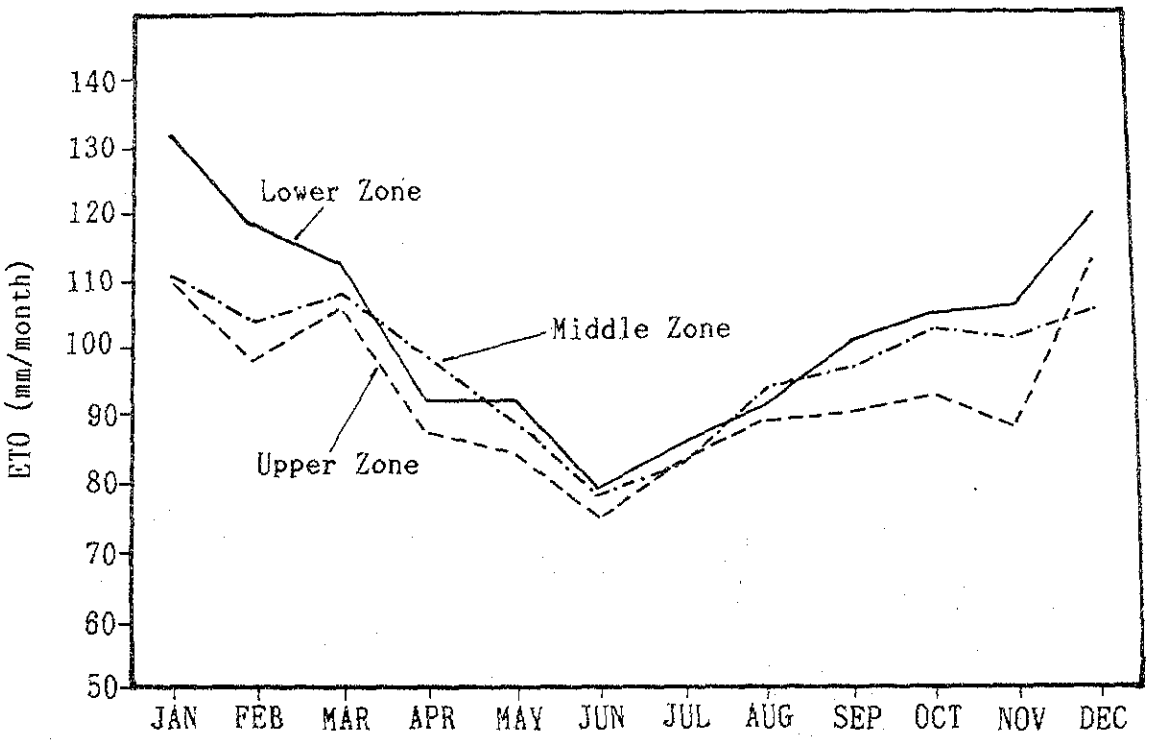


Table I-2-2 Kc Values for Proposed Crops

Annual Crop	Stage							
	Initial		Crop Development		Mid-Season		Late	
	days	kc	days	kc	days	kc	days	kc
Rice	30	1.10	30	1.05	60	1.05	30	0.95
Maize (1)	30	0.31	40	1.05	50	1.05	30	0.55
Maize (2)	30	0.40	40	1.05	50	1.05	30	0.55
Sorghun	20	0.35	30	1.00	40	1.00	30	0.55
Soy Beans (2)	20	0.40	30	1.00	60	1.00	25	0.45
Cassava	30	0.31	40	1.00	100	1.00	40	0.80
Sunflower	25	0.40	40	1.05	45	1.05	40	0.40
Sugarcane	60	0.50	60	1.05	280	1.05	30	0.60
Kidney Beans	15	0.40	25	1.05	50	1.05	20	0.30
Cotton	30	0.40	50	1.05	55	1.05	45	0.65

Purnnial Crop	Kc	Purnnial Crop	Kc	Purnnial Crop	Kc
Plantain	0.80~1.10	Tree Crop	0.90	Cacao	0.85
Papaya	1.00	Oil Parm	0.85		

Table I-2-3 Total Kc Values of Proposed Crops for Each Month

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rice (1)	-	0.54	1.08	1.06	1.05	1.02	0.50	-	-	-	-	-
Rice (2)	0.50	-	-	-	-	-	-	0.54	1.08	1.06	1.05	1.02
Maize (1)	-	0.16	0.45	0.80	1.04	0.93	0.4	-	-	-	-	-
Maize (2)	0.40	-	-	-	-	-	-	0.20	0.52	0.83	1.04	0.93
Sorghum	0.39	-	-	-	-	-	-	-	0.19	0.62	0.93	0.89
Soy Beans (2)	0.64	0.15	-	-	-	-	-	-	0.22	0.65	0.93	0.98
Cassava	0.88	0.84	0.41	0.16	0.44	0.77	0.99	1.00	1.00	0.98	0.95	0.91
Sunflower	0.56	0.09	-	-	-	-	-	-	0.20	0.59	0.91	1.00
Sugarcane	1.05	1.05	1.05	1.05	1.05	1.05	0.93	0.70	0.55	0.68	0.86	0.99
Kidney Beans	0.23	-	-	-	-	-	-	-	0.25	0.75	1.03	0.75
Cotton	0.90	0.39	-	-	-	-	-	0.20	0.50	0.78	1.01	1.03

Table I-2-4 Summary of Water Requirement

(mm/month)

Zone	Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
UPPER	Paddy Rice (1)	-	221.1	299.3	271.9	274.1	256.4	227.3	-	-	-	-	-
	Paddy Rice (2)	240.4	-	-	-	-	-	-	234.2	276.7	283.2	271.7	300.2
	Maize (1)	-	15.1	47.3	69.9	86.8	68.9	33.0	-	-	-	-	-
	Maize (2)	43.6	-	-	-	-	-	-	17.7	47.0	76.7	90.5	103.0
	Sorghum	42.2	-	-	-	-	-	-	-	17.3	57.0	80.9	98.9
	Beans (2)	24.6	-	-	-	-	-	-	-	22.4	69.2	89.8	83.7
	Soy beans (2)	69.2	15.0	-	-	-	-	-	-	19.5	59.7	81.4	109.4
	Cassava	95.3	81.8	43.1	13.5	36.9	57.4	81.4	88.7	89.9	90.5	82.9	101.7
	Sunflower	61.4	8.5	-	-	-	-	-	-	18.4	54.3	79.5	111.5
	Papaya	108.9	97.7	105.4	87.0	83.9	74.5	82.6	88.7	90.0	92.0	87.3	111.4
	Tree Crop	98.0	87.9	94.9	78.3	75.5	67.0	74.3	79.8	81.0	82.8	78.5	100.3
	Plantain	95.3	100.1	115.9	89.2	73.4	59.6	72.3	90.9	99.0	94.3	76.4	89.1
	Cacao	92.6	83.0	89.6	74.0	71.3	63.3	70.0	75.4	76.5	78.2	74.2	94.7
MIDDLE	Paddy Rice (1)	-	224.3	301.7	283.6	278.9	260.0	227.3	-	-	-	-	-
	Paddy Rice (2)	241.4	-	-	-	-	-	-	236.2	284.3	294.1	285.7	293.2
	Up Land Rice	-	56.3	115.7	103.6	92.9	79.9	41.4	-	-	-	-	-
	Up Land Rice	55.4	-	-	-	-	-	-	50.2	104.3	108.1	105.7	107.2
	Soy beans (2)	70.5	15.9	-	-	-	-	-	-	21.0	66.4	93.9	102.7
	Sugarcane	116.3	108.8	113.0	103.0	92.9	81.9	76.5	64.7	53.3	69.1	86.9	103.3
	Cotton	99.7	40.6	-	-	-	-	-	18.5	48.2	79.7	101.3	108.1
	Sunflower	62.4	9.0	-	-	-	-	-	-	19.8	60.4	91.7	104.7
	Maize (1)	-	16.1	48.3	78.9	91.6	72.2	33.1	-	-	-	-	-
	Maize (2)	44.3	-	-	-	-	-	-	18.5	50.7	85.3	104.4	96.8
	Tree Crop	99.7	93.2	96.8	88.3	79.7	70.2	74.4	83.2	87.3	92.1	90.6	94.1
	Plantain	121.9	106.2	94.2	78.5	77.4	80.0	91.0	94.7	84.9	81.8	88.1	107.2
	Cacao	94.2	88.1	91.5	83.4	75.2	66.3	70.3	78.5	82.5	87.0	85.6	88.9
	Oil Parm	94.2	88.1	91.5	83.4	75.2	66.3	70.3	78.5	82.5	87.0	85.6	88.9
LOWER	Paddy Rice (1)	-	232.2	306.2	276.9	282.6	261.0	228.8	-	-	-	-	-
	Paddy Rice (2)	252.1	-	-	-	-	-	-	235.6	287.8	297.8	292.0	308.3
	Up Land Rice	-	64.2	120.2	96.9	96.6	81.0	42.8	-	-	-	-	-
	Up Land Rice	66.2	-	-	-	-	-	-	49.6	107.8	111.8	112.0	122.3
	Soy beans (2)	84.1	18.2	-	-	-	-	-	-	21.7	68.7	99.5	117.1
	Sorghum	51.3	-	-	-	-	-	-	-	19.3	65.6	98.9	105.9
	Sunflower	74.5	10.3	-	-	-	-	-	-	20.5	62.4	97.2	119.4
	Sugarcane	72.8	79.7	96.4	90.6	96.6	83.0	89.9	95.9	105.3	111.1	98.7	83.5
	Maize (1)	-	18.3	50.2	73.7	95.2	73.1	24.2	-	-	-	-	-
	Maize (2)	122.4	47.2	-	-	-	-	-	-	20.1	55.2	89.0	123.7
	Plantain	145.5	121.0	97.8	73.4	30.5	81.0	94.2	93.6	87.8	84.6	93.4	122.8
	Cacao	112.5	100.3	95.0	77.9	78.2	67.2	72.8	77.6	85.3	89.9	90.7	101.4

Table I-2-5 (1) Crop Water Requirement of UPPER ZONE (mm/month) PAGE=1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Effective Rainfall												
Return Period 1/2	58.0	93.0	104.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	106.0	91.0
Return Period 1/5	48.0	84.0	101.0	108.0	108.0	108.0	106.0	106.0	105.0	108.0	103.0	81.0
Return Period 1/10	44.0	78.0	96.0	105.0	108.0	108.0	106.0	106.0	105.0	108.0	103.0	75.0
Return Period 1/20	40.0	72.0	92.0	106.0	106.0	106.0	106.0	105.0	105.0	106.0	100.0	70.0
Maize (1)	--	15.1	47.3	68.9	86.8	68.9	33.0	--	--	--	--	--
Return Period 1/2	--	--	--	--	--	--	--	--	--	--	--	--
Return Period 1/5	--	--	--	--	--	--	--	--	--	--	--	--
Return Period 1/10	--	--	--	--	--	--	--	--	--	--	--	--
Return Period 1/20	--	--	--	--	--	--	--	--	--	--	--	--
Maize (2)	43.6	--	--	--	--	--	--	17.7	47.0	76.7	90.5	103.0
Return Period 1/2	--	--	--	--	--	--	--	--	--	--	--	12.0
Return Period 1/5	--	--	--	--	--	--	--	--	--	--	--	22.0
Return Period 1/10	--	--	--	--	--	--	--	--	--	--	--	28.0
Return Period 1/20	3.6	--	--	--	--	--	--	--	--	--	--	33.0
Sorghum	42.2	--	--	--	--	--	--	--	17.3	57.0	80.9	98.9
Return Period 1/2	--	--	--	--	--	--	--	--	--	--	--	7.9
Return Period 1/5	--	--	--	--	--	--	--	--	--	--	--	17.9
Return Period 1/10	--	--	--	--	--	--	--	--	--	--	--	23.9
Return Period 1/20	2.2	--	--	--	--	--	--	--	--	--	--	28.9
Beans (2)	24.6	--	--	--	--	--	--	--	22.4	63.2	88.8	83.7
Return Period 1/2	--	--	--	--	--	--	--	--	--	--	--	--
Return Period 1/5	--	--	--	--	--	--	--	--	--	--	--	2.7
Return Period 1/10	--	--	--	--	--	--	--	--	--	--	--	8.7
Return Period 1/20	--	--	--	--	--	--	--	--	--	--	--	13.7
Soy beans (2)	68.2	15.0	--	--	--	--	--	--	19.5	58.7	81.4	108.4
Return Period 1/2	11.2	--	--	--	--	--	--	--	--	--	--	18.4
Return Period 1/5	21.2	--	--	--	--	--	--	--	--	--	--	28.4
Return Period 1/10	25.2	--	--	--	--	--	--	--	--	--	--	34.4
Return Period 1/20	29.2	--	--	--	--	--	--	--	--	--	--	39.4
Cassava	95.3	81.6	43.1	13.5	36.9	57.4	81.4	88.7	89.9	80.5	82.9	101.7
Return Period 1/2	37.3	--	--	--	--	--	--	--	--	--	--	10.7
Return Period 1/5	47.3	--	--	--	--	--	--	--	--	--	--	20.7
Return Period 1/10	51.3	3.8	--	--	--	--	--	--	--	--	--	26.7
Return Period 1/20	55.3	9.8	--	--	--	--	--	--	--	--	--	31.7
Sunflower	61.4	8.5	--	--	--	--	--	--	18.4	54.3	79.5	111.5
Return Period 1/2	5.4	--	--	--	--	--	--	--	--	--	--	20.5
Return Period 1/5	13.4	--	--	--	--	--	--	--	--	--	--	30.5
Return Period 1/10	17.4	--	--	--	--	--	--	--	--	--	--	35.5
Return Period 1/20	21.4	--	--	--	--	--	--	--	--	--	--	41.5
Papaya	108.9	97.7	105.4	87.0	83.9	74.5	82.6	88.7	90.0	92.0	87.3	111.4
Return Period 1/2	50.9	4.7	1.4	--	--	--	--	--	--	--	--	20.4
Return Period 1/5	60.9	13.7	4.4	--	--	--	--	--	--	--	--	30.4
Return Period 1/10	64.9	19.7	9.4	--	--	--	--	--	--	--	--	36.4
Return Period 1/20	68.9	25.7	13.4	--	--	--	--	--	--	--	--	41.4

Table I-2-5 (2) Crop Water Requirement of UPPER ZONE (mm/month) PAGE=2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Effective Rainfall												
Return Period 1/2	58.0	93.0	104.0	108.0	108.0	108.0	108.0	108.0	108.0	108.0	106.0	91.0
Return Period 1/5	48.0	84.0	101.0	108.0	108.0	108.0	106.0	106.0	106.0	108.0	103.0	81.0
Return Period 1/10	44.0	78.0	96.0	106.0	108.0	108.0	106.0	106.0	106.0	108.0	103.0	75.0
Return Period 1/20	40.0	72.0	92.0	106.0	106.0	106.0	106.0	105.0	105.0	106.0	100.0	70.0
Tree Crop	98.0	87.9	94.9	78.3	75.5	67.0	74.3	78.8	81.0	82.8	78.6	100.3
Return Period 1/2	40.0	--	--	--	--	--	--	--	--	--	--	9.3
Return Period 1/5	50.0	3.9	--	--	--	--	--	--	--	--	--	18.3
Return Period 1/10	54.0	9.9	--	--	--	--	--	--	--	--	--	25.3
Return Period 1/20	58.0	15.9	2.9	--	--	--	--	--	--	--	--	30.3
Plantain	95.3	100.1	115.9	88.2	73.4	59.6	72.3	80.9	88.0	94.3	76.4	88.1
Return Period 1/2	37.3	7.1	11.9	--	--	--	--	--	--	--	--	--
Return Period 1/5	47.3	16.1	14.9	--	--	--	--	--	--	--	--	8.1
Return Period 1/10	51.3	22.1	18.9	--	--	--	--	--	--	--	--	14.1
Return Period 1/20	55.3	28.1	23.9	--	--	--	--	--	--	--	--	19.1
Cacao	82.6	83.0	89.6	74.0	71.3	63.3	70.2	75.4	76.5	78.2	74.2	84.7
Return Period 1/2	34.6	--	--	--	--	--	--	--	--	--	--	3.7
Return Period 1/5	44.6	--	--	--	--	--	--	--	--	--	--	13.7
Return Period 1/10	48.6	5.0	--	--	--	--	--	--	--	--	--	19.7
Return Period 1/20	52.6	11.0	--	--	--	--	--	--	--	--	--	24.7

Table I-2-5 (3) Crop Water Requirement of MIDDLE ZONE (mm/month) PAGE=1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Effective Rainfall												
Return Period 1/2	24.0	106.0	101.0	108.0	106.0	108.0	108.0	108.0	108.0	108.0	103.0	70.0
Return Period 1/5	20.0	105.0	93.0	108.0	106.0	108.0	108.0	108.0	105.0	108.0	101.0	61.0
Return Period 1/10	18.0	103.0	90.0	106.0	104.0	108.0	108.0	108.0	105.0	108.0	97.0	56.0
Return Period 1/20	17.0	103.0	87.0	106.0	103.0	106.0	108.0	108.0	105.0	106.0	94.0	53.0
Paddy Rice	--	336.3	425.7	403.6	402.8	380.0	351.4	--	--	--	--	--
Return Period 1/2	--	230.3	324.7	295.6	296.9	271.9	243.4	--	--	--	--	--
Return Period 1/5	--	231.3	332.7	295.6	296.9	271.9	243.4	--	--	--	--	--
Return Period 1/10	--	233.3	335.7	297.6	298.9	271.9	243.4	--	--	--	--	--
Return Period 1/20	--	233.3	338.7	297.6	298.9	273.9	243.4	--	--	--	--	--
Paddy Rice	365.4	--	--	--	--	--	--	360.2	404.3	418.1	405.7	417.2
Return Period 1/2	341.4	--	--	--	--	--	--	252.2	296.3	310.1	302.7	347.2
Return Period 1/5	345.4	--	--	--	--	--	--	252.2	299.3	310.1	304.7	356.2
Return Period 1/10	347.4	--	--	--	--	--	--	252.2	299.3	310.1	308.7	361.2
Return Period 1/20	348.4	--	--	--	--	--	--	254.2	299.3	312.1	311.7	364.2
Up Land Rice	--	56.3	115.7	103.6	92.9	79.9	41.4	--	--	--	--	--
Return Period 1/2	--	--	14.7	--	--	--	--	--	--	--	--	--
Return Period 1/5	--	--	22.7	--	--	--	--	--	--	--	--	--
Return Period 1/10	--	--	25.7	--	--	--	--	--	--	--	--	--
Return Period 1/20	--	--	28.7	--	--	--	--	--	--	--	--	--
Up Land Rice	55.4	--	--	--	--	--	--	50.2	104.3	108.1	105.7	107.2
Return Period 1/2	31.4	--	--	--	--	--	--	--	--	.1	2.7	37.2
Return Period 1/5	35.4	--	--	--	--	--	--	--	--	.1	4.7	46.2
Return Period 1/10	37.4	--	--	--	--	--	--	--	--	.1	8.7	51.2
Return Period 1/20	38.4	--	--	--	--	--	--	--	--	2.1	11.7	54.2
Soy beans (2)	70.5	15.9	--	--	--	--	--	--	21.0	66.4	93.9	102.7
Return Period 1/2	46.5	--	--	--	--	--	--	--	--	--	--	32.7
Return Period 1/5	50.5	--	--	--	--	--	--	--	--	--	--	41.7
Return Period 1/10	52.5	--	--	--	--	--	--	--	--	--	--	46.7
Return Period 1/20	53.5	--	--	--	--	--	--	--	--	--	--	48.7
Sugarcane	116.3	106.8	113.0	103.0	82.9	81.9	75.5	64.7	53.3	68.1	86.9	103.3
Return Period 1/2	82.3	2.8	12.0	--	--	--	--	--	--	--	--	33.3
Return Period 1/5	86.3	3.8	20.0	--	--	--	--	--	--	--	--	42.3
Return Period 1/10	88.3	5.8	23.0	--	--	--	--	--	--	--	--	47.3
Return Period 1/20	88.3	5.8	26.0	--	--	--	--	--	--	--	--	50.3
Cotton	88.7	40.6	--	--	--	--	--	18.5	48.2	78.7	101.3	108.1
Return Period 1/2	75.7	--	--	--	--	--	--	--	--	--	--	38.1
Return Period 1/5	79.7	--	--	--	--	--	--	--	--	--	.3	47.1
Return Period 1/10	81.7	--	--	--	--	--	--	--	--	--	4.3	52.1
Return Period 1/20	82.7	--	--	--	--	--	--	--	--	--	7.3	55.1
Sunflower	62.4	9.0	--	--	--	--	--	--	19.8	50.4	81.7	104.7
Return Period 1/2	38.4	--	--	--	--	--	--	--	--	--	--	34.7
Return Period 1/5	42.4	--	--	--	--	--	--	--	--	--	--	43.7
Return Period 1/10	44.4	--	--	--	--	--	--	--	--	--	--	48.7
Return Period 1/20	45.4	--	--	--	--	--	--	--	--	--	--	51.7

Table I-2-5 (4) Crop Water Requirement of MIDDLE ZONE (mm/month) PAGE=2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Effective Rainfall												
Return Period 1/2	24.0	105.0	101.0	108.0	105.0	108.0	108.0	108.0	108.0	108.0	103.0	70.0
Return Period 1/5	20.0	105.0	93.0	108.0	106.0	108.0	108.0	108.0	105.0	108.0	101.0	61.0
Return Period 1/10	18.0	103.0	90.0	106.0	104.0	106.0	108.0	108.0	105.0	108.0	97.0	56.0
Return Period 1/20	17.0	103.0	87.0	105.0	103.0	106.0	108.0	105.0	105.0	106.0	94.0	53.0
Maize (1)	--	16.1	48.3	78.8	91.6	72.2	33.1	--	--	--	--	--
Return Period 1/2	--	--	--	--	--	--	--	--	--	--	--	--
Return Period 1/5	--	--	--	--	--	--	--	--	--	--	--	--
Return Period 1/10	--	--	--	--	--	--	--	--	--	--	--	--
Return Period 1/20	--	--	--	--	--	--	--	--	--	--	--	--
Maize (2)	44.3	--	--	--	--	--	--	18.5	50.7	85.3	104.4	96.8
Return Period 1/2	20.3	--	--	--	--	--	--	--	--	--	1.4	26.8
Return Period 1/5	24.3	--	--	--	--	--	--	--	--	--	3.4	35.8
Return Period 1/10	26.3	--	--	--	--	--	--	--	--	--	7.4	40.8
Return Period 1/20	27.3	--	--	--	--	--	--	--	--	--	10.4	43.8
Tree Crop	88.7	93.2	96.8	88.3	78.7	70.2	74.4	83.2	87.3	82.1	80.6	84.1
Return Period 1/2	75.7	--	--	--	--	--	--	--	--	--	--	24.1
Return Period 1/5	79.7	--	3.8	--	--	--	--	--	--	--	--	33.1
Return Period 1/10	81.7	--	6.8	--	--	--	--	--	--	--	--	38.1
Return Period 1/20	82.7	--	8.8	--	--	--	--	--	--	--	--	41.1
Plantain	121.9	106.2	84.2	78.5	77.4	80.0	91.0	94.7	84.9	81.8	88.1	107.2
Return Period 1/2	97.9	.2	--	--	--	--	--	--	--	--	--	37.2
Return Period 1/5	101.9	1.2	1.2	--	--	--	--	--	--	--	--	46.2
Return Period 1/10	103.9	3.2	4.2	--	--	--	--	--	--	--	--	51.2
Return Period 1/20	104.9	3.2	7.2	--	--	--	--	--	--	--	--	54.2
Cacao	84.2	88.1	91.5	83.4	75.2	66.3	70.3	78.5	82.5	87.0	85.6	88.9
Return Period 1/2	70.2	--	--	--	--	--	--	--	--	--	--	18.9
Return Period 1/5	74.2	--	--	--	--	--	--	--	--	--	--	27.8
Return Period 1/10	76.2	--	1.5	--	--	--	--	--	--	--	--	32.9
Return Period 1/20	77.2	--	4.5	--	--	--	--	--	--	--	--	35.9
Oil Palm	84.2	88.1	91.5	83.4	75.2	66.3	70.3	78.5	82.5	87.0	85.6	88.9
Return Period 1/2	70.2	--	--	--	--	--	--	--	--	--	--	18.9
Return Period 1/5	74.2	--	--	--	--	--	--	--	--	--	--	27.8
Return Period 1/10	76.2	--	1.5	--	--	--	--	--	--	--	--	32.9
Return Period 1/20	77.2	--	4.5	--	--	--	--	--	--	--	--	35.9

Table I-2-5 (5) Crop Water Requirement of LOWER ZONE (mm/month) PAGE=1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Effective Rainfall												
Return Period 1/2	48.0	103.0	96.0	103.0	108.0	108.0	108.0	106.0	108.0	107.0	105.0	88.0
Return Period 1/5	43.0	98.0	90.0	102.0	106.0	105.0	108.0	104.0	106.0	106.0	105.0	82.0
Return Period 1/10	40.0	96.0	87.0	100.0	107.0	105.0	108.0	103.0	106.0	106.0	104.0	78.0
Return Period 1/20	38.0	93.0	84.0	98.0	106.0	105.0	108.0	103.0	106.0	105.0	103.0	75.0
Paddy Rice	--	344.2	430.2	396.9	406.6	381.0	352.8	--	--	--	--	--
Return Period 1/2	--	241.2	334.2	293.9	298.6	273.0	244.8	--	--	--	--	--
Return Period 1/5	--	245.2	340.2	294.9	298.6	276.0	244.8	--	--	--	--	--
Return Period 1/10	--	248.2	343.2	296.9	298.6	276.0	244.8	--	--	--	--	--
Return Period 1/20	--	251.2	346.2	298.9	300.6	276.0	244.8	--	--	--	--	--
Paddy Rice	376.1	--	--	--	--	--	--	359.6	407.8	421.8	412.0	432.3
Return Period 1/2	328.1	--	--	--	--	--	--	253.6	298.8	314.8	307.0	343.3
Return Period 1/5	333.2	--	--	--	--	--	--	255.6	301.8	315.8	307.0	350.3
Return Period 1/10	336.2	--	--	--	--	--	--	256.6	301.8	315.8	308.0	354.3
Return Period 1/20	338.2	--	--	--	--	--	--	256.6	301.8	316.8	308.0	357.3
Up Land Rice	--	64.2	120.2	96.9	96.6	81.0	42.8	--	--	--	--	--
Return Period 1/2	--	--	24.2	--	--	--	--	--	--	--	--	--
Return Period 1/5	--	--	30.2	--	--	--	--	--	--	--	--	--
Return Period 1/10	--	--	33.2	--	--	--	--	--	--	--	--	--
Return Period 1/20	--	--	36.2	--	--	--	--	--	--	--	--	--
Up Land Rice	66.2	--	--	--	--	--	--	49.6	107.8	111.8	112.0	122.3
Return Period 1/2	18.2	--	--	--	--	--	--	--	--	4.8	7.0	33.3
Return Period 1/5	23.2	--	--	--	--	--	--	--	1.8	5.8	7.0	40.3
Return Period 1/10	26.2	--	--	--	--	--	--	--	1.8	5.8	8.0	44.3
Return Period 1/20	28.2	--	--	--	--	--	--	--	1.8	6.8	8.0	47.3
Soy beans (2)	84.1	18.2	--	--	--	--	--	--	21.7	68.7	98.5	117.1
Return Period 1/2	36.1	--	--	--	--	--	--	--	--	--	--	28.1
Return Period 1/5	41.1	--	--	--	--	--	--	--	--	--	--	35.1
Return Period 1/10	44.1	--	--	--	--	--	--	--	--	--	--	39.1
Return Period 1/20	46.1	--	--	--	--	--	--	--	--	--	--	42.1
Sorghum	51.3	--	--	--	--	--	--	--	19.3	65.6	88.8	105.9
Return Period 1/2	3.3	--	--	--	--	--	--	--	--	--	--	16.9
Return Period 1/5	8.3	--	--	--	--	--	--	--	--	--	--	23.9
Return Period 1/10	11.3	--	--	--	--	--	--	--	--	--	--	27.9
Return Period 1/20	13.3	--	--	--	--	--	--	--	--	--	--	30.9
Sunflower	74.5	10.3	--	--	--	--	--	--	20.5	62.4	87.2	118.4
Return Period 1/2	26.9	--	--	--	--	--	--	--	--	--	--	30.4
Return Period 1/5	31.5	--	--	--	--	--	--	--	--	--	--	37.4
Return Period 1/10	34.5	--	--	--	--	--	--	--	--	--	--	41.4
Return Period 1/20	36.5	--	--	--	--	--	--	--	--	--	--	44.4
Sugarcane	72.8	78.7	86.4	90.6	86.6	83.0	88.9	85.8	105.3	111.1	88.7	83.5
Return Period 1/2	24.8	--	.4	--	--	--	--	--	--	4.1	--	--
Return Period 1/5	28.8	--	6.4	--	--	--	--	--	--	5.1	--	1.5
Return Period 1/10	32.8	--	9.4	--	--	--	--	--	--	5.1	--	5.5
Return Period 1/20	34.8	--	12.4	--	--	--	--	--	--	6.1	--	8.5

Table I-2-5 (6) Crop Water Requirement of LOWER ZONE (mm/month) PAGE=2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Effective Rainfall												
Return Period 1/2	48.0	103.0	96.0	103.0	108.0	108.0	108.0	106.0	108.0	107.0	102.0	89.0
Return Period 1/5	43.0	98.0	90.0	102.0	108.0	105.0	108.0	104.0	106.0	106.0	105.0	82.0
Return Period 1/10	40.0	96.0	87.0	100.0	107.0	105.0	108.0	103.0	106.0	105.0	104.0	78.0
Return Period 1/20	38.0	93.0	84.0	98.0	106.0	105.0	108.0	103.0	106.0	105.0	103.0	75.0
Maize (1)	--	18.3	50.2	73.7	95.2	73.1	34.2	--	--	--	--	--
Return Period 1/2	--	--	--	--	--	--	--	--	--	--	--	--
Return Period 1/5	--	--	--	--	--	--	--	--	--	--	--	--
Return Period 1/10	--	--	--	--	--	--	--	--	--	--	--	--
Return Period 1/20	--	--	--	--	--	--	--	--	--	--	--	--
Maize (2)	122.4	47.2	--	--	--	--	--	--	20.1	55.2	89.0	123.7
Return Period 1/2	74.4	--	--	--	--	--	--	--	--	--	--	34.7
Return Period 1/5	79.4	--	--	--	--	--	--	--	--	--	--	41.7
Return Period 1/10	82.4	--	--	--	--	--	--	--	--	--	--	45.7
Return Period 1/20	84.4	--	--	--	--	--	--	--	--	--	--	48.7
Plantain	145.5	121.0	97.8	73.4	80.5	81.0	94.2	93.6	87.8	84.5	95.4	122.3
Return Period 1/2	97.5	18.0	1.8	--	--	--	--	--	--	--	--	33.3
Return Period 1/5	102.5	22.0	7.8	--	--	--	--	--	--	--	--	40.3
Return Period 1/10	105.5	25.0	10.8	--	--	--	--	--	--	--	--	44.3
Return Period 1/20	107.5	28.0	13.8	--	--	--	--	--	--	--	--	47.3
Cacao	112.5	100.3	95.0	77.8	78.2	67.2	72.8	77.6	85.3	88.9	90.7	101.4
Return Period 1/2	64.5	--	--	--	--	--	--	--	--	--	--	12.4
Return Period 1/5	69.5	1.3	5.0	--	--	--	--	--	--	--	--	18.4
Return Period 1/10	72.5	4.3	8.0	--	--	--	--	--	--	--	--	23.4
Return Period 1/20	74.5	7.3	11.0	--	--	--	--	--	--	--	--	26.4

Table I-2-6 CONSTANTS of INTAKE RATE (PAGE 1)

D=C*T^n : Df=Cf*T^n
I=K*T^m : If=Kf*T^m

Name of Point	C	n	K	m	Ib	Cf	Kf
TL (A)	3.29	.46	91.27	-.54	4.07	.94	26.08
TL (B)	2.56	.54	82.75	-.46	6.20	.73	23.64
TL (C)	1.91	.52	59.49	-.48	3.92	.54	17.00
MEAN	2.59	.51	77.83	-.49	4.73	.74	22.24
UP (A)	19.56	.45	530.52	-.55	22.17	5.59	151.58
UP (B)	8.99	.45	241.79	-.55	9.86	2.57	69.08
UP (C)	17.33	.26	268.43	-.74	2.91	4.95	76.69
MEAN	15.29	.39	346.91	-.61	11.65	4.37	99.12
MC (A)	56.54	.48	1615.53	-.52	79.49	16.15	461.58
MC (B)	14.90	.75	672.95	-.25	195.52	4.26	192.27
MC (C)	19.95	.69	831.36	-.31	169.17	5.70	237.53
MEAN	30.46	.64	1039.95	-.36	148.06	8.70	297.13

NOTE

D	:	Cylinder Accumlated Intake	(mm)
Df	:	Furrow Accumlated Intake	(mm)
T	:	Time	(min)
I	:	Cylinder Intake Rate	(mm/hr)
If	:	Furrow Intake Rate	(mm/hr)
Ib	:	Basic Intake Rate	(mm/hr)
C,Cf,n	:	Constants of Accumlated Discharge	
K,Kf,m	:	Constants of Intake Rate	

Table I-2-6 CONSTANTS of INTAKE RATE (PAGE 2)

D=C*T^n : Df=Cf*T^n
I=K*T^m : If=Kf*T^m

Name of Point	C	n	K	m	Ib	Cf	Kf
GFA (A)	5.82	.32	111.86	-.68	1.88	1.66	31.96
GFA (B)	5.94	.25	88.93	-.75	.91	1.70	25.41
GFA (C)	8.20	.42	207.49	-.58	7.04	2.34	59.28
MEAN	6.66	.33	136.09	-.67	3.27	1.90	38.88
FO (A)	13.71	.22	177.02	-.78	1.41	3.92	50.58
FO (B)	11.21	.64	432.98	-.36	63.96	3.20	123.71
FO (C)	9.43	.45	253.56	-.55	10.31	2.58	72.45
MEAN	11.45	.44	287.85	-.56	25.23	3.27	82.24
PQ (A)	8.82	.38	202.99	-.62	5.31	2.52	58.00
PQ (B)	7.79	.47	220.30	-.53	10.50	2.22	62.94
PQ (C)	6.90	.69	287.82	-.31	58.75	1.97	82.23
MEAN	7.84	.52	237.04	-.48	24.85	2.24	67.72

NOTE

D	:	Cylinder Accumlated Intake	(mm)
Df	:	Furrow Accumlated Intake	(mm)
T	:	Time	(min)
I	:	Cylinder Intake Rate	(mm/hr)
If	:	Furrow Intake Rate	(mm/hr)
Ib	:	Basic Intake Rate	(mm/hr)
C,Cf,n	:	Constants of Accumlated Discharge	
K,Kf,m	:	Constants of Intake Rate	

Table I-2-6 CONSTANTS of INTAKE RATE (PAGE 3)

D=C*T^n : Df=Cf*T^n
I=K*T^m : If=Kf*T^m

Name of Point	C	n	K	m	Ib	Cf	Kf
EC (A)	2.88	.31	53.15	-.69	.82	.82	15.19
EC (B)	1.27	.18	13.58	-.82	.08	.36	3.88
EC (C)	.24	.68	9.92	-.32	1.82	.07	2.83
MEAN	1.46	.39	25.55	-.61	.91	.42	7.30
GU1 (A)	.51	.26	8.11	-.74	.09	.15	2.32
GU1 (B)	.86	.68	34.72	-.32	6.26	.24	9.92
GU1 (C)	1.16	.85	59.32	-.15	30.81	.33	16.95
MEAN	.84	.60	34.05	-.40	12.39	.24	9.73
GU2 (A)	3.84	.22	51.25	-.78	.43	1.10	14.64
GU2 (B)	1.84	.56	54.49	-.44	4.55	.47	15.57
GU2 (C)	4.98	.28	83.06	-.72	1.04	1.42	23.73
MEAN	3.48	.35	62.93	-.65	2.01	.99	17.98

NOTE

D	:	Cylinder Accumlated Intake	(mm)
Df	:	Furrow Accumlated Intake	(mm)
T	:	Time	(min)
I	:	Cylinder Intake Rate	(mm/hr)
If	:	Furrow Intake Rate	(mm/hr)
Ib	:	Basic Intake Rate	(mm/hr)
C,Cf,n	:	Constants of Accumlated Discharge	
K,Kf,m	:	Constants of Intake Rate	

Table I-2-7 Field Capacity and Available Moisture

Sampl	FCW	SDW	FCWP	WP	AM	DP	RAM
TL 1-1	128.80	86.90	41.90	36.00	5.90	36.50	5.40
TL 1-2	157.50	117.40	40.10	30.70	9.40	31.90	8.20
TL 1-3	163.10	123.90	39.20	26.50	12.70	34.20	5.00
UP 1-1	159.80	118.00	41.80	33.00	8.80	37.50	4.30
UP 1-2	170.90	130.20	40.70	35.81	4.89	38.50	2.20
UP 1-3	175.20	136.90	38.30	15.70	22.60	16.40	21.90
MC 1-1	151.30	103.20	48.10	43.10	5.00	43.69	4.41
MC 1-2	148.80	98.00	50.80	42.10	8.70	43.90	6.90
MC 1-3	179.10	106.20	72.90	64.70	8.20	66.40	6.50
GF 1-1	173.90	137.60	36.30	29.90	6.40	32.80	3.50
GF 1-2	174.30	130.70	43.60	36.20	7.40	41.20	2.40
GF 1-3	198.60	130.90	67.70	48.20	19.50	62.50	5.20
FO 1-1	167.50	123.90	43.60	40.21	3.39	41.20	2.40
FO 1-2	176.80	133.50	43.30	41.80	1.50	42.80	.50
FO 1-3	179.20	135.30	43.90	31.20	12.70	38.30	7.60
PQ 1-1	171.50	124.50	47.00	41.50	5.50	41.93	5.07
PQ 1-2	183.50	142.50	41.00	37.81	3.19	38.12	2.88
PQ 1-3	177.60	138.70	38.90	33.30	5.60	33.83	5.07
EC 1-1	197.40	162.00	35.40	34.59	.81	34.62	.78
EC 1-2	192.20	154.00	38.20	33.29	4.91	33.76	4.44
EC 1-3	189.00	152.20	36.80	35.30	1.50	35.37	1.43
GU 1-1	171.40	132.60	38.80	38.49	.31	38.52	.28
GU 1-2	186.10	147.10	39.00	34.91	4.09	35.05	3.95
GU 1-3	187.30	148.10	39.20	27.50	11.70	27.74	11.46
GU 2-1	189.10	147.70	41.40	40.50	.90	40.57	.83
GU 2-2	187.70	147.20	40.50	39.99	.51	40.04	.46
GU 2-3	196.90	158.40	38.50	36.43	2.07	36.69	1.81

Note
FCW : Weight of Wet Soil of Field Capadity (g)
SDW : Weight of Dry Soil (g)
FCWP : Water Content of Field Capadity (%)
WP : Water Content of Wilting Point (%)
AM : Available Moisture (%) [FCWP-WP]
DP : Depletion of Water Content for Optimum Growth (%)
RAM : Readily Available Moisture (%) [FCWP-DP]

Table I-2-8 Summary of Land Use Plan

	Present Landuse		Plan I-1		Plan I-2		Plan II-1		Plan II-2	
	1st Seme	2nd Seme	1st Seme	2nd Seme	1st Seme	2nd Seme	1st Seme	2nd Seme	1st Seme	2nd Seme
Rice	15,270	3,290	18,990		18,990	15,070	15,070		15,070	10,000
Paddy(Irri.)	(1,870)	(1,440)	(18,990)		(18,990)	(15,070)	(15,070)		(15,070)	(10,000)
U/Rice	(13,400)	(1,850)	(0)		(0)	(0)	(0)		(0)	(0)
Annual Crop	2,440	9,110	1,270		1,270	5,190	4,790		4,790	9,860
Irrigate	(0)	(0)	(895)		(895)	(4,815)	(4,415)		(4,415)	(9,485)
Non-Irrigate	(2,440)	(9,110)	(375)		(375)	(375)	(375)		(375)	(375)
Perennial Crop	2,370		2,370		2,370		2,570		2,570	
Irrigate	(0)		(2,310)		(2,310)		(2,510)		(2,510)	
Non-Irrigate	(2,370)		(60)		(60)		(60)		(60)	
Tree Crop	2,060		2,060		2,060		2,260		2,260	
Irrigate	(0)		(1,625)		(1,625)		(1,820)		(1,820)	
Non-Irrigate	(2,060)		(440)		(440)		(440)		(440)	
Pasture	13,000		10,200		10,200		10,200		10,200	
Irrigate	(0)		(0)		(0)		(0)		(0)	
Non-Irrigate	(13,000)		(10,200)		(10,200)		(10,200)		(10,200)	
Fallow Land	0	5,310	0		0		0		0	
Irrigate	(0)	(0)	(0)		(0)		(0)		(0)	
Non-Irrigate	(0)	(5,310)	(0)		(0)		(0)		(0)	
Arable Land	35,140		34,890		34,890		34,890		34,890	
Irrigate	(1,870)	(1,440)	(23,815)		(23,815)		(23,815)		(23,815)	
Non-Irrigate	(33,270)	(33,700)	(11,075)		(11,075)		(11,075)		(11,075)	
Un-Alable Land	5,960		6,210		6,210		6,210		6,210	
Forest	(4,800)		(4,880)		(4,880)		(4,880)		(4,880)	
Road,Cano.etc	(1,080)		(1,330)		(1,330)		(1,330)		(1,330)	
Grand Total	41,100		41,100		41,100		41,100		41,100	

Table I-2-9 (1) Land Use Plan I-1

	1st Semester(Rainy Season)			
	Upper	Middle	Lower	Total
Paddy	2,715	8,300	7,975	18,990
Sub total	2,715	8,300	7,975	18,990
(Irrigable)	(2,715)	(8,300)	(7,975)	(18,990)
(Non Irri.)	(0)	(0)	(0)	(0)
Maize	500	400	300	1,200
Soybean	0	0	0	0
Sorghum	0	0	0	0
Others	5	5	60	70
Sub total	505	405	360	1,270
(Irrigable)	(375)	(380)	(140)	(895)
(Non Irri.)	(130)	(25)	(220)	(375)
Plantain	1,020	590	760	2,370
Sub total	1,020	590	760	2,370
(Irrigable)	(960)	(590)	(760)	(2,310)
(Non Irri.)	(60)	(0)	(0)	(60)
Cacao	260	380	230	870
Papaya	840	0	0	840
Oilpalm	0	320	0	320
Others	10	10	10	30
Sub total	1,110	710	240	2,060
(Irrigable)	(680)	(700)	(240)	(1,620)
(Non Irri.)	(430)	(10)	(0)	(440)
Pasture	2,600	3,395	4,205	10,200
Sub total	2,600	3,395	4,205	10,200
(Irrigable)	(0)	(0)	(0)	(0)
(Non Irri.)	(2,600)	(3,395)	(4,205)	(10,200)
Arable Land Total	7,950	13,400	13,540	34,890
(Irrigable)	(4,730)	(9,970)	(9,115)	(23,815)
(Non Irri.)	(3,220)	(3,430)	(4,425)	(11,075)
Forest	720	1,500	2,660	4,880
Road,Cano,etc	430	500	400	1,330
Sub total	1,150	2,000	3,060	6,210
Total	9,100	15,400	16,600	41,100

	2nd Semester(Dry Season)			
	Upper	Middle	Lower	Total
Paddy	2,715	8,300	7,975	18,990
Sub total	2,715	8,300	7,975	18,990
(Irrigable)	(2,715)	(8,300)	(7,975)	(18,990)
(Non Irri.)	(0)	(0)	(0)	(0)
Maize	130	100	100	330
Soybean	250	150	100	500
Sorghum	75	100	100	275
Others	50	55	60	165
Sub total	505	405	360	1,270
(Irrigable)	(375)	(380)	(140)	(895)
(Non Irri.)	(130)	(25)	(220)	(375)
Plantain	1,020	590	760	2,370
Sub total	1,020	590	760	2,370
(Irrigable)	(960)	(590)	(760)	(2,310)
(Non Irri.)	(60)	(0)	(0)	(60)
Cacao	260	380	230	870
Papaya	840	0	0	840
Oilpalm	0	320	0	320
Others	10	10	10	30
Sub total	1,110	710	240	2,060
(Irrigable)	(680)	(700)	(240)	(1,620)
(Non Irri.)	(430)	(10)	(0)	(440)
Pasture	2,600	3,395	4,205	10,200
Sub total	2,600	3,395	4,205	10,200
(Irrigable)	(0)	(0)	(0)	(0)
(Non Irri.)	(2,600)	(3,395)	(4,205)	(10,200)
Arable Land Total	7,950	13,400	13,540	34,890
(Irrigable)	(4,730)	(9,970)	(9,115)	(23,815)
(Non Irri.)	(3,220)	(3,430)	(4,425)	(11,075)
Forest	720	1,500	2,660	4,880
Road,Cano,etc	430	500	400	1,330
Sub total	1,150	2,000	3,060	6,210
Total	9,100	15,400	16,600	41,100

Table I-2-9 (2) Land Use Plan I-2

	1st Semester(Rainy Season)			
	Upper	Middle	Lower	Total
Paddy	2,715	8,300	7,975	18,990
Sub total	2,715	8,300	7,975	18,990
(Irrigable)	(2,715)	(8,300)	(7,975)	(18,990)
(Non Irri.)	(0)	(0)	(0)	(0)
Maize	500	400	300	1,200
Soybean	0	0	0	0
Sorghum	0	0	0	0
Others	5	5	60	70
Sub total	505	405	360	1,270
(Irrigable)	(375)	(380)	(140)	(895)
(Non Irri.)	(130)	(25)	(220)	(375)
Plantain	1,020	590	760	2,370
Sub total	1,020	590	760	2,370
(Irrigable)	(960)	(590)	(760)	(2,310)
(Non Irri.)	(60)	(0)	(0)	(60)
Cacao	260	380	230	870
Papaya	840	0	0	840
Oilpalm	0	320	0	320
Others	10	10	10	30
Sub total	1,110	710	240	2,060
(Irrigable)	(680)	(700)	(240)	(1,620)
(Non Irri.)	(430)	(10)	(0)	(440)
Pasture	2,600	3,395	4,205	10,200
Sub total	2,600	3,395	4,205	10,200
(Irrigable)	(0)	(0)	(0)	(0)
(Non Irri.)	(2,600)	(3,395)	(4,205)	(10,200)
Arable Land Total	7,950	13,400	13,540	34,890
(Irrigable)	(4,730)	(9,970)	(9,115)	(23,815)
(Non Irri.)	(3,220)	(3,430)	(4,425)	(11,075)
Forest	720	1,500	2,660	4,880
Road,Cano,etc	430	500	400	1,330
Sub total	1,150	2,000	3,060	6,210
Total	9,100	15,400	16,600	41,100

	2nd Semester(Dry Season)			
	Upper	Middle	Lower	Total
Paddy	1,860	6,660	6,550	15,070
Sub total	1,860	6,660	6,550	15,070
(Irrigable)	(1,860)	(6,660)	(6,550)	(15,070)
(Non Irri.)	(0)	(0)	(0)	(0)
Maize	130	150	220	500
Soybean	700	1,200	850	2,750
Sorghum	300	500	500	1,300
Others	230	195	215	640
Sub total	1,360	2,045	1,785	5,190
(Irrigable)	(1,230)	(2,020)	(1,565)	(4,815)
(Non Irri.)	(130)	(25)	(220)	(375)
Plantain	1,020	590	760	2,370
Sub total	1,020	590	760	2,370
(Irrigable)	(960)	(590)	(760)	(2,310)
(Non Irri.)	(60)	(0)	(0)	(60)
Cacao	260	380	230	870
Papaya	840	0	0	840
Oilpalm	0	320	0	320
Others	10	10	10	30
Sub total	1,110	710	240	2,060
(Irrigable)	(680)	(700)	(240)	(1,620)
(Non Irri.)	(430)	(10)	(0)	(440)
Pasture	2,600	3,395	4,205	10,200
Sub total	2,600	3,395	4,205	10,200
(Irrigable)	(0)	(0)	(0)	(0)
(Non Irri.)	(2,600)	(3,395)	(4,205)	(10,200)
Arable Land Total	7,950	13,400	13,540	34,890
(Irrigable)	(4,730)	(9,970)	(9,115)	(23,815)
(Non Irri.)	(3,220)	(3,430)	(4,425)	(11,075)
Forest	720	1,500	2,660	4,880
Road,Cano,etc	430	500	400	1,330
Sub total	1,150	2,000	3,060	6,210
Total	9,100	15,400	16,600	41,100

Table I-2-9 (3) Land Use Plan II-1

	1st Semester(Rainy Season)			
	Upper	Middle	Lower	Total
Paddy	1,860	6,660	6,550	15,070
Sub total	1,860	6,660	6,550	15,070
(Irrigable)	(1,860)	(6,660)	(6,550)	(15,070)
(Non Irri.)	(0)	(0)	(0)	(0)
Maize	1,340	1,960	1,420	4,720
Soybean	0	0	0	0
Sorghum	0	0	0	0
Others	5	5	60	70
Sub total	1,345	1,965	1,480	4,790
(Irrigable)	(1,215)	(1,940)	(1,260)	(4,415)
(Non Irri.)	(130)	(25)	(220)	(375)
Plantain	1,120	640	810	2,570
Sub total	1,120	640	810	2,570
(Irrigable)	(1,060)	(640)	(810)	(2,510)
(Non Irri.)	(60)	(0)	(0)	(60)
Cacao	260	380	230	870
Papaya	1,040	0	0	1,040
Oilpalm	0	320	0	320
Others	10	10	10	30
Sub total	1,310	710	240	2,260
(Irrigable)	(880)	(700)	(240)	(1,820)
(Non Irri.)	(430)	(10)	(0)	(440)
Pasture	2,315	3,425	4,460	10,200
Sub total	2,315	3,425	4,460	10,200
(Irrigable)	(0)	(0)	(0)	(0)
(Non Irri.)	(2,315)	(3,425)	(4,460)	(10,200)
Arable Land				
Total	7,950	13,400	13,540	34,890
(Irrigable)	(5,015)	(9,940)	(8,860)	(23,815)
(Non Irri.)	(2,935)	(3,460)	(4,680)	(11,075)
Forest	720	1,500	2,660	4,880
Road,Cano,etc	430	500	400	1,330
Sub total	1,150	2,000	3,060	6,210
Total	9,100	15,400	16,600	41,100

	2nd Semester(Dry Season)			
	Upper	Middle	Lower	Total
Paddy	1,860	6,660	6,550	15,070
Sub total	1,860	6,660	6,550	15,070
(Irrigable)	(1,860)	(6,660)	(6,550)	(15,070)
(Non Irri.)	(0)	(0)	(0)	(0)
Maize	130	150	220	500
Soybean	700	1,100	750	2,550
Sorghum	300	500	400	1,200
Others	215	215	110	540
Sub total	1,345	1,965	1,480	4,790
(Irrigable)	(1,215)	(1,940)	(1,260)	(4,415)
(Non Irri.)	(130)	(25)	(220)	(375)
Plantain	1,120	640	810	2,570
Sub total	1,120	640	810	2,570
(Irrigable)	(1,060)	(640)	(810)	(2,510)
(Non Irri.)	(60)	(0)	(0)	(60)
Cacao	260	380	230	870
Papaya	1,040	0	0	1,040
Oilpalm	0	320	0	320
Others	10	10	10	30
Sub total	1,310	710	240	2,260
(Irrigable)	(880)	(700)	(240)	(1,820)
(Non Irri.)	(430)	(10)	(0)	(440)
Pasture	2,315	3,425	4,460	10,200
Sub total	2,315	3,425	4,460	10,200
(Irrigable)	(0)	(0)	(0)	(0)
(Non Irri.)	(2,315)	(3,425)	(4,460)	(10,200)
Arable Land				
Total	7,950	13,400	13,540	34,890
(Irrigable)	(5,015)	(9,940)	(8,860)	(23,815)
(Non Irri.)	(2,935)	(3,460)	(4,680)	(11,075)
Forest	720	1,500	2,660	4,880
Road,Cano,etc	430	500	400	1,330
Sub total	1,150	2,000	3,060	6,210
Total	9,100	15,400	16,600	41,100

Table I-2-9 (4) Land Use Plan II-2

	1st Semester(Rainy Season)			
	Upper	Middle	Lower	Total
Paddy	1,860	6,660	6,550	15,070
Sub total	1,860	6,660	6,550	15,070
(Irrigable)	(1,860)	(6,660)	(6,550)	(15,070)
(Non Irri.)	(0)	(0)	(0)	(0)
Maize	1,340	1,960	1,420	4,720
Soybean	0	0	0	0
Sorghum	0	0	0	0
Others	5	5	60	70
Sub total	1,345	1,965	1,480	4,790
(Irrigable)	(1,215)	(1,940)	(1,260)	(4,415)
(Non Irri.)	(130)	(25)	(220)	(375)
Plantain	1,120	640	810	2,570
Sub total	1,120	640	810	2,570
(Irrigable)	(1,060)	(640)	(810)	(2,510)
(Non Irri.)	(60)	(0)	(0)	(60)
Cacao	260	380	230	870
Papaya	1,040	0	0	1,040
Oilpalm	0	320	0	320
Others	10	10	10	30
Sub total	1,310	710	240	2,260
(Irrigable)	(880)	(700)	(240)	(1,820)
(Non Irri.)	(430)	(10)	(0)	(440)
Pasture	2,315	3,425	4,460	10,200
Sub total	2,315	3,425	4,460	10,200
(Irrigable)	(0)	(0)	(0)	(0)
(Non Irri.)	(2,315)	(3,425)	(4,460)	(10,200)
Arable Land				
Total	7,950	13,400	13,540	34,890
(Irrigable)	(5,015)	(9,940)	(8,860)	(23,815)
(Non Irri.)	(2,935)	(3,460)	(4,680)	(11,075)
Forest	720	1,500	2,660	4,880
Road,Cano,etc	430	500	400	1,330
Sub total	1,150	2,000	3,060	6,210
Total	9,100	15,400	16,600	41,100

	2nd Semester(Dry Season)			
	Upper	Middle	Lower	Total
Paddy	590	4,290	5,120	10,000
Sub total	590	4,290	5,120	10,000
(Irrigable)	(590)	(4,290)	(5,120)	(10,000)
(Non Irri.)	(0)	(0)	(0)	(0)
Maize	500	300	290	1,090
Soybean	1,000	2,440	1,530	4,970
Sorghum	900	1,380	980	3,260
Others	215	215	110	540
Sub total	2,615	4,335	2,910	9,860
(Irrigable)	(2,485)	(4,310)	(2,690)	(9,485)
(Non Irri.)	(130)	(25)	(220)	(375)
Plantain	1,120	640	810	2,570
Sub total	1,120	640	810	2,570
(Irrigable)	(1,060)	(640)	(810)	(2,510)
(Non Irri.)	(60)	(0)	(0)	(60)
Cacao	260	380	230	870
Papaya	1,040	0	0	1,040
Oilpalm	0	320	0	320
Others	10	10	10	30
Sub total	1,310	710	240	2,260
(Irrigable)	(880)	(700)	(240)	(1,820)
(Non Irri.)	(430)	(10)	(0)	(440)
Pasture	2,315	3,425	4,460	10,200
Sub total	2,315	3,425	4,460	10,200
(Irrigable)	(0)	(0)	(0)	(0)
(Non Irri.)	(2,315)	(3,425)	(4,460)	(10,200)
Arable Land				
Total	7,950	13,400	13,540	34,890
(Irrigable)	(5,015)	(9,940)	(8,860)	(23,815)
(Non Irri.)	(2,935)	(3,460)	(4,680)	(11,075)
Forest	720	1,500	2,660	4,880
Road,Cano,etc	430	500	400	1,330
Sub total	1,150	2,000	3,060	6,210
Total	9,100	15,400	16,600	41,100

Table I-2-10 (1) Crop Water Requirement

Crop Water Requirement of CASE-I-1 UPPER ZONE (mm/s) Page 1

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Paddy Rice	(2715)	6.106	4.825	4.981	5.788	5.634	5.474	5.353	4.726	4.853	5.845	5.770	4.943
Paddy Rice	1/2	4.916	2.813	2.858	3.508	3.418	3.185	3.337	2.510	2.964	3.628	3.523	3.077
	1/5	5.121	3.017	2.918	3.508	3.418	3.185	3.378	2.551	2.606	3.628	3.587	3.282
	1/10	5.205	3.154	3.022	3.551	3.418	3.185	3.378	2.551	2.606	3.628	3.587	3.405
	1/20	5.283	3.280	3.104	3.551	3.459	3.227	3.378	2.572	2.627	3.670	3.651	3.507
Maize (1)	(230)	.185	.044	.044	.106	.180	.212	.204	.085	.054	.159	.224	.292
Soy beans (2)	1/2	.030	----	----	----	----	----	----	----	----	----	----	.048
	1/5	.057	----	----	----	----	----	----	----	----	----	----	.076
	1/10	.067	----	----	----	----	----	----	----	----	----	----	.092
	1/20	.078	----	----	----	----	----	----	----	----	----	----	.105
Maize (1)	(75)	.024	----	.013	.032	.054	.064	.061	.026	.014	.046	.067	.078
Sorghum	1/2	----	----	----	----	----	----	----	----	----	----	----	.008
	1/5	----	----	----	----	----	----	----	----	----	----	----	.014
	1/10	----	----	----	----	----	----	----	----	----	----	----	.018
	1/20	.002	----	----	----	----	----	----	----	----	----	----	.023
Maize (1)	(30)	.060	.002	.001	.022	.036	.042	.041	.018	.010	.024	.037	.060
Cotton	1/2	.029	----	----	----	----	----	----	----	----	----	----	.011
	1/5	.034	.002	----	----	----	----	----	----	----	----	----	.017
	1/10	.037	.006	----	----	----	----	----	----	----	----	----	.020
	1/20	.039	.008	----	----	----	----	----	----	----	----	----	.022
Plantain	(960)	1.227	1.135	.944	.737	.752	.808	.930	.831	.833	.754	.808	1.168
	1/2	.833	.061	----	----	----	----	----	----	----	----	----	.237
	1/5	.755	.185	----	----	----	----	----	----	----	----	----	.340
	1/10	.776	.251	----	----	----	----	----	----	----	----	----	.401
	1/20	.817	.319	.002	----	----	----	----	----	----	----	----	.452
Cocoa	(260)	.257	.255	.248	.212	.198	.181	.185	.209	.219	.217	.213	.263
	1/2	.096	----	----	----	----	----	----	----	----	----	----	.010
	1/5	.124	----	----	----	----	----	----	----	----	----	----	.038
	1/10	.135	.015	----	----	----	----	----	----	----	----	----	.055
	1/20	.146	.034	----	----	----	----	----	----	----	----	----	.068
Papaya	(410)	.426	.423	.461	.385	.367	.337	.361	.388	.407	.402	.385	.467
	1/2	.220	.020	.006	----	----	----	----	----	----	----	----	.089
	1/5	.268	.066	.018	----	----	----	----	----	----	----	----	.173
	1/10	.284	.095	.041	----	----	----	----	----	----	----	----	.198
	1/20	.301	.124	.069	----	----	----	----	----	----	----	----	.181
Tree Crop	(10)	.010	.010	.010	.009	.008	.007	.008	.009	.009	.009	.009	.011
	1/2	.004	----	----	----	----	----	----	----	----	----	----	.001
	1/5	.008	0.000	----	----	----	----	----	----	----	----	----	.002
	1/10	.008	.001	----	----	----	----	----	----	----	----	----	.003
	1/20	.006	.002	0.000	----	----	----	----	----	----	----	----	.002
Total	(4730)	6.354	5.695	5.743	7.310	7.228	7.126	7.353	6.404	6.389	7.456	7.523	7.304
	1/2	5.930	2.917	2.864	3.508	3.418	3.185	3.337	2.510	2.564	3.628	3.523	3.481
	1/5	6.342	3.270	2.939	3.508	3.418	3.185	3.378	2.551	2.606	3.628	3.587	3.901
	1/10	6.507	3.523	3.063	3.551	3.418	3.185	3.378	2.551	2.606	3.628	3.587	4.153
	1/20	6.674	3.779	3.165	3.551	3.459	3.227	3.378	2.572	2.627	3.670	3.651	4.363

Table I-2-10 (2) Crop Water Requirement

Crop Water Requirement of CASE-I-1 MIDDLE ZONE (m3/s) Page 1

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Paddy Rice	(3300)	18.786	15.252	15.554	18.499	17.528	16.975	16.981	14.562	15.085	18.562	18.558	14.665
Paddy Rice	1/2	17.282	7.802	9.000	11.500	10.880	9.374	10.208	7.789	8.084	11.789	11.885	10.275
	1/5	17.555	7.371	9.302	11.500	10.880	9.374	10.208	7.789	8.273	11.739	12.013	10.839
	1/10	17.535	8.110	9.690	11.650	11.005	9.374	10.208	7.789	8.279	11.789	12.272	11.155
	1/20	17.721	8.110	9.378	11.650	11.068	10.105	10.208	7.815	8.279	11.314	12.466	11.341
Maize (1)	(73)	.082	.037	.013	.036	.057	.067	.061	.030	.018	.043	.069	.087
Maize (2)	1/2	.063	----	----	----	----	----	----	----	----	----	----	.031
	1/5	.066	----	----	----	----	----	----	----	----	----	----	.036
	1/10	.068	----	----	----	----	----	----	----	----	----	----	.042
	1/20	.068	----	----	----	----	----	----	----	----	----	----	.044
Maize (1)	(130)	.113	.028	.027	.073	.114	.133	.122	.059	.035	.106	.155	.164
Soy beans (2)	1/2	.074	----	----	----	----	----	----	----	----	----	----	.052
	1/5	.081	----	----	----	----	----	----	----	----	----	----	.067
	1/10	.084	----	----	----	----	----	----	----	----	----	----	.075
	1/20	.086	----	----	----	----	----	----	----	----	----	----	.080
Maize (1)	(100)	.046	----	.018	.049	.076	.089	.082	.039	.021	.068	.103	.099
Sorghum	1/2	.020	----	----	----	----	----	----	----	----	----	----	.024
	1/5	.024	----	----	----	----	----	----	----	----	----	----	.034
	1/10	.027	----	----	----	----	----	----	----	----	----	----	.039
	1/20	.028	----	----	----	----	----	----	----	----	----	----	.042
Maize (1)	(55)	.067	.061	.035	.027	.042	.040	.045	.022	.012	.030	.048	.062
Cotton	1/2	.053	----	----	----	----	----	----	----	----	----	----	.021
	1/5	.055	----	----	----	----	----	----	----	----	----	----	.026
	1/10	.057	----	----	----	----	----	----	----	----	----	----	.029
	1/20	.057	----	----	----	----	----	----	----	----	----	----	.031
Plantain	(590)	.767	.740	.583	.510	.487	.520	.373	.596	.552	.515	.573	.675
	1/2	.816	.001	----	----	----	----	----	----	----	----	----	.234
	1/5	.841	.008	.007	----	----	----	----	----	----	----	----	.291
	1/10	.854	.022	.026	----	----	----	----	----	----	----	----	.322
	1/20	.860	.022	.043	----	----	----	----	----	----	----	----	.341
Cacao	(380)	.282	.287	.371	.349	.305	.278	.285	.318	.343	.352	.359	.360
	1/2	.304	----	----	----	----	----	----	----	----	----	----	.077
	1/5	.301	----	----	----	----	----	----	----	----	----	----	.113
	1/10	.309	----	.006	----	----	----	----	----	----	----	----	.133
	1/20	.313	----	.018	----	----	----	----	----	----	----	----	.146
Oil Palm	([illegible])	.321	.337	.312	.294	.257	.234	.240	.268	.291	.297	.302	.302
	1/2	.240	----	----	----	----	----	----	----	----	----	----	.065
	1/5	[illegible]	----	----	----	----	----	----	----	----	----	----	.095
	1/10	.267	----	.005	----	----	----	----	----	----	----	----	.112
	1/20	.253	----	.012	----	----	----	----	----	----	----	----	.123
Total	(5070)	20.256	18.835	16.702	19.028	18.085	18.342	18.289	15.825	16.354	19.573	20.167	16.415
	1/2	18.503	7.803	9.000	11.500	10.880	9.374	10.208	7.789	8.084	11.789	11.885	10.778
	1/5	18.855	7.379	9.309	11.500	10.880	9.374	10.208	7.789	8.279	11.789	12.013	11.503
	1/10	19.115	8.132	9.727	11.650	11.005	9.374	10.208	7.789	8.279	11.789	12.272	11.906
	1/20	19.137	8.132	9.356	11.650	11.068	10.105	10.208	7.915	8.279	11.914	12.466	12.147

Table I-2-10 (3) Crop Water Requirement

Crop Water Requirement of CASE-I-1 LOWER ZONE (m3/s) Page 1

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Paddy Rice	(7975)	19.380	15.144	14.871	17.348	17.084	16.373	16.495	13.959	14.804	18.062	18.226	15.021
Paddy Rice	1/2	16.487	8.277	9.087	10.933	10.556	9.648	9.987	7.572	7.879	11.614	11.688	9.857
	1/5	16.783	8.540	9.443	10.995	10.556	9.835	9.987	7.682	8.004	11.674	11.688	10.079
	1/10	16.870	8.740	9.629	11.120	10.616	9.835	9.987	7.752	8.004	11.674	11.750	10.320
	1/20	17.080	8.940	9.810	11.244	10.676	9.835	9.987	7.752	8.004	11.735	11.812	10.501
Maize (1)	(100)	.090	.021	.018	.043	.079	.090	.084	.039	.024	.073	.110	.125
Soy beans (2)	1/2	.039	----	----	----	----	----	----	----	----	----	----	.050
	1/5	.044	----	----	----	----	----	----	----	----	----	----	.037
	1/10	.047	----	----	----	----	----	----	----	----	----	----	.042
	1/20	.048	----	----	----	----	----	----	----	----	----	----	.045
Maize (1)	(40)	.053	.050	.026	.018	.052	.036	.034	.016	.009	.022	.027	.051
Cotton	1/2	.038	.002	----	----	----	----	----	----	----	----	----	.017
	1/5	.040	.003	----	----	----	----	----	----	----	----	----	.016
	1/10	.041	.005	----	----	----	----	----	----	----	----	----	.018
	1/20	.042	.006	----	----	----	----	----	----	----	----	----	.019
Plantain	(760)	1.180	1.086	.780	.615	.650	.678	.760	.759	.735	.686	.782	.991
	1/2	.791	.181	.015	----	----	----	----	----	----	----	----	.270
	1/5	.831	.197	.060	----	----	----	----	----	----	----	----	.327
	1/10	.856	.224	.068	----	----	----	----	----	----	----	----	.359
	1/20	.872	.251	.112	----	----	----	----	----	----	----	----	.380
Cacao	(230)	.276	.272	.230	.198	.192	.170	.179	.180	.216	.221	.230	.249
	1/2	.158	----	----	----	----	----	----	----	----	----	----	.030
	1/5	.170	.004	.012	----	----	----	----	----	----	----	----	.048
	1/10	.178	.012	.020	----	----	----	----	----	----	----	----	.057
	1/20	.183	.020	.027	----	----	----	----	----	----	----	----	.063
Tree Crop	(10)	.013	.013	.011	.009	.009	.008	.008	.009	.010	.010	.011	.011
	1/2	.008	0.000	0.000	----	----	----	----	----	----	----	----	.002
	1/5	.008	.001	.001	----	----	----	----	----	----	----	----	.003
	1/10	.008	.001	.001	----	----	----	----	----	----	----	----	.002
	1/20	.009	.002	.002	----	----	----	----	----	----	----	----	.003
Total	(9115)	20.996	16.587	15.957	18.231	18.028	17.356	17.564	14.871	15.586	19.073	19.393	16.448
	1/2	17.520	8.436	9.102	10.933	10.556	9.648	9.987	7.572	7.879	11.614	11.688	10.002
	1/5	17.882	8.744	9.523	10.995	10.556	9.835	9.987	7.682	8.004	11.674	11.688	10.310
	1/10	18.100	8.981	9.736	11.120	10.616	9.835	9.987	7.752	8.004	11.674	11.750	10.600
	1/20	18.244	9.218	9.951	11.244	10.676	9.835	9.987	7.752	8.004	11.735	11.812	11.017

Table I-2-10 (4) Crop Water Requirement

Crop Water Requirement v.A IASE-1-2 UPPER ZONE (m3/s) Page 1

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Paddy Rice	(1080)	4.133	3.374	3.426	3.372	3.360	3.730	3.804	3.237	3.323	4.004	3.933	3.387
Paddy Rice	1/2	3.368	1.927	1.838	2.404	2.342	2.182	2.285	1.720	1.756	2.486	2.414	2.108
	1/5	3.308	2.067	2.000	2.404	2.342	2.182	2.314	1.748	1.783	2.486	2.457	2.248
	1/10	3.734	2.161	2.070	2.433	2.342	2.182	2.314	1.748	1.783	2.486	2.457	2.333
	1/20	3.621	2.254	2.127	2.433	2.370	2.211	2.314	1.762	1.800	2.514	2.501	2.403
Paddy Rice	(700)	.317	124	1.287	1.495	1.453	1.311	1.432	1.218	.150	.446	.628	.817
Soy beans (2)	1/2	.084	----	.737	.903	.881	.821	.860	.647	----	----	----	.137
	1/5	.139	----	.753	.903	.881	.821	.871	.638	----	----	----	.212
	1/10	.183	----	.772	.916	.861	.821	.871	.653	----	----	----	.233
	1/20	.216	----	.800	.916	.892	.832	.871	.663	----	----	----	.294
Paddy Rice	([illegible])	.070	----	.385	.331	.322	.313	.317	.270	.030	.094	.138	.163
Sorghum	1/2	----	----	.163	.200	.193	.182	.181	.143	----	----	----	.013
	1/5	----	----	.187	.200	.193	.182	.193	.146	----	----	----	.030
	1/10	----	----	.173	.203	.195	.182	.193	.146	----	----	----	.079
	1/20	.004	----	.177	.203	.197	.184	.193	.147	----	----	----	.048
Maize (2)	(145)	.063	----	.023	.062	.104	.123	.118	.055	.028	.088	.129	.153
Sorghum	1/2	----	----	----	----	----	----	----	----	----	----	----	.012
	1/5	----	----	----	----	----	----	----	----	----	----	----	.028
	1/10	----	----	----	----	----	----	----	----	----	----	----	.037
	1/20	.003	----	----	----	----	----	----	----	----	----	----	.043
Maize (1)	(230)	.275	.239	.141	.039	.163	.193	.197	.087	.046	.112	.172	.275
Cotton	1/2	.124	----	----	----	----	----	----	----	----	----	----	.052
	1/5	.153	.011	----	----	----	----	----	----	----	----	----	.076
	1/10	.169	.027	----	----	----	----	----	----	----	----	----	.091
	1/20	.178	.043	----	----	----	----	----	----	----	----	----	.103
Plantain	(860)	1.227	1.133	.344	.737	.752	.808	.930	.931	.833	.754	.808	1.169
	1/2	.633	.081	----	----	----	----	----	----	----	----	----	.237
	1/5	.733	.183	----	----	----	----	----	----	----	----	----	.340
	1/10	.776	.231	----	----	----	----	----	----	----	----	----	.401
	1/20	.817	.319	.002	----	----	----	----	----	----	----	----	.452
[illegible]	(230)	.277	.237	.248	.212	.188	.181	.195	.209	.219	.217	.213	.263
	[illegible]	.066	----	----	----	----	----	----	----	----	----	----	.010
	1/5	.124	----	----	----	----	----	----	----	----	----	----	.028
	1/10	.177	.015	----	----	----	----	----	----	----	----	----	.033
	1/20	.143	.034	----	----	----	----	----	----	----	----	----	.068
[illegible]	([illegible])	.473	[illegible]	.461	.391	.367	.337	.361	.338	.407	.402	.335	.487
	[illegible]	[illegible]	[illegible]	.008	----	----	----	----	----	----	----	----	.083
	[illegible]	.233	.066	.019	----	----	----	----	----	----	----	----	.133
	[illegible]	.234	.085	.041	----	----	----	----	----	----	----	----	.159
	[illegible]	.301	.124	.059	----	----	----	----	----	----	----	----	.161
Tree Crop	(10)	.010	.010	.010	.009	.008	.007	.008	.009	.009	.009	.009	.011
	1/2	.004	----	----	----	----	----	----	----	----	----	----	.001
	1/5	.005	0.000	----	----	----	----	----	----	----	----	----	.002
	1/10	.006	.001	----	----	----	----	----	----	----	----	----	.003
	1/20	.006	.002	0.000	----	----	----	----	----	----	----	----	.003

Table I-2-10 (5) Crop Water Requirement

Crop Water Requirement of CASE-I-2 UPPER ZONE (m3/s) Page 2

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total	(4730)	7.081	5.611	6.022	7.710	7.228	7.126	7.253	6.404	5.046	6.126	6.446	6.723
	1/2	4.541	3.031	2.864	3.509	3.418	3.180	3.337	2.310	1.756	2.486	2.414	2.660
	1/3	4.956	3.028	2.936	3.509	3.418	3.183	3.378	2.551	1.780	2.486	2.457	3.107
	1/10	3.122	3.031	3.060	3.551	3.418	3.185	3.378	2.551	1.785	2.486	2.457	3.275
	1/20	3.284	2.776	3.160	3.551	3.459	3.227	3.378	2.572	1.800	2.514	2.501	3.388

Table I-2-10 (6) Crop Water Requirement

Crop Water Requirement of CASE-I-2 MIDDLE ZONE (m3/s) Page 1

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Paddy Rice	(8660)	15.075	12.248	12.304	14.844	14.064	13.618	13.626	11.685	12.103	14.694	14.881	11.767
Paddy Rice	1/2	13.868	8.240	7.222	9.228	8.730	8.003	8.191	6.250	6.487	8.459	8.335	8.244
	1/5	14.068	8.286	7.324	9.228	8.730	8.003	8.191	6.250	6.643	8.459	8.838	8.597
	1/10	14.170	8.308	7.375	9.332	8.831	8.003	8.191	6.250	6.643	8.459	8.847	8.949
	1/20	14.220	8.308	7.326	9.332	8.881	8.107	8.191	6.351	6.643	8.560	10.003	9.100
Paddy Rice	(1280)	.902	.228	2.217	2.675	2.534	2.454	2.455	2.105	.278	.850	1.242	1.315
Soy Beans (2)	1/2	.680	----	1.301	1.662	1.573	1.442	1.476	1.126	----	----	----	.418
	1/5	.646	----	1.274	1.660	1.572	1.442	1.476	1.126	----	----	----	.534
	1/10	.671	----	1.401	1.681	1.591	1.442	1.476	1.126	----	----	----	.588
	1/20	.684	----	1.423	1.681	1.600	1.461	1.476	1.144	----	----	----	.606
Paddy Rice	(440)	.202	----	.913	.981	.929	.900	.900	.772	.091	.288	.453	.436
Sorghum	1/2	.085	----	.477	.610	.577	.529	.541	.413	----	----	----	.107
	1/5	.108	----	.504	.610	.577	.529	.541	.413	----	----	----	.148
	1/10	.117	----	.514	.617	.583	.529	.541	.413	----	----	----	.173
	1/20	.122	----	.524	.617	.587	.536	.541	.420	----	----	----	.187
Maize (1)	(60)	.027	----	.011	.029	.046	.053	.045	.024	.013	.041	.062	.059
Sorghum	1/2	.012	----	----	----	----	----	----	----	----	----	----	.015
	1/5	.015	----	----	----	----	----	----	----	----	----	----	.020
	1/10	.016	----	----	----	----	----	----	----	----	----	----	.024
	1/20	.017	----	----	----	----	----	----	----	----	----	----	.025
Maize (1)	(125)	.137	.061	.022	.061	.095	.111	.102	.049	.027	.071	.116	.145
Maize (2)	1/2	.105	----	----	----	----	----	----	----	----	----	----	.051
	1/5	.110	----	----	----	----	----	----	----	----	----	----	.063
	1/10	.113	----	----	----	----	----	----	----	----	----	----	.070
	1/20	.114	----	----	----	----	----	----	----	----	----	----	.074
Maize (1)	(185)	.208	.216	.122	.095	.148	.174	.159	.077	.042	.106	.169	.219
Cotton	1/2	.188	----	----	----	----	----	----	----	----	----	----	.073
	1/5	.197	----	----	----	----	----	----	----	----	----	----	.092
	1/10	.201	----	----	----	----	----	----	----	----	----	----	.102
	1/20	.203	----	----	----	----	----	----	----	----	----	----	.108
Pigeon	(260)	.767	.748	.382	.510	.487	.520	.573	.536	.552	.515	.373	.675
	1/2	.616	.301	----	----	----	----	----	----	----	----	----	.234
	1/5	.641	.308	.007	----	----	----	----	----	----	----	----	.281
	1/10	.654	.022	.026	----	----	----	----	----	----	----	----	.322
	1/20	.660	.033	.040	----	----	----	----	----	----	----	----	.341
Cacao	(280)	.301	.280	.071	.349	.305	.278	.285	.318	.345	.352	.358	.360
	1/2	.204	----	----	----	----	----	----	----	----	----	----	.077
	1/5	.264	----	----	----	----	----	----	----	----	----	----	.113
	1/10	.288	----	.006	----	----	----	----	----	----	----	----	.133
	1/20	.211	----	.013	----	----	----	----	----	----	----	----	.146
Oil Palm	(320)	.324	.302	.312	.284	.257	.234	.240	.268	.281	.287	.302	.303
	1/2	.240	----	----	----	----	----	----	----	----	----	----	.065
	1/5	.260	----	----	----	----	----	----	----	----	----	----	.085
	1/10	.280	----	.005	----	----	----	----	----	----	----	----	.112
	1/20	.281	----	.015	----	----	----	----	----	----	----	----	.123

Table I-2-10 (7) Crop Water Requirement

Crop Water Requirement of CASE-I-2 MIDDLE ZONE (m3/s) Page 2

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total	(9970)	18.051	14.218	16.760	19.838	18.865	18.342	18.388	15.890	13.740	17.404	18.166	16.278
	1/2	13.986	8.342	9.000	11.300	10.880	9.974	10.208	7.789	8.487	9.459	9.550	9.289
	1/5	16.209	8.404	9.509	11.500	10.880	9.974	10.208	7.789	8.643	9.459	9.639	10.056
	1/10	16.210	8.330	9.727	11.630	11.005	9.974	10.208	7.789	8.643	9.459	9.847	10.484
	1/20	16.366	8.330	9.956	11.630	11.068	10.103	10.208	7.815	8.643	9.580	10.003	10.741

Table I-2-10 (8) Crop Water Requirement

Crop Water Requirement of CASE-I-2 LOWER ZONE (mm/s) Page 1

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Paddy Rice	(6550)	15.917	12.438	12.214	14.247	14.015	13.448	13.548	11.482	11.385	14.835	14.366	12.227
Paddy Rice	1/2	13.341	8.783	7.463	8.979	8.670	7.924	8.203	6.219	6.471	9.539	9.389	7.832
	1/5	12.788	7.014	7.760	9.000	8.670	8.078	8.203	6.218	6.574	9.588	9.589	8.278
	1/10	13.937	7.178	7.908	9.133	8.718	8.078	8.203	6.367	6.574	9.588	9.651	8.476
	1/20	14.036	7.342	8.057	9.235	8.769	8.078	8.203	6.367	6.574	9.638	9.702	8.625
Paddy Rice	(850)	.760	.182	1.585	1.849	1.819	1.745	1.758	1.488	.203	.823	.932	1.062
Soy Beans (2)	1/2	.328	----	.868	1.165	1.125	1.028	1.064	.807	----	----	----	.255
	1/5	.373	----	1.007	1.172	1.125	1.048	1.064	.820	----	----	----	.319
	1/10	.400	----	1.026	1.193	1.132	1.048	1.064	.826	----	----	----	.355
	1/20	.418	----	1.045	1.198	1.138	1.048	1.064	.826	----	----	----	.382
Paddy Rice	(500)	.273	----	.832	1.088	1.070	1.027	1.034	.875	.107	.350	.545	.563
Sorghum	1/2	.017	----	.570	.685	.662	.605	.626	.475	----	----	----	.080
	1/5	.044	----	.592	.689	.662	.617	.626	.482	----	----	----	.127
	1/10	.060	----	.604	.697	.666	.617	.626	.486	----	----	----	.148
	1/20	.071	----	.615	.705	.669	.617	.626	.486	----	----	----	.165
Paddy Rice	(75)	.109	.084	.175	.163	.160	.154	.155	.131	.017	.042	.069	.086
Cotton	1/2	.071	.003	.085	.103	.098	.091	.094	.071	----	----	----	.025
	1/5	.075	.006	.089	.103	.098	.092	.094	.072	----	----	----	.030
	1/10	.077	.009	.091	.105	.100	.092	.094	.073	----	----	----	.034
	1/20	.079	.012	.092	.106	.100	.092	.094	.073	----	----	----	.036
Maize (1)	(140)	.204	.176	.091	.064	.110	.126	.118	.059	.031	.079	.128	.179
Cotton	1/2	.132	.005	----	----	----	----	----	----	----	----	----	.046
	1/5	.140	.012	----	----	----	----	----	----	----	----	----	.057
	1/10	.144	.017	----	----	----	----	----	----	----	----	----	.062
	1/20	.147	.022	----	----	----	----	----	----	----	----	----	.067
Plantain	(760)	1.180	1.086	.780	.615	.653	.678	.760	.759	.735	.686	.782	.981
	1/2	.791	.161	.013	----	----	----	----	----	----	----	----	.270
	1/5	.831	.197	.060	----	----	----	----	----	----	----	----	.327
	1/10	.856	.224	.088	----	----	----	----	----	----	----	----	.359
	1/20	.872	.251	.112	----	----	----	----	----	----	----	----	.383
Cacao	(230)	.276	.272	.255	.198	.192	.170	.179	.190	.216	.221	.230	.248
	1/2	.138	----	----	----	----	----	----	----	----	----	----	.030
	1/5	.170	.004	.012	----	----	----	----	----	----	----	----	.048
	1/10	.178	.012	.020	----	----	----	----	----	----	----	----	.057
	1/20	.183	.020	.027	----	----	----	----	----	----	----	----	.065
Tree Crop	(10)	.012	.012	.011	.009	.009	.008	.008	.009	.010	.010	.011	.011
	1/2	.000	0.000	0.000	----	----	----	----	----	----	----	----	.002
	1/5	.002	.001	.001	----	----	----	----	----	----	----	----	.003
	1/10	.008	.001	.001	----	----	----	----	----	----	----	----	.003
	1/20	.009	.002	.002	----	----	----	----	----	----	----	----	.003
Total	(9115)	18.735	14.251	16.035	18.231	18.028	17.356	17.564	14.871	13.313	16.844	17.666	15.491
	1/2	15.046	8.964	9.102	10.933	10.556	9.648	9.987	7.572	6.471	9.539	9.589	8.651
	1/5	15.451	7.233	9.525	10.995	10.556	9.835	9.987	7.692	6.574	9.588	9.589	9.189
	1/10	15.681	7.441	9.736	11.120	10.616	9.835	9.987	7.752	6.574	9.588	9.651	9.496
	1/20	15.815	7.648	9.951	11.244	10.676	9.835	9.987	7.752	6.574	9.638	9.702	9.726

Table I-2-10 (9) Crop Water Requirement

Crop Water Requirement of CASE-II-1 UPPER ZONE (mm/s) Page 1

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Paddy Rice	(1860)	4.180	3.274	3.429	3.872	3.860	3.750	3.804	3.237	3.323	4.004	3.953	3.387
Paddy Rice	1/2	3.368	1.827	1.958	2.404	2.342	2.182	2.286	1.720	1.756	2.486	2.414	2.108
	1/5	3.508	2.087	2.000	2.404	2.342	2.182	2.314	1.748	1.785	2.486	2.457	2.248
	1/10	3.564	2.161	2.070	2.433	2.342	2.182	2.314	1.748	1.785	2.486	2.457	2.322
	1/20	3.621	2.254	2.127	2.433	2.370	2.211	2.314	1.782	1.800	2.514	2.501	2.403
Maize (1)	(700)	.517	.124	.122	.301	.504	.695	.571	.265	.150	.446	.628	.817
Soy beans (2)	1/2	.084	----	----	----	----	----	----	----	----	----	----	.177
	1/5	.158	----	----	----	----	----	----	----	----	----	----	.212
	1/10	.186	----	----	----	----	----	----	----	----	----	----	.237
	1/20	.218	----	----	----	----	----	----	----	----	----	----	.294
Maize (1)	(300)	.155	----	.052	.129	.216	.255	.245	.114	.057	.182	.268	.316
Sorghum	1/2	----	----	----	----	----	----	----	----	----	----	----	.025
	1/5	----	----	----	----	----	----	----	----	----	----	----	.037
	1/10	----	----	----	----	----	----	----	----	----	----	----	.078
	1/20	.007	----	----	----	----	----	----	----	----	----	----	.092
Maize (1)	(215)	.258	.223	.102	.090	.135	.180	.175	.081	.043	.100	.161	.257
Cotton	1/2	.125	----	----	----	----	----	----	----	----	----	----	.048
	1/5	.146	.010	----	----	----	----	----	----	----	----	----	.071
	1/10	.167	.023	----	----	----	----	----	----	----	----	----	.085
	1/20	.186	.040	----	----	----	----	----	----	----	----	----	.097
Plantain	(1060)	1.353	1.254	1.043	.813	.830	.882	1.027	1.028	.820	.832	.883	1.231
Cotton	1/2	.699	.089	----	----	----	----	----	----	----	----	----	.262
	1/5	.812	.202	----	----	----	----	----	----	----	----	----	.370
	1/10	.857	.277	----	----	----	----	----	----	----	----	----	.443
	1/20	.902	.352	.000	----	----	----	----	----	----	----	----	.500
Cacao	(260)	.257	.255	.248	.212	.198	.181	.195	.208	.218	.217	.213	.263
	1/2	.096	----	----	----	----	----	----	----	----	----	----	.010
	1/5	.121	----	----	----	----	----	----	----	----	----	----	.028
	1/10	.135	.015	----	----	----	----	----	----	----	----	----	.055
	1/20	.146	.034	----	----	----	----	----	----	----	----	----	.068
Papaya	(810)	.709	.704	.686	.585	.546	.501	.537	.577	.605	.599	.587	.725
	1/2	.331	.034	.009	----	----	----	----	----	----	----	----	.155
	1/5	.386	.099	.029	----	----	----	----	----	----	----	----	.198
	1/10	.422	.142	.061	----	----	----	----	----	----	----	----	.227
	1/20	.446	.185	.087	----	----	----	----	----	----	----	----	.260
Tree Crop	(10)	.010	.010	.010	.008	.008	.007	.008	.008	.009	.008	.008	.011
	1/2	.004	----	----	----	----	----	----	----	----	----	----	.001
	1/5	.005	0.000	----	----	----	----	----	----	----	----	----	.002
	1/10	.006	.001	----	----	----	----	----	----	----	----	----	.003
	1/20	.006	.002	0.000	----	----	----	----	----	----	----	----	.002
Total	(5015)	7.423	5.845	5.713	6.114	6.316	6.365	6.562	5.520	5.228	6.384	6.711	7.066
	1/2	4.707	2.050	1.967	2.404	2.342	2.182	2.286	1.720	1.756	2.486	2.414	2.725
	1/5	5.152	2.378	2.029	2.404	2.342	2.182	2.314	1.748	1.785	2.486	2.457	3.202
	1/10	5.330	2.622	2.132	2.433	2.342	2.182	2.314	1.748	1.785	2.486	2.457	3.488
	1/20	5.515	2.868	2.217	2.433	2.370	2.211	2.314	1.782	1.800	2.514	2.501	3.727

Table I-2-10 (10) Crop Water Requirement

Crop Water Requirement of CASE-II-1 MIDDLE ZONE (mm/s) Page 1

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Paddy Rice	(6660)	15.075	12.246	12.304	14.844	14.064	13.618	13.626	11.685	12.103	14.884	14.881	11.767
Paddy Rice	1/2	13.868	6.340	7.222	8.228	8.730	8.003	8.191	6.250	6.487	8.458	8.535	8.244
	1/5	14.069	6.386	7.624	8.228	8.730	8.003	8.191	6.250	6.643	8.458	8.639	8.687
	1/10	14.170	6.508	7.775	8.332	8.831	8.003	8.191	6.250	6.643	8.458	8.847	8.948
	1/20	14.220	6.508	7.826	8.332	8.881	8.107	8.191	6.351	6.643	8.560	10.003	9.100
Maize (1)	(1100)	.827	.207	.196	.534	.835	.979	.896	.434	.254	.779	1.139	1.203
Soy beans (2)	1/2	.545	----	----	----	----	----	----	----	----	----	----	.284
	1/5	.582	----	----	----	----	----	----	----	----	----	----	.488
	1/10	.616	----	----	----	----	----	----	----	----	----	----	.548
	1/20	.627	----	----	----	----	----	----	----	----	----	----	.583
Maize (1)	(300)	.226	----	.089	.245	.378	.445	.406	.197	.103	.338	.515	.485
Sorghum	1/2	.101	----	----	----	----	----	----	----	----	----	----	.122
	1/5	.122	----	----	----	----	----	----	----	----	----	----	.170
	1/10	.133	----	----	----	----	----	----	----	----	----	----	.186
	1/20	.138	----	----	----	----	----	----	----	----	----	----	.212
Maize (1)	(125)	.107	.061	.022	.061	.085	.111	.102	.048	.027	.071	.116	.145
Maize (2)	1/2	.105	----	----	----	----	----	----	----	----	----	----	.051
	1/5	.110	----	----	----	----	----	----	----	----	----	----	.063
	1/10	.113	----	----	----	----	----	----	----	----	----	----	.070
	1/20	.114	----	----	----	----	----	----	----	----	----	----	.074
Maize (1)	(215)	.283	.227	.135	.104	.165	.191	.175	.085	.048	.117	.185	.241
Cotton	1/2	.208	----	----	----	----	----	----	----	----	----	----	.081
	1/5	.217	----	----	----	----	----	----	----	----	----	----	.102
	1/10	.221	----	----	----	----	----	----	----	----	----	----	.113
	1/20	.224	----	----	----	----	----	----	----	----	----	----	.120
Plantain	(640)	.832	.803	.643	.554	.529	.564	.621	.647	.598	.559	.622	.732
Cotton	1/2	.668	.001	----	----	----	----	----	----	----	----	----	.254
	1/5	.696	.009	.008	----	----	----	----	----	----	----	----	.316
	1/10	.709	.024	.028	----	----	----	----	----	----	----	----	.350
	1/20	.716	.024	.048	----	----	----	----	----	----	----	----	.370
Cacao	(380)	.382	.393	.371	.349	.305	.278	.285	.318	.345	.352	.359	.380
	1/2	.284	----	----	----	----	----	----	----	----	----	----	.077
	1/5	.301	----	----	----	----	----	----	----	----	----	----	.113
	1/10	.309	----	.006	----	----	----	----	----	----	----	----	.133
	1/20	.313	----	.018	----	----	----	----	----	----	----	----	.146
Papaya	(320)	.378	.382	.367	.346	.302	.275	.282	.315	.342	.348	.355	.357
	1/2	.296	----	.023	----	----	----	----	----	----	----	----	.118
	1/5	.310	----	.050	----	----	----	----	----	----	----	----	.149
	1/10	.317	.002	.060	----	----	----	----	----	----	----	.013	.166
	1/20	.320	.002	.070	----	----	----	----	----	----	----	.024	.176
Total	(9840)	18.122	14.341	14.127	17.035	16.672	16.462	16.387	13.730	13.819	17.460	18.181	15.303
	1/2	16.075	6.342	7.244	8.228	8.730	8.003	8.191	6.250	6.487	8.458	8.535	8.331
	1/5	16.416	6.405	7.682	8.228	8.730	8.003	8.191	6.250	6.643	8.458	8.639	10.099
	1/10	16.587	6.534	7.870	8.332	8.831	8.003	8.191	6.250	6.643	8.458	8.860	10.525
	1/20	16.672	6.534	8.063	8.332	8.881	8.107	8.191	6.351	6.643	8.560	10.027	10.781

Table I-2-10 (11) Crop Water Requirement

Crop Water Requirement of CASE-II-1 LOWER ZONE (mm/m) Page 1

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Paddy Rice	(8550)	15.917	12.458	12.214	14.247	14.015	13.448	13.548	11.465	11.985	14.835	14.969	12.337
Paddy Rice	1/2	10.041	6.795	7.463	8.979	8.670	7.924	8.203	6.219	6.471	9.539	9.599	7.832
	1/5	10.789	7.014	7.760	9.030	8.670	8.078	8.203	6.318	6.574	9.588	9.599	8.278
	1/10	13.937	7.178	7.908	9.133	8.719	8.078	8.203	6.367	6.574	9.588	9.651	8.476
	1/20	14.036	7.343	8.057	9.235	8.769	8.078	8.203	6.367	6.574	9.638	9.702	8.625
Maize (1)	(750)	.670	.161	.139	.340	.592	.676	.633	.292	.178	.549	.825	.937
Soy Beans (2)	1/2	.289	----	----	----	----	----	----	----	----	----	----	.225
	1/5	.329	----	----	----	----	----	----	----	----	----	----	.281
	1/10	.353	----	----	----	----	----	----	----	----	----	----	.313
	1/20	.369	----	----	----	----	----	----	----	----	----	----	.337
Maize (1)	(400)	.219	----	.074	.182	.316	.360	.338	.156	.095	.280	.436	.452
Sorghum	1/2	.014	----	----	----	----	----	----	----	----	----	----	.072
	1/5	.035	----	----	----	----	----	----	----	----	----	----	.102
	1/10	.048	----	----	----	----	----	----	----	----	----	----	.119
	1/20	.057	----	----	----	----	----	----	----	----	----	----	.132
Maize (1)	(110)	.160	.138	.072	.050	.087	.099	.093	.043	.024	.062	.101	.141
Cotton	1/2	.104	.004	----	----	----	----	----	----	----	----	----	.036
	1/5	.110	.008	----	----	----	----	----	----	----	----	----	.045
	1/10	.113	.013	----	----	----	----	----	----	----	----	----	.049
	1/20	.116	.017	----	----	----	----	----	----	----	----	----	.053
Plantain	(810)	1.257	1.157	.845	.655	.696	.720	.814	.809	.784	.731	.834	1.057
Cotton	1/2	.843	.172	.016	----	----	----	----	----	----	----	----	.288
	1/5	.886	.210	.068	----	----	----	----	----	----	----	----	.348
	1/10	.912	.239	.094	----	----	----	----	----	----	----	----	.385
	1/20	.929	.267	.119	----	----	----	----	----	----	----	----	.409
Cacao	(230)	.276	.272	.233	.198	.192	.170	.179	.180	.216	.221	.230	.249
	1/2	.158	----	----	----	----	----	----	----	----	----	----	.030
	1/5	.170	.004	.012	----	----	----	----	----	----	----	----	.048
	1/10	.178	.012	.020	----	----	----	----	----	----	----	----	.057
	1/20	.183	.020	.027	----	----	----	----	----	----	----	----	.065
Tree Crop	(10)	.010	.010	.011	.009	.009	.008	.008	.009	.010	.010	.011	.011
	1/2	.008	0.000	0.000	----	----	----	----	----	----	----	----	.002
	1/5	.008	.001	.001	----	----	----	----	----	----	----	----	.003
	1/10	.008	.001	.001	----	----	----	----	----	----	----	----	.003
	1/20	.009	.002	.002	----	----	----	----	----	----	----	----	.003
Total	(9350)	18.513	14.179	13.598	15.681	15.309	15.484	15.613	12.963	13.293	16.688	17.402	15.183
	1/2	14.857	6.971	7.479	8.979	8.670	7.924	8.203	6.219	6.471	9.539	9.599	8.585
	1/5	15.328	7.237	7.841	9.030	8.670	8.078	8.203	6.318	6.574	9.588	9.599	9.104
	1/10	15.550	7.443	8.022	9.133	8.719	8.078	8.203	6.367	6.574	9.588	9.651	9.401
	1/20	15.698	7.648	8.205	9.235	8.769	8.078	8.203	6.367	6.574	9.638	9.702	9.623

Table I-2-10 (12) Crop Water Requirement

Crop Water Requirement of CASE-II-2 UPPER ZONE (m3/s) Page 1

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Paddy Rice	(580)	1.327	1.070	1.085	1.260	1.224	1.190	1.207	1.027	1.055	1.270	1.254	1.074
Paddy Rice	1/2	1.066	.611	.621	.760	.740	.692	.725	.545	.557	.788	.766	.668
	1/5	1.113	.656	.634	.760	.740	.692	.734	.554	.566	.788	.778	.710
	1/10	1.131	.685	.657	.772	.740	.692	.734	.554	.566	.788	.778	.740
	1/20	1.148	.715	.675	.772	.752	.701	.734	.558	.571	.798	.783	.762
Paddy Rice	(1000)	.758	.178	1.838	2.136	2.075	2.016	2.045	1.741	.215	.637	.898	1.167
Soy beans (2)	1/2	.120	----	1.053	1.282	1.259	1.173	1.229	.924	----	----	----	.136
	1/5	.227	----	1.070	1.282	1.259	1.173	1.244	.940	----	----	----	.302
	1/10	.269	----	1.113	1.308	1.259	1.173	1.244	.940	----	----	----	.367
	1/20	.312	----	1.143	1.308	1.274	1.188	1.244	.947	----	----	----	.420
Paddy Rice	(270)	.122	----	.486	.577	.560	.544	.552	.470	.052	.164	.241	.285
Sorghum	1/2	----	----	.284	.348	.340	.317	.332	.250	----	----	----	.023
	1/5	----	----	.280	.348	.340	.317	.336	.254	----	----	----	.051
	1/10	----	----	.301	.350	.340	.317	.336	.254	----	----	----	.069
	1/20	.006	----	.309	.353	.344	.321	.336	.256	----	----	----	.082
Maize (1)	(630)	.284	----	.110	.271	.463	.535	.513	.238	.120	.383	.562	.664
Sorghum	1/2	----	----	----	----	----	----	----	----	----	----	----	.055
	1/5	----	----	----	----	----	----	----	----	----	----	----	.120
	1/10	----	----	----	----	----	----	----	----	----	----	----	.160
	1/20	.015	----	----	----	----	----	----	----	----	----	----	.194
Maize (1)	(370)	.388	.171	.064	.159	.266	.314	.302	.140	.073	.190	.297	.456
Maize (2)	1/2	.169	----	----	----	----	----	----	----	----	----	----	.097
	1/5	.208	----	----	----	----	----	----	----	----	----	----	.136
	1/10	.224	----	----	----	----	----	----	----	----	----	----	.160
	1/20	.240	----	----	----	----	----	----	----	----	----	----	.180
Maize (1)	(215)	.258	.223	.132	.093	.155	.183	.175	.081	.043	.105	.161	.257
Cotton	1/2	.125	----	----	----	----	----	----	----	----	----	----	.048
	1/5	.148	.010	----	----	----	----	----	----	----	----	----	.071
	1/10	.157	.025	----	----	----	----	----	----	----	----	----	.085
	1/20	.166	.040	----	----	----	----	----	----	----	----	----	.097
Plantain	(1060)	1.355	1.234	1.043	.815	.830	.892	1.027	1.028	.820	.832	.893	1.291
	1/2	.688	.088	----	----	----	----	----	----	----	----	----	.262
	1/5	.812	.202	----	----	----	----	----	----	----	----	----	.375
	1/10	.857	.277	----	----	----	----	----	----	----	----	----	.443
	1/20	.902	.352	.003	----	----	----	----	----	----	----	----	.500
Cacao	(260)	.257	.353	.248	.212	.198	.181	.185	.209	.219	.217	.213	.263
	1/2	.096	----	----	----	----	----	----	----	----	----	----	.010
	1/5	.124	----	----	----	----	----	----	----	----	----	----	.038
	1/10	.135	.015	----	----	----	----	----	----	----	----	----	.055
	1/20	.146	.034	----	----	----	----	----	----	----	----	----	.068
Papaya	(810)	.709	.704	.686	.583	.546	.501	.537	.577	.605	.589	.587	.725
	1/2	.331	.034	.009	----	----	----	----	----	----	----	----	.133
	1/5	.386	.088	.029	----	----	----	----	----	----	----	----	.198
	1/10	.422	.142	.061	----	----	----	----	----	----	----	----	.237
	1/20	.448	.185	.087	----	----	----	----	----	----	----	----	.269

Table I-2-10 (13) Crop Water Requirement

Crop Water Requirement of CASE-II-2 UPPER ZONE (m3/s) Page 2

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tree Crop	(10)	.010	.010	.010	.009	.008	.007	.008	.009	.009	.009	.009	.011
	1/2	.004	----	----	----	----	----	----	----	----	----	----	.001
	1/5	.005	0.000	----	----	----	----	----	----	----	----	----	.002
	1/10	.006	.001	----	----	----	----	----	----	----	----	----	.003
	1/20	.006	.002	0.000	----	----	----	----	----	----	----	----	.003
Total	(5015)	3.457	3.865	3.713	6.114	6.316	6.363	6.562	5.520	3.311	4.406	5.113	6.183
	1/2	2.812	.735	1.987	2.404	2.342	2.182	2.286	1.720	.557	.783	.766	1.481
	1/5	3.033	.867	2.029	2.404	2.342	2.182	2.314	1.748	.566	.783	.775	2.008
	1/10	3.201	1.146	2.132	2.433	2.342	2.182	2.314	1.748	.566	.783	.775	2.313
	1/20	3.380	1.329	2.217	2.433	2.370	2.211	2.314	1.762	.571	.788	.780	2.576

Table I-2-10 (14) Crop Water Requirement

Crop Water Requirement of CASE-II-2 MIDDLE ZONE (m3/s) Page 1

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Paddy Rice	(4230)	9.711	7.386	7.926	5.562	8.059	8.772	8.777	7.527	7.786	8.584	8.582	7.580
Paddy Rice	1/2	8.935	4.084	4.632	5.944	5.623	5.155	5.276	4.026	4.178	6.083	6.142	5.311
	1/5	8.062	4.120	4.911	5.944	5.623	5.155	5.276	4.026	4.278	6.083	6.208	5.602
	1/10	8.127	4.192	5.008	6.011	5.688	5.155	5.276	4.026	4.278	6.083	6.343	5.764
	1/20	8.160	4.192	5.106	6.011	5.721	5.222	5.276	4.091	4.278	6.108	6.443	5.862
Paddy Rice	(2270)	1.781	.446	4.379	5.282	5.005	4.846	4.848	4.108	.548	1.679	2.454	2.597
Soy beans (2)	1/2	1.174	----	3.570	3.284	3.107	2.848	2.915	2.224	----	----	----	.827
	1/5	1.276	----	3.713	3.284	3.107	2.848	2.913	2.224	----	----	----	1.053
	1/10	1.326	----	3.767	3.321	3.142	2.848	2.913	2.224	----	----	----	1.181
	1/20	1.351	----	3.821	3.321	3.160	2.885	2.915	2.260	----	----	----	1.257
Maize (1)	(70)	.053	.013	.012	.024	.053	.062	.057	.028	.016	.050	.072	.077
Soy beans (2)	1/2	.035	----	----	----	----	----	----	----	----	----	----	.024
	1/5	.038	----	----	----	----	----	----	----	----	----	----	.031
	1/10	.039	----	----	----	----	----	----	----	----	----	----	.035
	1/20	.040	----	----	----	----	----	----	----	----	----	----	.037
Maize (1)	(1380)	.632	----	.246	.670	1.047	1.228	1.126	.544	.284	.933	1.420	1.367
Sorghum	1/2	.278	----	----	----	----	----	----	----	----	----	----	.336
	1/5	.338	----	----	----	----	----	----	----	----	----	----	.469
	1/10	.367	----	----	----	----	----	----	----	----	----	----	.542
	1/20	.382	----	----	----	----	----	----	----	----	----	----	.586
Maize (1)	(275)	.301	.105	.049	.134	.209	.245	.224	.108	.059	.157	.255	.318
Maize (2)	1/2	.230	----	----	----	----	----	----	----	----	----	----	.113
	1/5	.242	----	----	----	----	----	----	----	----	----	----	.139
	1/10	.248	----	----	----	----	----	----	----	----	----	----	.154
	1/20	.251	----	----	----	----	----	----	----	----	----	----	.163
Maize (1)	(215)	.262	.227	.135	.104	.162	.191	.175	.085	.046	.117	.186	.241
Cotton	1/2	.208	----	----	----	----	----	----	----	----	----	----	.081
	1/5	.217	----	----	----	----	----	----	----	----	----	----	.102
	1/10	.221	----	----	----	----	----	----	----	----	----	----	.113
	1/20	.224	----	----	----	----	----	----	----	----	----	----	.120
Plantain	(640)	.802	.803	.640	.504	.523	.564	.621	.647	.599	.559	.622	.732
	1/2	.668	.001	----	----	----	----	----	----	----	----	----	.254
	1/5	.696	.009	.008	----	----	----	----	----	----	----	----	.316
	1/10	.709	.024	.028	----	----	----	----	----	----	----	----	.350
	1/20	.716	.024	.048	----	----	----	----	----	----	----	----	.370
Cacao	(330)	.382	.385	.371	.349	.305	.278	.285	.318	.345	.352	.359	.360
	1/2	.284	----	----	----	----	----	----	----	----	----	----	.077
	1/5	.301	----	----	----	----	----	----	----	----	----	----	.113
	1/10	.309	----	.006	----	----	----	----	----	----	----	----	.133
	1/20	.313	----	.018	----	----	----	----	----	----	----	----	.146
Oil Palm	(320)	.321	.332	.312	.294	.257	.234	.240	.268	.291	.297	.302	.303
	1/2	.240	----	----	----	----	----	----	----	----	----	----	.065
	1/5	.253	----	----	----	----	----	----	----	----	----	----	.085
	1/10	.260	----	.005	----	----	----	----	----	----	----	----	.112
	1/20	.263	----	.015	----	----	----	----	----	----	----	----	.123

Table I-2-10 (15) Crop Water Requirement

Crop Water Requirement of CASE-II-2 MIDDLE ZONE (m3/s) Page 2

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total	(9840)	14.275	10.250	14.072	16.983	16.627	16.421	16.353	12.680	8.984	13.737	15.261	13.275
	1/2	12.051	4.086	7.222	8.228	8.730	8.003	8.191	8.250	4.178	8.083	8.142	7.087
	1/5	12.421	4.128	7.632	8.228	8.730	8.003	8.191	8.250	4.278	8.083	8.209	7.921
	1/10	12.607	4.216	7.815	8.332	8.831	8.003	8.191	8.250	4.278	8.083	8.343	8.385
	1/20	12.689	4.216	8.008	8.332	8.881	8.107	8.191	8.351	4.278	8.158	8.443	8.563

Table I-2-10 (16) Crop Water Requirement

Crop Water Requirement of CASE-II-2 LOWER ZONE (m3/s) Page 1

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Paddy Rice	(5120)	12.442	8.723	9.048	11.137	10.955	10.512	10.580	8.962	9.376	11.586	11.701	9.845
Paddy Rice	1/2	10.585	5.311	5.834	7.019	6.777	6.194	6.412	4.861	5.059	7.456	7.504	6.200
	1/5	10.778	5.482	6.066	7.059	6.777	6.314	6.412	4.938	5.138	7.485	7.504	6.471
	1/10	10.695	5.611	6.182	7.139	6.816	6.314	6.412	4.977	5.139	7.495	7.544	6.626
	1/20	10.872	5.708	6.298	7.219	6.854	6.314	6.412	4.977	5.139	7.534	7.584	6.742
Paddy Rice	(1430)	1.263	.307	2.667	3.110	3.060	2.936	2.956	2.503	.342	1.047	1.569	1.787
Soy beans (2)	1/2	.551	----	1.629	1.960	1.893	1.750	1.791	1.358	----	----	----	.429
	1/5	.627	----	1.684	1.972	1.893	1.764	1.791	1.378	----	----	----	.536
	1/10	.673	----	1.727	1.984	1.904	1.764	1.791	1.390	----	----	----	.597
	1/20	.704	----	1.759	2.016	1.914	1.764	1.791	1.390	----	----	----	.643
Maize (1)	(100)	.080	.021	.018	.045	.079	.090	.084	.039	.024	.077	.110	.125
Soy beans (2)	1/2	.039	----	----	----	----	----	----	----	----	----	----	.030
	1/5	.044	----	----	----	----	----	----	----	----	----	----	.037
	1/10	.047	----	----	----	----	----	----	----	----	----	----	.042
	1/20	.049	----	----	----	----	----	----	----	----	----	----	.045
Maize (1)	(980)	.536	----	.181	.445	.773	.883	.828	.382	.209	.685	1.089	1.107
Sorghum	1/2	.034	----	----	----	----	----	----	----	----	----	----	.176
	1/5	.086	----	----	----	----	----	----	----	----	----	----	.250
	1/10	.118	----	----	----	----	----	----	----	----	----	----	.291
	1/20	.139	----	----	----	----	----	----	----	----	----	----	.323
Maize (1)	(70)	.091	.039	.013	.032	.055	.063	.059	.027	.015	.041	.069	.092
Maize (2)	1/2	.056	----	----	----	----	----	----	----	----	----	----	.026
	1/5	.058	----	----	----	----	----	----	----	----	----	----	.031
	1/10	.062	----	----	----	----	----	----	----	----	----	----	.034
	1/20	.063	----	----	----	----	----	----	----	----	----	----	.036
Maize (1)	(110)	.160	.138	.072	.050	.087	.099	.093	.043	.024	.062	.101	.141
Cotton	1/2	.104	.004	----	----	----	----	----	----	----	----	----	.026
	1/5	.110	.008	----	----	----	----	----	----	----	----	----	.045
	1/10	.113	.013	----	----	----	----	----	----	----	----	----	.049
	1/20	.116	.017	----	----	----	----	----	----	----	----	----	.053
Plantain	(810)	1.257	1.157	.845	.655	.686	.723	.814	.809	.784	.731	.834	1.057
	1/2	.843	.172	.016	----	----	----	----	----	----	----	----	.283
	1/5	.886	.210	.068	----	----	----	----	----	----	----	----	.348
	1/10	.912	.228	.094	----	----	----	----	----	----	----	----	.385
	1/20	.928	.247	.119	----	----	----	----	----	----	----	----	.409
Cacao	(230)	.276	.272	.233	.198	.192	.170	.179	.190	.216	.221	.230	.249
	1/2	.158	----	----	----	----	----	----	----	----	----	----	.030
	1/5	.170	.004	.012	----	----	----	----	----	----	----	----	.048
	1/10	.178	.012	.020	----	----	----	----	----	----	----	----	.057
	1/20	.183	.020	.027	----	----	----	----	----	----	----	----	.063
Tree Crop	(10)	.013	.013	.011	.009	.009	.008	.008	.009	.010	.010	.011	.011
	1/2	.008	0.000	0.000	----	----	----	----	----	----	----	----	.002
	1/5	.008	.001	.001	----	----	----	----	----	----	----	----	.003
	1/10	.008	.001	.001	----	----	----	----	----	----	----	----	.003
	1/20	.009	.002	.002	----	----	----	----	----	----	----	----	.003

Table I-2-10 (17) Crop Water Requirement

Crop Water Requirement of CASE-II-2 LOWER ZONE (mm/a) Page 2

Crop (ha)		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total	(8860)	16.149	11.670	13.988	15.681	15.905	15.484	15.613	12.963	11.000	14.467	15.692	14.212
	1/2	12.277	9.487	7.473	8.973	8.870	7.924	8.205	6.218	5.059	7.456	7.504	7.218
	1/5	12.770	9.706	7.841	9.030	8.870	8.078	8.205	6.318	5.139	7.495	7.504	7.768
	1/10	13.008	9.876	8.023	9.133	8.719	8.078	8.205	6.367	5.139	7.495	7.544	8.083
	1/20	13.162	9.045	8.205	9.235	8.769	8.078	8.205	6.367	5.139	7.534	7.584	8.313