FEASIBILITY STUDY

ON

BOHOL IRRIGATION DEVELOPMENT PROJECT

(PHASE II)

IN

THE REPUBLIC OF THE PHILIPPINES

SUPPLEMENTAL REPORT

NOVEMBER, 1985

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MAP OF BOHOL IRRIGATION DEVELOPMENT PROJECT
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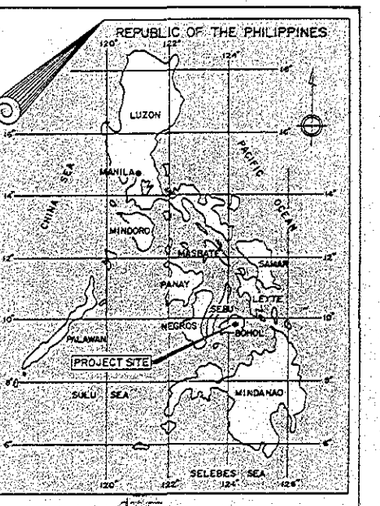


CAMOTE SEA

TALIBON

To JETAFE

BIEM UNIDO

TRINIDAD

UBAY

SOGOD RIVER

TRINIDAD RIVER

PHASE-II AREA

CAPAYAS DAM

SAYANG RIVER

SAN MIGUEL

CAMBANGAY RIVER

BOYONGAN DAM

MAHAYAG

CABATANG RIVER

DELIVERY POINT OF SURPLUS WATER FOR PHASE-II AREA

PHASE-I AREA

DAGOHOY

BATUANAN

To KANDIJAT

WAHIG RIVER

To CARMEN

MALINAO DIVERSION DAM

PILAR

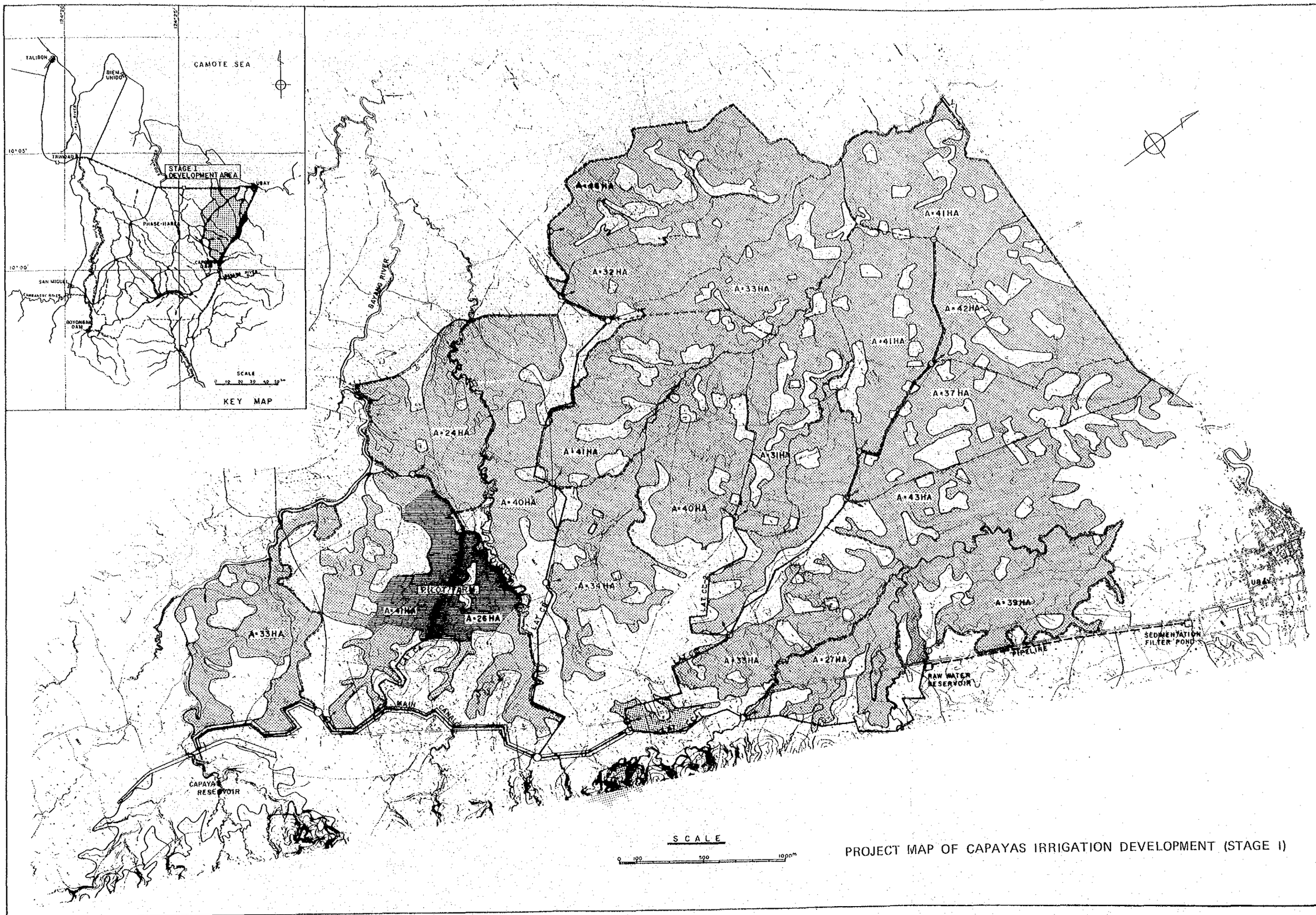
SIERRA BULLONES

PANGLAMAN RIVER

WAHIG RIVER

10°10'
10°05'
10°00'
9°55'
9°50'
9°45'
124°15'
124°20'
124°25'
124°30'

SCALE 0 1.0 2.0 3.0 4.0 5.0 km.



PROJECT MAP OF CAPAYAS IRRIGATION DEVELOPMENT (STAGE I)

OUTLINE OF CAPAYAS IRRIGATION SYSTEM PROJECT (STAGE I)

A. Irrigation Project

1. Project Area	:	Municipality of Ubay
2. Service Area		
Irrigation Area in Wet Season	:	Max. 750 ha (Ave. 620 ha)
Irrigation Area in Dry Season	:	Max. 750 ha (Ave. 700 ha)
Rainfed Upland Crop Area	:	140 ha
3. Reservoir		
Annual Average Runoff	:	10.3 MCM
Drainage Area	:	14.6 sq.km
Reservoir Area	:	0.6 MSM
Full Water Level	:	34.0 m
Low Water Level	:	30.0 m
Total Reservoir Capacity	:	2.3 MCM
Effective Reservoir Capacity	:	1.6 MCM
Dead Reservoir Capacity	:	0.7 MCM
4. Dam		
Dam Type	:	Homogeneous Fill
Dam Height	:	17.0 m
Dam Length	:	1,150 m
Dam Volume	:	0.2 MCM
Intake Discharge	:	Max. 2.13 cu.m/sec
Intake Type	:	Conduit Pipe
Spillway Flood Discharge	:	226 cu.m/sec
Spillway Type	:	Side Channel
5. Canal		
Service Area	:	750 ha
Maximum Canal Capacity	:	2.13 cu.m/sec
Main Canal Length	:	3.3 km
Lateral Canal Length	:	12.5 km
6. On-Farm Development		
Existing Area	:	320 ha
Land Reclamation Area	:	430 ha
Total		750 ha
7. Project Cost		
Foreign Cost	:	68.0 million pesos
Local Cost	:	42.0 million pesos
Total		110.0 million pesos
8. Project Evaluation		
Internal Rate of Return (EIRR)	:	14%

B. Appurtenant Project

1. Pilot Farm	:	32 ha
2. Domestic Water Supply		
Daily Demand	:	340 cu.m/day
Annual Demand	:	0.3 MCM
3. Project Cost		
Foreign Cost	:	45.5 million pesos
Local Cost	:	11.5 million pesos
Total	:	57.0 million pesos

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CHAPTER I. INTRODUCTION

CHAPTER I. INTRODUCTION

The Bohol Irrigation development Project-Phase II is to develop the irrigation service area of 5,300 ha located at the Ubay, San Miguel and Trinidad municiparities in the north-eastern part of Bohol province and its project component consists of two reservoirs, the Bayongan and the Capayas, irrigation canal networks covering the service area of 5,300 ha and the land development works to convert into the paddy field from the grass land and upland areas.

The project has a high potentiality technically and economically as described in the Main Report for the Bohol Irrigation Project-Phase II. However, the project is a large scale one with the project cost of about 660 million Pesos and includes the land development works of about 3,600 ha in the service area. It is recommendable, therefore, that the project implementation will be made by the stage development.

Fortunately, the project has a possibility of the stage development implementing the Capayas system in advance prior to the Bayongan system and this stage development will have the following advantage for the project development.

- The Capayas system is a small scale project with the project cost of about 110 million Pesos and can be implemented with a short period of about two years.

- This early implementation of the Capayas system can irrigate about 750 ha by using the Bayang river water itself and introduce many development models which are useful for the development practice in the whole project area. Namely the method of land development, water management for irrigation, modernized farming practice including farm mechanization etc. could be promoted in the Capayas service area.

- This idea of stage development could make the disbursement schedule of Phase II Project cost easy from the financial viewpoint.

In accordance with the above consideration, the possibility of Capayas system development by utilizing only the Bayang river water without the Bayongan reservoir water has been additionally studied and its report is prepared as the supplemental one in the Feasibility Study on the Bohol Irrigation Development Project-Phase II.

CHAPTER II. PROJECT AREA

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2.1. General Features

The project area covered by the Capayas system is located in the north-eastern corner of the Ubay municipality. The project service area of 1,160 ha lies on the elevation of 25 to 10 m from the south to north direction with undulated hilly topography.

Some small streams flow down from the southern ridge in the project area and join the Soom river which is emptying into the Camotes Sea. The Bayang river which is the water source in the project is the largest tributary of the Soom river and located in the south-eastern corner of the project area.

The depression areas along the streams between hills are presently cultivated as rainfed paddy fields but the higher hilly areas are covered with the grass land.

There are five barangays with households of about 600 and population of about 3,700 in the project service area. About 500 households are farmers engaging in agriculture. Farmers, however, have been placed under poor situation due to several constraints for agriculture such as undulated land, irregular distribution of rainfall, no irrigation water, limited transportation means, insufficient extension services etc.

Ubay is located at the north-eastern corner of the project service area and has administrative and commercial functions to not only the Capayas project area but all service area in Phase II Project having marketing system for agricultural products to Cebu island. Population in Ubay is about 2,300 at present, but will be considerably increased in future due to an agricultural activity in Bohol Irrigation Development Project and a fishery development under promotion by the Bohol provincial government.

2.2. Physical Conditions

a) Water Resources

Annual rainfall in the project area is about 1,750 mm on an average but drops about 1,000 to 1,200 mm in dry year. In addition, monthly rainfall pattern has a big fluctuation which does not meet the water demand of paddy growing. Therefore, the supplemental irrigation water is required to stabilize paddy cultivation.

Bayang river water is only available water resource for the project service area. The river has a catchment area of 13.1 sq.km, a length of 6 km and mean river slope of about 1/60 at the proposed damsite. Annual runoff of the Bayang river is 11.0 MCM on an average year and 7.5 MCM on an average dry year. The runoff, however, appears in July to February and is scarce in March to June.

b) Land Resources

The soil in the project service area belongs to Ubay Soil Series consisting of medium to fine texture mixed with gravel and presenting a high acidic character such as PH value of 4 to 5.

The most of land belongs to class II and III in the land classification category, and presents land slope of two to five percent at the undulated hilly area.

2.3. Present Agriculture

The major crops planted presently in the project service area are rice, cassava and sweet potato. The rice cultivation is prevailing in the depression area along the stream under rainfed and utilizing stream water. The rice harvesting area has been changed considerably year by year in accordance with the rainfall conditions and its cropping intensity ranges from 60 to 70 percent against

available cultivation area. The average yield of rice is also as low as 1.0 to 1.5 ton/ha due to insufficient irrigation water and traditional farming practices.

Upland crops such as cassava and sweet potato are planted at the hilly area under rainfed, and its cropping intensity is only 20 to 30 percent. The yield is also very low as 2.0 ton/ha for sweet potato and 4.7 ton/ha for cassava respectively.

The farm size per household is about 2.5 ha consisting of 0.9 ha in paddy and 1.6 ha in upland crop. Out of about 500 farm households, about 150 farm households are land owner and the remaining one of about 350 is tenant and land-less farmer.

CHAPTER III. PROJECT FORMULATION

CHAPTER III. PROJECT FORMULATION

3.1. Objectives and Components of the Project

a) Objectives

Objectives of the project are to implement the Capayas irrigation system as the Stage I project prior to whole implementation of the Bohol Irrigation Development Project-Phase II and to introduce the development model of irrigated agriculture in the project area. In addition, the project aims at the domestic water supply to Ubay.

b) Project Components

The project component consists of the following development concept to achieve the project objectives mentioned in the above.

- Water resource development by the Capayas reservoir to control the runoff of the Bayang river.

- Land resources development to improve the existing paddy field along the depression area between hills and to reclaim the new land located in hilly area to convert into the paddy field from the existing grass land.

- Irrigation development to supply irrigation water to the service area by providing irrigation networks and to introduce the suitable water operation and management method.

- Irrigated agricultural development to select adaptable cropping pattern and intensity to increase the agricultural productivity and farmer's income.

- Pilot farm to demonstrate the modernized farming practice to the farmer and to provide the agro-processing and marketing model.

- Water supply system for the domestic water supply to Ubay.

3.2. Land Use Plan

The proposed irrigation area in the Capayas system under the full development is 1,160 ha in accordance with the Feasibility Study. However, the area of 1,160 ha will be reduced in the Stage I Project due to limited water resources developed by the Capayas reservoir only without the Bayongan reservoir.

Accordingly, the land use plan in Stage I is made on the basis of the following considerations.

- The service area to be developed in Stage I is studied on the basis of water balance study depending on the available Bayang river water and required water demand in case of introduced cropping intensity.

- The service area should be selected near the Capayas reservoir and the alignment of main canal in order to minimize the construction cost of lateral canals and maintenance roads.

In accordance with the above study, the land use plan is decided as shown in TABLE 3-1.

The boundary of proposed service area in Stage I development is shown in the Project Map.

TABLE 3-1 PRESENT AND PROPOSED LAND USE

(Unit: ha)

Description	Present Land Use	Proposed Land Use					
		Paddy Field	Upland[1/] Field	Gross Land	Coconuts	Others	Total
1. Existing Paddy Field	330	320	-	-	-	10	330
2. Upland Field							
Class I	220	200	-	-	-	20	220
Class II	40	-	40	-	-	-	40
Sub-total	260	200	40	-	-	20	260
3. Grass Land							
Class I	260	230	-	-	-	30	260
Class II, III	110	-	100	-	-	10	110
Class IV	80	-	-	80	-	-	80
Class V	-	-	-	-	-	-	-
Sub-total	450	230	100	80	-	40	450
4. Coconuts & Residence	170	-	-	-	170	-	170
5. Others	20	-	-	-	-	20	20
Total	1,230	750	140	80	170	90	1,230

Note: 1/ : Reinfed field.

3.3. Available Water Resources

The Bayang river water is irrigation water resources for the Capayas system in Stage I and its annual runoff is summarized as follows:

Annual Runoff of Bayang River

(Unit: MCM)

Year	Runoff	Year	Runoff
56-57	14.489	70-71	13.701
57-58	7.736	71-72	11.379
58-59	10.577	72-73	8.585
59-60	10.083	73-74	12.327
60-61	11.402	74-75	12.809
61-62	12.873	75-76	8.881
62-63	13.584	76-77	12.190
63-64	10.672	77-78	9.595
64-65	16.062	78-79	8.438
65-66	9.631	79-80	16.134
66-67	11.868	80-81	10.317
67-68	7.950	81-82	11.484
68-69	9.181	82-83	6.534
69-70	9.609	83-84	9.754
		Average	10.994

Note: Details are shown in TABLE E2-3, Annex E.

Monthly Runoff Pattern of Bayang River

Month	Runoff		Month	Runoff	
	Average Year	Dry Year		Average Year	Dry Year
Jan.	1.08	0.75	Jul.	1.29	1.40
Feb.	0.74	0.32	Aug.	1.00	0.74
Mar.	0.51	0.48	Sep.	1.07	1.04
Apr.	0.34	0.29	Oct.	1.15	0.68
May	0.51	0.34	Nov.	1.19	0.95
Jun.	1.03	0.87	Dec.	1.07	0.82
			Average	10.99	8.68

As shown in the above table, the runoff has a considerable fluctuation in month, so that it should be used for irrigation by the Capayas reservoir's control.

3.4. Irrigation Plan

a) Irrigation Requirements

The irrigation requirements were studied in detail in the Main Report taking into consideration crop water requirements, effective rainfall and irrigation efficiency. The irrigation requirements are summarized as follows;

Monthly Irrigation Requirements

(Unit: mm)

Month	Dry Season Paddy		Wet Season Paddy		Upland Crops	
	Average Year	Dry Year	Average Year	Dry Year	Average Year	Dry Year
Jan.	118.2	170.3	-	-	0	0
Feb.	93.3	143.9	-	-	7.7	61.5
Mar.	42.6	55.8	-	-	73.8	137.3
Apr.	-	-	-	-	0.8	4.3
May	-	-	15.4	17.7	-	-
Jun.	-	-	193.1	207.8	-	-
Jul.	-	-	172.9	193.4	-	-
Aug.	-	-	133.1	173.5	-	-
Sep.	-	-	57.2	90.0	-	-
Oct.	11.4	13.1	11.9	13.3	-	-
Nov.	156.9	173.6	-	-	-	-
Dec.	119.8	156.6	-	-	0	0
Total	542.2	713.3	583.6	695.7	82.3	203.1

b) Domestic Water Requirements

The domestic water requirements for Ubay was studied in detail in the Main Report with the following considerations;

- Population of Ubay will be 3,200 in 20 years later.

- Daily water requirements per capita are estimated as 260 liter, 150 liter for drinking purpose and 110 liter for miscellaneous one.

Annual amount of domestic water will be about 0.3 MCM.

c) Proposed Irrigation Canal System

Proposed irrigation systems for the Capayas system in Stage I covering the irrigation area of 750 ha are shown in diagram as shown in FIGURE 3-1.

Although the design canal capacity to meet the peak irrigation period will be 1.07 cu.m/sec in accordance with the peak water requirements of 1.422 liter/ha, the canal should be designed with the maximum discharge capacity of 1.65 cu.m/sec taking into consideration the full development of the Capayas system with the proposed service area of 1,160 ha.

The water balance study for the Capayas system in the Stage I will be made on the basis of the proposed diagram as shown in FIGURE 3-1.

3.5. Water Balance Study

The water balance studies were made based on the water requirements for the several different cropping intensities and the runoff of the Bayang river.

As the result of water balance study, the most adequate size of irrigation area from viewpoint of available water resources and the operation rule of the reservoir are formulated as indicated below;

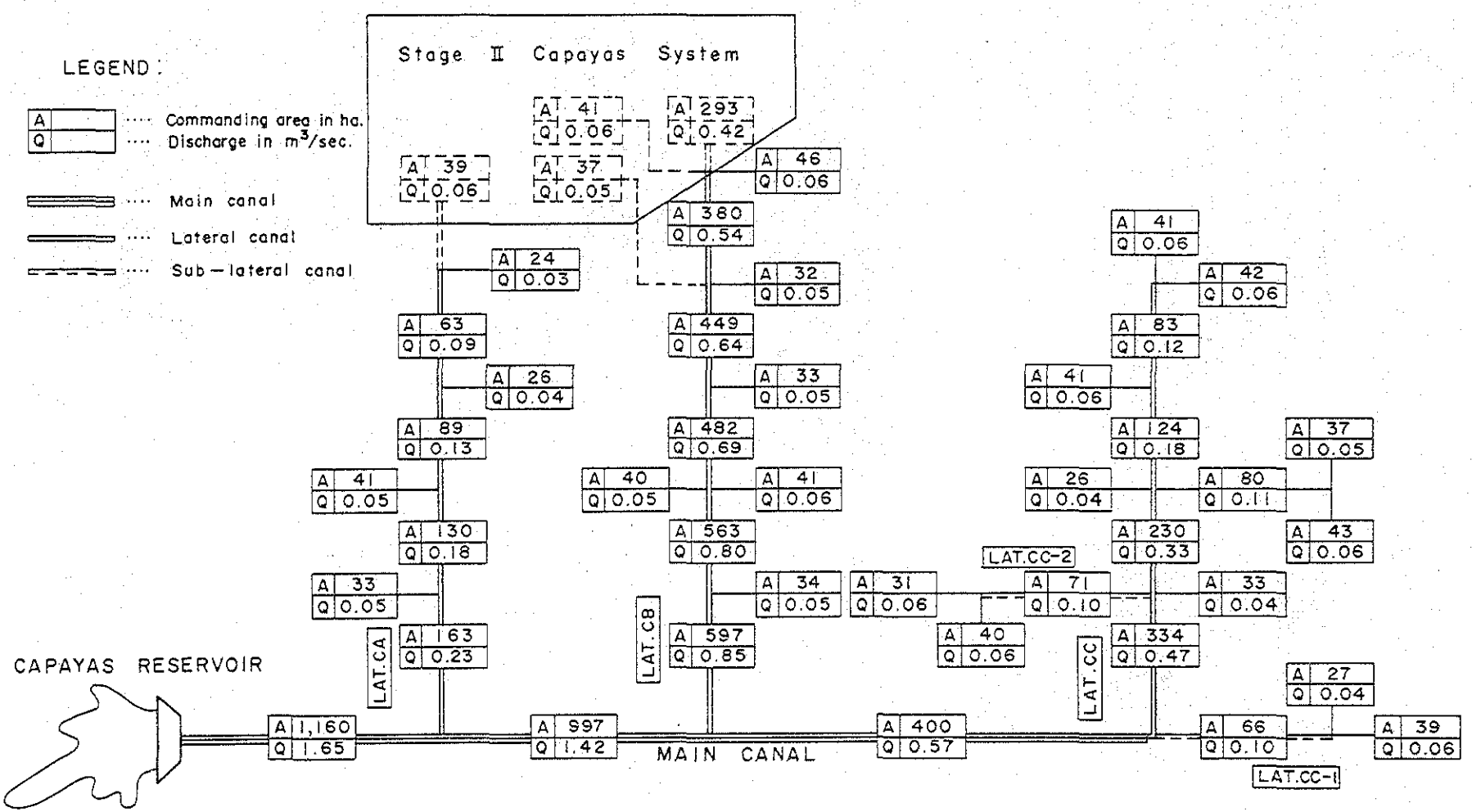


FIGURE 3–1 PROPOSED IRRIGATION DIAGRAM (STAGE I)

a) Proposed Irrigation Area

- In the wet year, the service area of about 750 ha corresponding to 65 percent for the total area of 1,160 ha could be irrigated in both wet and dry seasons.

- In the dry year, the service area of 580 ha for the dry season crop could be irrigated. However the service area for the wet season crops will be reduced as 520 ha to 230 ha depending on the runoff fluctuation of the Bayang river.

b) Reservoir Operation Rule

The reservoir operation rule for the different cropping intensity in the wet and dry years was formulated as follows in accordance with the result of water balance study;

- In case the water level of the Capayas reservoir is the full water level of 34.0 m at the end of October, which is the beginning stage of dry season crop, the area of 750 ha could be fully irrigated. In case the water level is below the full water level of 34.0 m, the irrigation area for dry season crop will be reduced to about 580 ha.

- In case the water level of the reservoir is observed at above 32.5 m at the end of May which is the beginning stage of the wet season paddy, the area of 750 ha could be fully irrigated.

  However, in case the water level of reservoir is below 32.5 m and 31.0 m, the irrigation area for the wet season paddy will be reduced to 520 ha and 230 ha respectively, due to insufficient runoff and reservoir water.

c) Frequency of Water Shortage

The water balance study under the above conditions is presented in Appendix-A. As the result of water balance study, water shortage for dry and wet season crops is four and eight years respectively out of 28 years of studied period as shown in TABLE 3-2, that is, these water shortages correspond to about seven and four years return period respectively, resulting in three years return period on an average.

3.6. Agricultural Plan

The proposed crops to be introduced are rice and upland crops. The upland crops are mungbean, peanut, corn and fruit crops/vegetable as shown in FIGURE 3-2.

Crop productions with and without project are estimated based on the land use and cropping pattern, and presented in TABLE 3-3. In this estimation, average cropping areas corresponding to the return period of about three years on average, which were obtained by the water balance study for 28 years, 1956-1983, as shown in TABLE 3-2, are summarized as follows:

Proposed Cropping Area

Crops	Physical Area (ha)	Cropping Area	
		Wet Year (ha)	Average Year (ha)
Paddy Field (Irrigated)			
Wet Season Paddy	750	750	620
Dry Season Paddy	590	590	550
Upland Field (Irrigated)			
Mungbean	40	40	37
Peanut	40	40	37
Feedgrain (Corn)	40	40	38
Fruit Crops/Vegetable	40	40	38

TABLE 3-2 RESULTS OF WATER BALANCE STUDY FOR 28 YEARS

Year	Cropping Area		Water Shortage		
	Dry Season (ha)	Wet Season (ha)	Dry Season (MCM)	Wet Season (MCM)	Total (MCM)
1956 - 1957	750	750	0	0	0
1957 - 1958	750	520	0	0	0
1958 - 1959	580	750	0	0	0
1959 - 1960	750	750	0	0	0
1960 - 1961	580	750	0	0	0
1961 - 1962	750	750	0	0	0
1962 - 1963	750	750	0	(0.054)	(0.054)
1963 - 1964	750	750	(0.062)	(0.086)	(0.148)
1964 - 1965	750	750	0	0.277	0.277
1965 - 1966	580	750	0	0.222	0.222
1966 - 1967	750	750	0	0.667	0.667
1967 - 1968	750	230	0	0	0
1968 - 1969	750	230	0.753	0	0.753
1969 - 1970	750	520	0	0	0
1970 - 1971	750	750	0	0	0
1971 - 1972	750	230	0	0	0
1972 - 1973	580	230	0.895	0.348	1.243
1973 - 1974	580	750	0	0.153	0.153
1974 - 1975	580	750	0	0.535	0.535
1975 - 1976	750	520	0	0	0
1976 - 1977	580	750	0	0	0
1977 - 1978	750	750	0	0	0
1978 - 1979	750	520	0.152	0	0.152
1979 - 1980	580	750	0	0	0
1980 - 1981	750	520	0	0	0
1981 - 1982	750	750	0	0	0
1982 - 1983	750	230	2.619	0.479	3.098
1983 - 1984	750	750	0	1.845	1.845
Average	700	620	0.160 (4 years)	0.167 (8 years)	0.327 (10 years)

Note: 1/; Figures in parenthesis show an allowable water shortage from view point of plant growth.

2/; Detailed calculation is shown in Appendix. A.

TABLE 3-3 CROP PRODUCTION WITH AND WITHOUT PROJECT
(AVERAGE CROPPING INTENSITY)

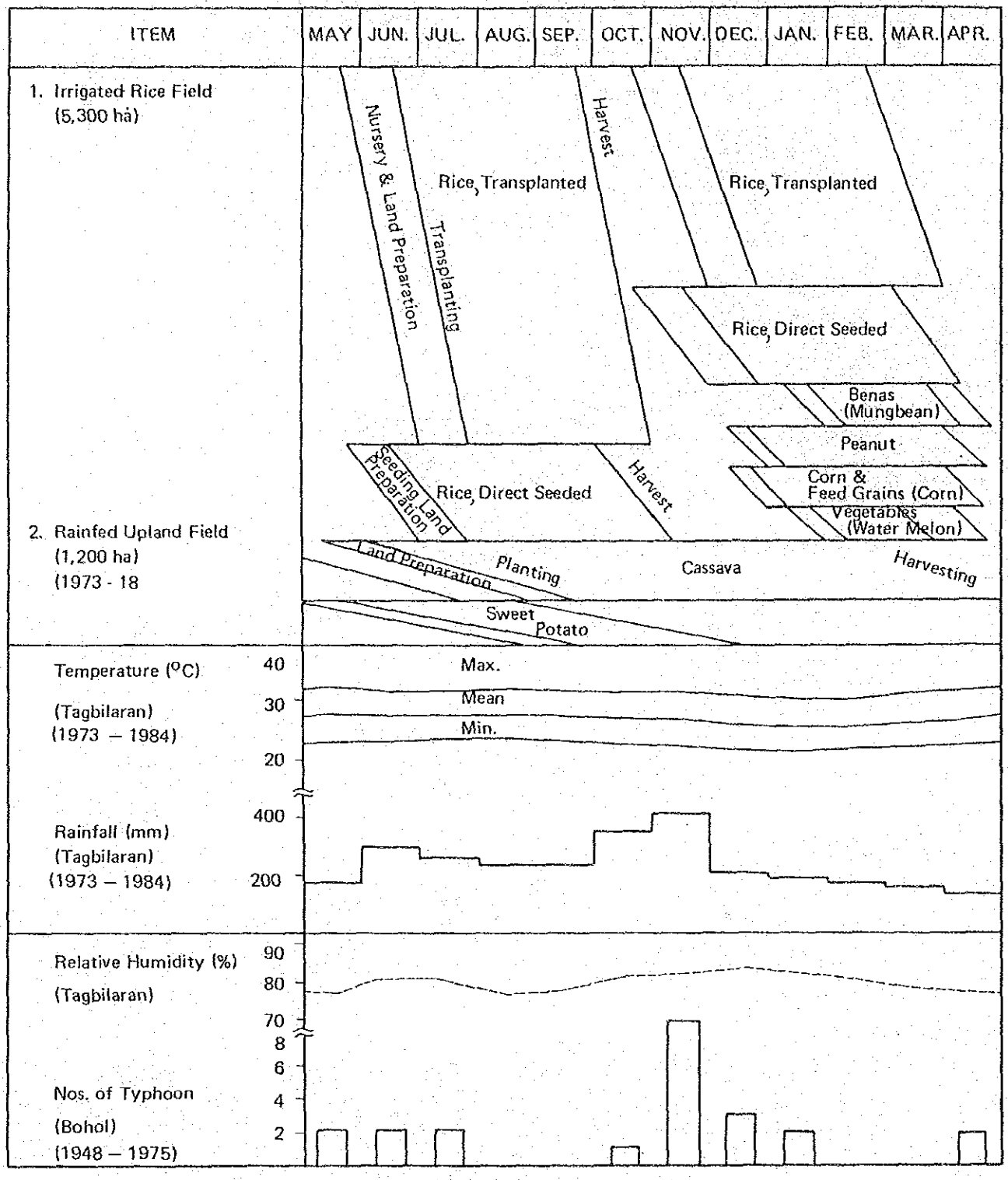
A) With Project

Crops	Area (ha)	Yield (ton/ha)	Production (ton)
1. Paddy Field, Irrigated			
a) Wet Season Paddy	620	4.2	2,604
b) Dry Season Paddy	550	4.5	2,475
Sub-total	1,170		5,079
c) Mungbean	37	1.0	37
d) Peanut	37	1.7	63
e) Feedgrain	38	2.7	103
f) Fruit Crops/Vegetable	38	8.9	338
Sub-total	150		541
2. Upland Field, Rainfed			
a) Cassava	85	14.2	1,207
b) Sweet Potato	55	10.8	594
Sub-total	140		1,801
Total	1,460		7,421

B) Without Project

Crops	Physical Area (ha)	Cropping Intensity (%)	Planted Area (ha)	Harvested Area (ha)	Yield (ton/ha)	Crop Production (ton)
1. Paddy Field	330	165	545	462	1.32	610
a) Wet Season Paddy	-	90	297	252	1.37	345
b) Dry Season Paddy	-	75	248	210	1.26	265
2. Upland Field	260	52	140	140		511
a) Cassava	-	30	85	85	4.71	400
b) Sweet Potato	-	23	55	55	2.02	111
Total	590	115	685	602		1,121

FIGURE 3-2 PROPOSED CROPPING PATTERN



CHAPTER IV. PROJECT FACILITIES

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4.1. Capayas Dam

a) Location, Topography and Geology

The Capayas dam site is selected near the bridge where the existing highway crosses the Bayang river. This site has a possibility to store the maximum capacity of 2.34 MCM at the full water level of 34.0 m. The reservoir area and capacity of the dam is estimated on the basis of map with scale of 1:4,000 as shown in FIGURE 4-1.

The topography of damsite is formed with a narrow river section having the width of about 20 m at the elevation of 21 m and with both bank sections which have a very gentle slope and require a long distance dike of about 1,100 m to store the water.

The reservoir area is surrounded by hills with the elevation of about 100 m and with the catchment area of 13.1 sq.km.

The foundation of damsite is covered with thin overburden with a thickness of two to five meters and consists of consolidated and impervious rock formation of siltstone, sandstone and conglomerate.

In accordance with the geological investigation with three boreholes and six test pits, there is no problem to construct the low height dam presenting the permeability value less than 5 Lugeon in rock formation.

b) Construction Material

Impervious and semi-pervious materials are easily found at the borrow area located on the both banks of damsite and the upstream

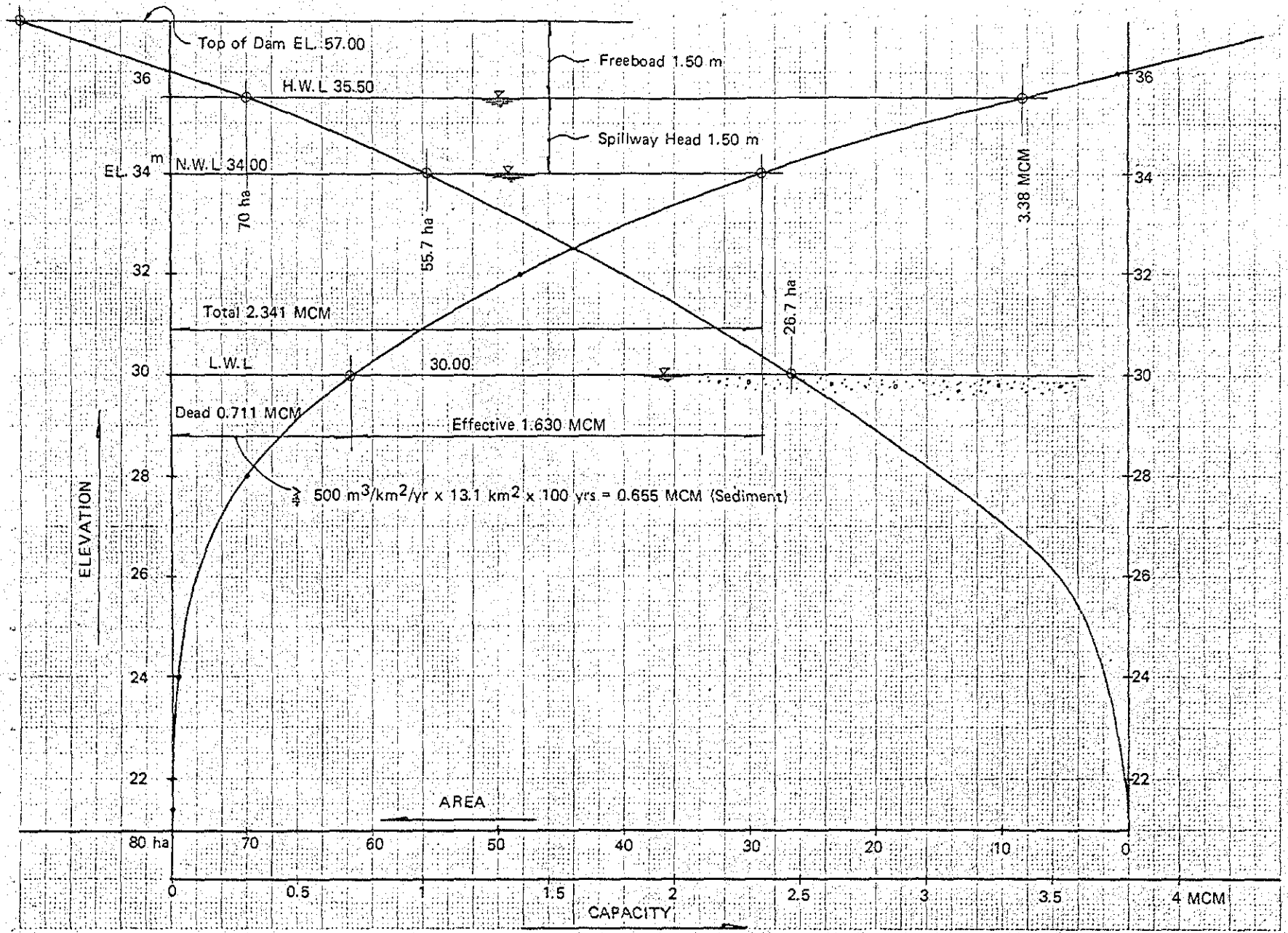


FIGURE 4–1 RESERVOIR AREA AND CAPACITY CURVE (CAPAYAS DAM)

area in the reservoir. The excavated materials at the intake and spillway structure site are also available as the embankment material.

These earth materials mainly consist of sandy clay and silty clay containing moderate weathered rock fragment and gravel, which are the most suitable materials for the earth fill dam.

The filter and concrete aggregate materials will be collected at the Ilaya river and their gradation presents a good distribution curve suitable for the filter material.

The riprap material for the fill dam is taken from the Dagohoy quarry site, where the rock materials for concrete aggregate and riprap material are proposed to be collected in the Malinao dam construction of Phase I Project.

c) Preliminary Design of Dam

- Dam Foundation

The dam base except core trench would be stripped with a depth of 0.5 to one meter to remove a top soil with vegetation and loose surface layer. The excavation of core trench should be extended up to the firm rock formation and its depth is about one meter at the river bed and about five meters at maximum in both banks of damesite. No grouting works to improve the core trench foundation are required because of the consolidated and impervious rock foundation and the low dam with the maximum height of 17 m at the river section.

- Dam Type and Standard Section

The Capayas dam consists of a short section of about 20 m length with a height of 17.0 m in the river bed and a long section of about 1,150 m length of an earth dike with a low height of five to ten meters.

Homogeneous dam type is adopted for the Capayas dam taking into consideration the low height dam and the availability of embankment materials.
The standard section of the dam is shown in DRAWING NO: 2.

- Spillway

The spillway design capacity was estimated at 226 cu.m/sec based on the formula prepared by Bureau of Public Works in the Philippines and checked by Creager formula and considering the surcharge effect in the reservoir area.
In accordance with the design capacity of 226 cu.m/sec and topographical condition at the damsite, the spillway will be placed at the left bank and designed with the non-controlled overflow type with weir length of 60 m and overflow depth of 1.5 m.
The layout of spillway design is shown in DRAWING NO: 5.

- Intake

Intake facility site is selected at the right bank of damsite taking into account the river direction, irrigation canal alignment for the service area and river diversion during construction.

The design discharge capacity is 2.13 cu.m/sec at the maximum to cover the proposed Capayas irrigation system area of 1,160 ha at the full development stage.
The layout of intake facility is shown in DRAWING NO: 4.

- Major Features and Dimension of Dam

In accordance with the reservoir plan and preliminary design of dam, the reservoir and dam dimension are summerized in TABLE 4-1.

4.2. Irrigation Canal

a) Main Canal

The main irrigation canal for the Capayas area starts from the Capayas dam outlet and reaches near Ubay passing through the moderately undulated hilly area having the elevation of 30 m to 25 m. The canal is designed with the discharge capacity of 1.65 cu.m/sec (1.422 liter/sec/ha x 1,160 ha) taking into account the peak irrigation water requirement during the rice growing period. The maximum discharge of 2.13 cu.m/sec which takes place at only 10 days period during the land soaking and preparation period is planned to be released by using the freeboard of the canal in order to economize the canal construction cost.

The main canal of total length of 3.27 km is designed with the concrete lining and with several related structures such as drops, checks, turnout and crossing culverts as shown in DRAWING NO: 7, and its outline is summerized in TABLE 4-2.

Although the Capayas system in the first stage development covers the area of 750 ha, the main canal should be constructed with the canal design capacity of 1.65 cu.m/sec to cover the area of 1,160 ha, because the canal constructed with the small discharge capacity such as 1.65 - 1.0 cu.m/sec does not present much difference in the construction cost and the improvement of the constructed canal to enlarge the discharge capacity requires much construction cost.

TABLE 4-1 OUTLINE OF RESERVOIR AND DAM

Description	Unit	Capayas System
1. General		
Name of Basin		Capayas
Name of River		Bayang
Base Rock Formation		Siltstone, Mudstone, Sandstone & Conglometrate
Catchment Area	sq.km	14.6
Annual Mean Rainfall	mm	2,050
Annual Mean Runoff	MCM	10.99
2. Reservoir		
Reservoir Area	sq.km	0.56
Total Reservoir Capacity	MCM	2.34
Effective Reservoir Capacity	"	1.63
Dead Water Capacity	"	0.71
High Water Level	m	35.50
Full Water Level	"	34.00
Low Water Level	"	30.00
Effective Water Depth	"	4.00
3. Dam		
Dam Type	m	Homogeneous
Dam Height	"	17.00
Dam Length		1,150.00
Dam Crest Width	"	6.00
Dam Crest Elevation	"	37.00
Embankment Volume	1,000 cu.m	233
4. Spillway		
Type		Side Channel
Design Flood Discharge	cu.m/sec	419.1
Design Flood Capacity for Spillway	"	226.0
Overflow Depth	m	1.50
Overflow Length	"	60.0
5. Intake Facilities		
Type		Conduit
Maximum Intake Capacity	cu.m/sec	2.13
Size of Intake	mm	1,300

In the canal with the small discharge capacity, the construction costs for maintenance road, crossing bridge at canal, crossing culvert through streams, drops, side spillway etc. are mostly same even if the design discharge capacity is changed a little.

b) Lateral Canal

The alignment of lateral irrigation canal is selected to place it at the higher place of a hilly area in order to cover the service area as much as possible by the gravity system. Three laterals and one sub-lateral are planned to cover the area of 1,160 ha at the full development stage as shown in FIGURE 3-1, "Irrigation Diagram for Capayas System". Since the irrigation area in the first stage development becomes 750 ha, the downstream canals at the laterals of CA and CB are excluded from the construction in the first stage development.

The lateral canal is designed with the earth canal, because of the small discharge capacity of 1.10 cu.m/sec to 0.3 cu.m/sec and the consolidated and impervious soil foundation along the canal alignment. The layout design of the lateral canal is shown in DRAWING NO: 7 and summerized in TABLE 4-2.

4.3. Land Development

The land development works consisting of the land leveling and preparation of ridges are to be carried out at the hilly area with land slope less than three percent in order to convert into the paddy field from the present upland and grass lands.

Although the size of paddy plot prepared by the land development works varies based on the degree of land slope, the following standard dimension is considered as the optimum size.

TABLE 4-2 OUTLINES OF IRRIGATION CANALS

Description	Unit	Capayas System
Irrigation Area	ha	750
No. of Service Unit	unit	21
Total Length of Canal	km	15.77
Main Canal	"	3.27
Lateral Canal 1/	"	12.52
Canal Density, Total	m/ha	19.00
Main Canal	"	4.36
Lateral Canal 1/	"	16.69
No. of Lateral	line	3
No. of Sub-Lateral	"	1
Maximum Design Discharge		
Main Canal	cu.m/sec.	2.13
Lateral Canal	"	1.10
Canal Gradient		
Main Canal		1/3,000
Lateral Canal 1/		1/3,000 - 1/1,000
Length of Lining Section		
Main Canal	km	3.27
Related Structure		
No. of Head Regulator	place	3
No. of Turnout	"	32
No. of Check	"	10
No. of Drop	"	19
No. of Spillway	"	3
No. of Crossing	"	29
No. of Bridge	"	4
No. of Syphon	"	2
No. of Cross Drain	"	47
Length of O & M Road		
Main Canal	km	2.6
Lateral Canal 1/	"	10.6

Note: 1/; including sub-lateral canal

- The maximum length of a paddy plot along the contour line will be about 100 m.

- The standard width of a paddy plot across the contour line will be 20 m, 10 m wide at the slope of three percent and 30 m wide at the slope less than one percent.

- The maximum different height between the paddy terraces will be 60 cm.

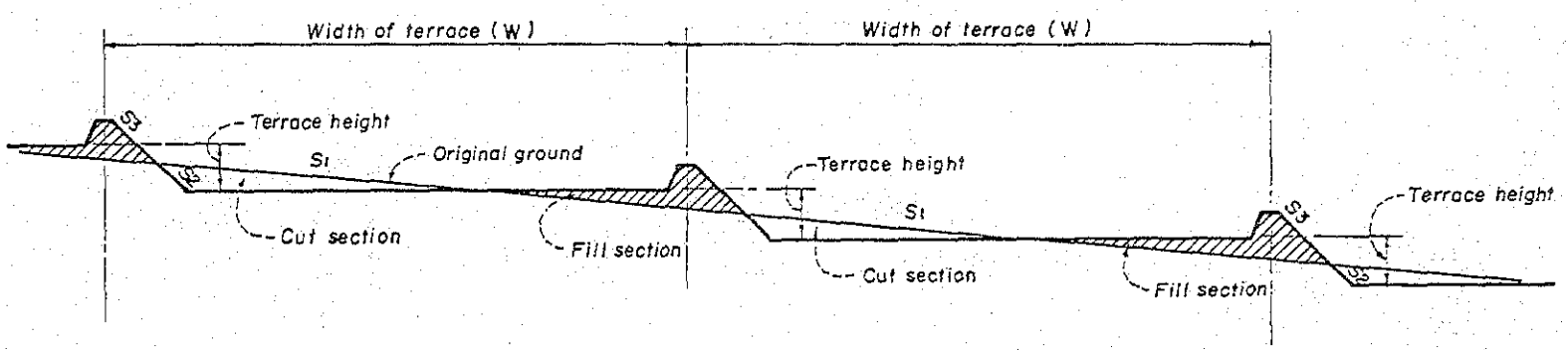
The layout plan of the land development works is shown in FIGURE 4-2.

4.4. On-Farm Development

The on-farm development works are to be carried out by farmer himself at the each farm unit of 20 to 50 ha and include the farm ditches, turnout, diversion box, farm road and other related structures.

In accordance with the study of the on-farm development works in the selected sample area, the facilities with the following scale will be required for the on-farm development;

- Main farm ditches ..... 16.2 m/ha
  Supplementary farm ditches ..... 52.7 m/ha
  Farm drain ..... 55.3 m/ha
  Farm road ..... 50.2 m/ha
  Turnout ..... 1 place/40 ha
  Diversion box ..... 2 - 3 places/40 ha
  Drops ..... 8 places/40 ha
  Road crossing 11 places/40ha



REMARKS:

S1 : Ground slope,(%)

S2 : Cut slope, 1:1

S3 : Raise slope, 1:1

TERRACE DIMENSION AND EARTH WORK VOLUME IN EACH GROUND SLOPE

ITEM	UNIT	GROUND SLOPE IN PERCENT (%)									
		1.0		2.0		3.0		4.0		5.0	
WIDTH OF TERRACE	m	20	30	20	30	10	20	10	20	5	10
HEIGHT OF TERRACE	cm	20	30	40	60	30	60	40	80	5	100
LEVELING WORKS	m^3	250	375	500	750	375	750	500	1,000	625	1,250

FIGURE 4–2 SKETCH AND DIMENSION OF LAND TERRACING

4.5. Project Cost

The project cost is estimated as follows in accordance with the data in the Main Report, and its details are shown in Appendix B.

Project Cost for Irrigation Development

Description	Foreign Currency	Local Currency	Total
1. Construction Cost			
a) Preparatory Works	400	300	700
b) Dam Works	16,900	8,300	25,200
c) Canal Works	7,200	3,700	10,900
d) Land Leveling	1,900	800	2,700
Sub-Total	26,400	13,100	39,500
2. On-farm Development	2,000	1,000	3,000
3. Land Acquisition & Compensation	-	800	800
4. Engineering & Administration	13,700	3,900	17,600
5. O & M Equipment	900	100	1,000
6. Total (1 - 5)	43,000	18,900	61,900
7. Physical Contingencies (15%)	6,400	2,800	9,200
8. Total (6 - 7)	49,000	21,700	71,100
9. Price Escalation	18,600	20,300	38,900
10. Grand Total	68,000	42,000	110,000

CHAPTER V. APPURTENANT PROJECT

CHAPTER V. APPURTENANT PROJECT

5.1. Pilot Farm

The project aims at not only the supply of irrigation water to the Capayas system area but the increase of agricultural production in the area by introduction of modernized farming practices to the farmers.

The Ubay experimental farm of about 2.0 ha had been constructed near the project service area since 1984 and is under operation by the Agricultural Promotion Center (APC) in order to research the most suitable paddy plantation method to increase the paddy production.

The pilot farm, however, would be necessary to present the practical paddy plantation by farmers in accordance with the research result of APC experimental farm and to transfer and demonstrate the farming technology to the service area developed by the irrigation project. In addition, the function for the seed center and the rice mill to serve the project service area would be also required in the pilot farm.

In this connection, the pilot farm with the following facilities is planned and its layout is shown in FIGURE 5-1.

a) Land Preparation

Total area of about 32 ha including the net farm area of 24 ha and the other area of 8 ha for roads, farmer's houses, warehouses etc. will be provided. The farm area is divided into 10 units and each unit consists of paddy area of 2.0 ha and upland area of 0.4 ha.

b) Farmer

Ten farm households are selected mostly from tenants living in the Capayas system area under the regulation of Ministry of Agrarian Reform and newly settled in the pilot farm. These farmers cultivate their farm land under the technical guidance by the extension service staff of APC.

c) Facilities in Pilot Farm

The following facilities are provided in the pilot farm;

- Road; main road with a width of 8 m surrounding the pilot farm and farm roads with width of 4 m between the farm areas.

- Buildings

Items	Building	Remarks
Farmer's Houses (10 units)	1,000 sq.m	Constructed by farmer
Training Center	200	
Machinery Shed.	100	
Warehouse	200	
Rice Mill 11 ton/day	200	
Extension Service Office	100	
Others	-	
Total	1,800	800 sq.m constructed by project

- Agricultural Machinery

Hand Tractor	7 to 8 HP	3 units
Power Thresher	7 to 8 HP	1 "
Pedal Thresher		2 "
Rice Drier	2 ton, 5HP	1 "

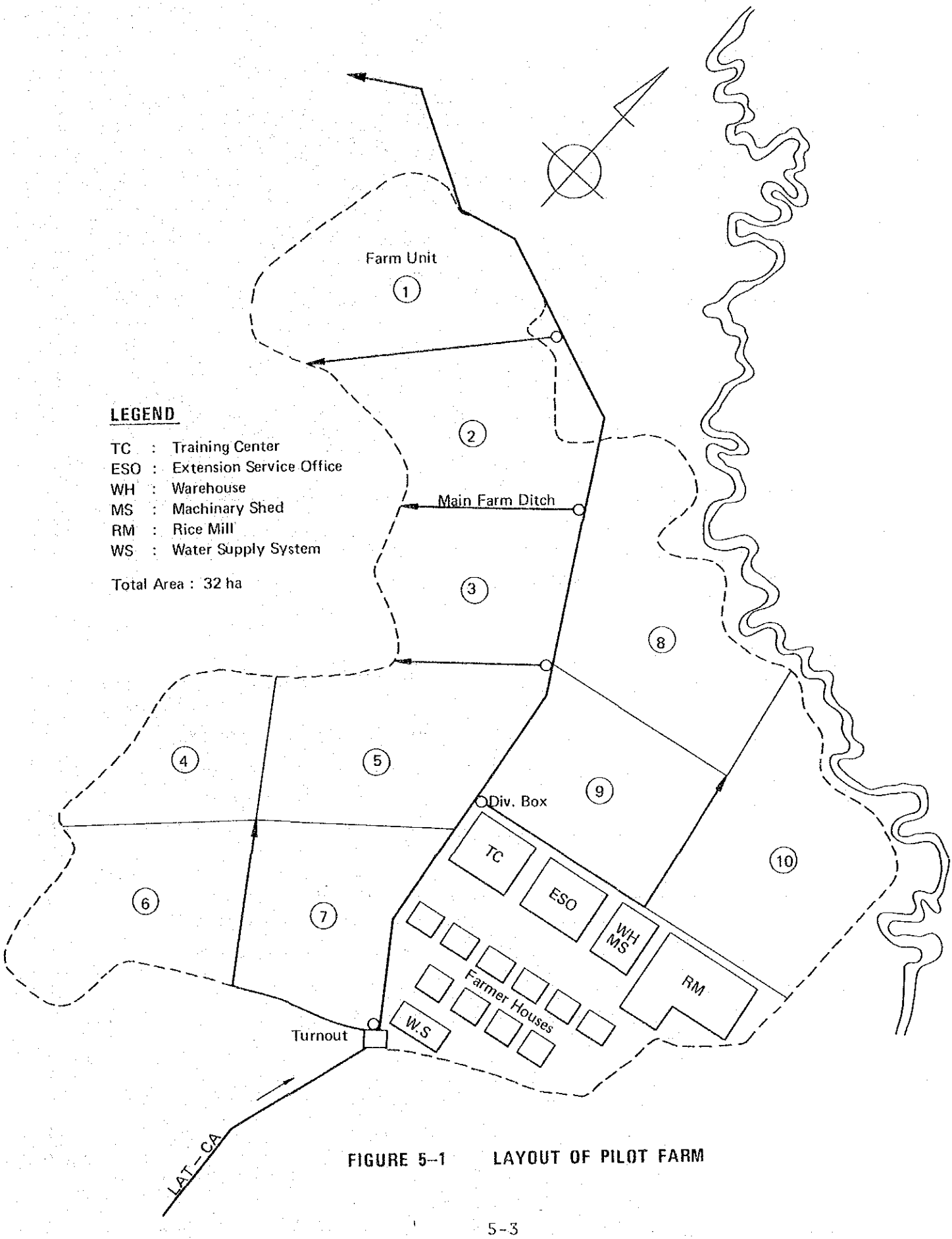


FIGURE 5-1 LAYOUT OF PILOT FARM

- Rice Mill

  The capacity of rice mill is estimated as follows taking into account the project service area of about 620 ha in wet season and 550 ha in dry season.

  Paddy production; 4 ton/ha x 1,170 ha/year = 4,680 ton
  Mill operation period 250 days/year
  Mill capacity (4,680 ton x 0.6 ton)/250 days = 11.0 ton

- Potable Water Facilities; water tank and pipe system with capacity of 10 cu.m/day.

5.2. Domestic Water Supply

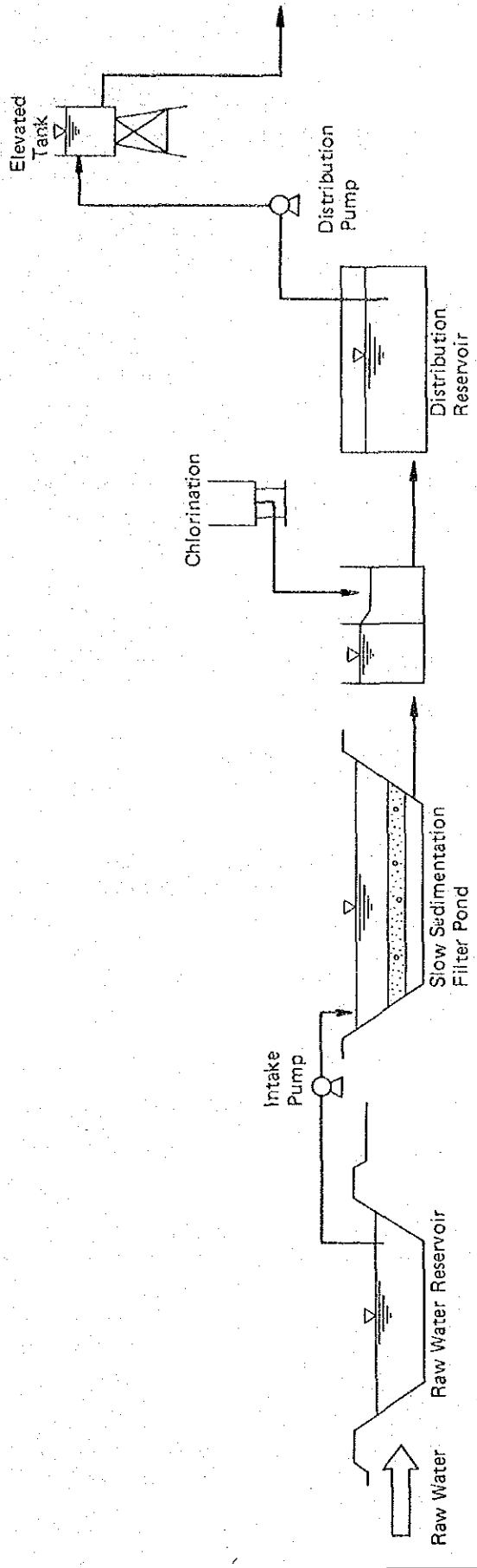
The project could supply the domestic water to Ubay which has been suffered from the quality and quantity of the drinking water for the population of 2,300.

a) Water Supply System

The storaged water in the Capayas reservoir is to be conveyed together with irrigation water by the main canal and lateral canal of CC-1, and then the water is delivered by the pipeline with a length of about 1,600 m to the raw water reservoir provided at Ubay.

The raw water delivered through pipeline is treated at the water treatment plants consisting of the slow sedimentation filter pond, chlorination system, distribution pond and elevated tank and supplied to the consumers.
The layout plan of water supply system is shown in FIGURE 5-2.

FIGURE 5-2 PROPOSED WATER SUPPLY SYSTEM



b) Raw Water Quality

The water quality in the Bayang river is suitable for the drinking water as shown in the following table;

Water Quality of Bayang River

Description		Quality
PH (units)		7.9 - 8.0
Alkalinity	(mg/L as $CaCo_3$)	68 - 118
Chloride	(mg/L)	7.4
Ammonia	(mg/L, N)	0.064 - 0.093
Nitrate	(mg/L, N)	0.024 - 0.016
Phosphate	(mg/L, P)	0.012 - 0.04
Chemical Oxygen Demand	(mg/L)	< 4
Conductivity	(mmhos/cm)	0.0682 - 0.1833
Total Solids	(mg/L)	127 - 171
Total Dissolved Solids	(mg/L)	111 - 152
Total Suspended Solids	(mg/L)	9 - 3

i) Ammonium nitrogen is detectable but its concentration is too low to be hazardous for health.

ii) Chemical oxygen demand more than ten mg/L indicates some organic contamination. This water shows value less than four and has no problem for drinking.

iii) Other analytical items present ordinary value for the drinking water, so that the water will be used for drinking purpose without any particular treatment except chlorination.

c) Water Demand

The water demand for the forecasted 3,200 habitants in Ubay in 20 years later is estimated at about 340 cu.m/day as follows;

- Average water consumption: 80 lit./cap.-day/(1-0.3)
  = 120 lit./cap.-day
- Peak water consumption : 120 lit./cap.-day x 1.25
  = 150 lit./cap.-day
- Services population : 3,200 persons x 0.7
  = 2,240 persons
- Daily Demand : 150 lit. x 2,240 = 336 cu.m/day
  = 340 cu.m/day

d) Facility Planning for Water Supply System

The each facility for water supply system is planned as follows based on the water supply amount of 340 cu.m/day;

- Conveyance Pile
  - Length : L = 1,600 m
  - Capacity : 340 cu.m/day/86,400 = 4.0 lit./sec
- Intake Facility
  - Plain Sedimentation Basin: 340 cu.m/day x 1.1 = 370 cu.m/day
    370 cu.m/day x 2 days = 740 cu.m
  - Pumps : 340 cu.m/day/24 hr = 15 cu.m/hr, 2 units
- Slow Sand Filtration Pond
  - Treatment Capacity : 15 cu.m/hr
  - Size of Pond : 15 cu.m/hr x 24 hr/4.0 m/day = 90 sq.m, 10 m x 10 m x 3 m (depth), 2 ponds
- Distribution Reservoir : 15 cu.m/hr x 6 hr = 90 cu.m
- Distribution Pumps : 15 cu.m/hr x 1.5 (hourly peak factor) = 22.5 cu.m/hr, 2 units
- Elevated Tank : 15 cu.m/hr x 2 hr = 30 cu.m

Layout of water supply facility is shown in DRAWING NO: 17 and NO: 18.

5.3. Project Cost

The project cost for appurtenant project such as pilot farm and domestic water supply system is summerized as follows and its detail is shown in Appendix C.

(Unit: ₱'1000)

Description	F/C	L/C	Total
Construction Cost of Pilot Farm	22,270	3,230	25,500
Construction Cost of Domestic Water Supply System	970	170	1,140
Engineering and Administration Expenses	5,390	1,540	6,930
Land Acquisition Expenses	-	290	290
Contingencies (15%)	4,370	770	5,140
Price Escalation	12,500	5,500	18,000
Total	45,500	11,500	57,000

CHAPTER VI. IMPLEMENTATION PROGRAM

CHAPTER VI. IMPLEMENTATION PROGRAM

6.1. Executing Agency of the Project

The executing agency of the irrigation project is the National Irrigation Administration (NIA), which has a sufficient capability and deep experience in carrying out the detailed design, construction of the project facilities and operation and maintenance of the completed irrigation facilities.

The appurtenant project facilities such as the pilot farm and the domestic water supply system to Ubay would be operated and maintained by the A.P.C and Ubay municipality respectively. However, the project facilities would be constructed by NIA together with other governmental agencies concerned, because APC and Ubay municipality does not have capacity to design and construct the project facilities.

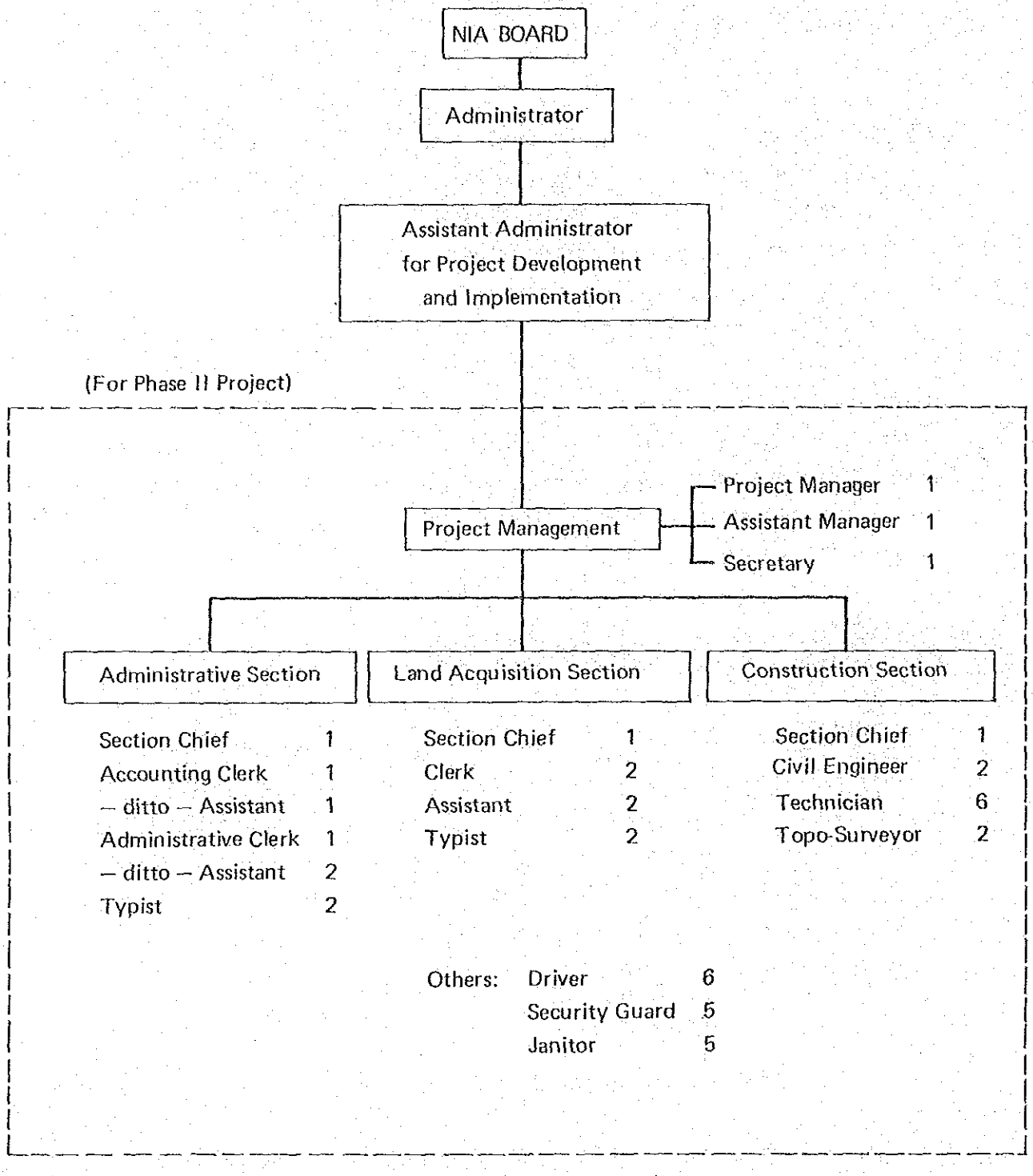
6.2. Design and Construction Mode

The detailed design works will be carried out by recruiting a consulting firm under NIA. On the other hand, the construction works will be made with a competent contractor to be selected by international competitive bidding. The on-farm works will be made by Farmer's Irrigator Association to be newly established in the project service area under the technical guidance by NIA, System Management Department, NIA.

6.3. Administration Office and Consulting Services

The organization of NIA project implementation office is proposed as shown in FIGURE 6-1. The consulting services are required for the detailed design and construction supervision and their total man-month for foreign and local expert is shown in TABLE B-7, Appendix B.

FIGURE 6-1 PROPOSED ORGANIZATION OF PROJECT IMPLEMENTATION



6.4. Operation and Maintenance

a) Irrigation Facilities

Major project facilities consisting of the Capayas dam, main and lateral irrigation canals are operated and maintained by NIA. The principal operation and maintenance works are as follows;

- Preparation of guide line and criteria for the Capayas reservoir operation and the water operation at turnout of the main and lateral canals.

- Water management to release the irrigation water from the lateral turnout to the farm area on the weekly or 10 days basis.

- Water management to release the domestic water to Ubay at the terminal point of the lateral canal CC-1.

- Maintenance of dam and irrigation canals including periodical cleaning and repairing.

The detail of operation and maintenance for the irrigation facilities is described in the Main Report.

b) Pilot Farm

The operation and maintenance of pilot farm is principally made by the farmers themselves. However, the facilities for supporting services such as training center, extension service staff office, rice mill etc. will be operated and maintained by the APC.

c) Domestic Water Supply Facilities

The domestic water supply facilities should be operated and maintained by Ubay municipality. The water charge will be determined taking into account the facility amortization and O/M cost.

6.5. Implementation Schedule

The implementation schedule for the irrigation project and appurtenant project is prepared as shown in FIGURE 6-2. The project will be completed with about two and half years including the detailed design works.

FIGURE 6-2 IMPLEMENTATION PROGRAM FOR THE PROJECT

Description	1985		1986		1987		1988		1989		1990	
	4	8	4	8	4	8	4	8	4	8	4	8
A. Irrigation Development Project												
1. Feasibility Study	▬	▬										
2. Detailed Design												
Consultant Recruitment			▬									
Detailed Design Works					▬	▬						
3. Construction												
Construction Tender						▬						
Dam Works							▬	▬	▬	▬		
Canal Works							▬	▬	▬	▬		
Land Leveling Works								▬	▬	▬		
4. Land Acquisition and Compensation						▬	▬					
5. Project Administration					▬	▬	▬	▬	▬	▬		
B. Appurtenant Project												
1. Detailed Design					▬	▬						
2. Construction												
Pilot Farm								▬	▬	▬		
Domestic Water Supply								▬	▬	▬		

CHAPTER VII. PROJECT EVALUATION

CHAPTER VII. PROJECT EVALUATION

7.1. Project Benefit

The project evaluation is made on the basis of the Capayas irrigation project excluding the appurtenant project.

Project benefits to be created by the project implementation were estimated on the basis of crop products and the raw water benefit for domestic water supply.

a) Crop Production Benefits

Incremental net crop production value is estimated based on the same procedures used in the Chapter VII "Project Evaluation" in the Main Report. Estimated crop benefits are tabulated in TABLE D-2 to TABLE D-6, Appendix D, and they are summarized as shown below;

Incremental Net Production Value (NPV)

(Unit: million pesos)

Without Project	1989	1990	1991	1995	1996	1997
Cross Production Value	2.32	2.33	2.34	2.38	2.39	2.40
Production Cost	0.75	0.76	0.77	0.78	0.78	0.78
N.P.V	1.57	1.57	1.57	1.60	1.61	1.62
With Project						
Gross Production Value	7.89	13.16	14.89	17.90	18.28	18.53
Production Cost	2.95	5.37	5.63	6.61	6.61	6.61
N.P.V	4.94	7.79	9.26	11.29	11.67	11.92
Incremental N.P.V	3.37	6.22	7.69	9.69	10.06	10.30

b) Domestic Water benefits

Annual benefits of the raw water for the domestic water supply would be expected at 1.17 million pesos as discussed in the Main Report.

7.2. Economic Project Cost

Economic project cost for the Capayas Irrigation Project is estimated as follows;

Economic Project Cost

(Unit: million pesos)

Item	Total	1987	1988	1989	1990
Financial Cost	71.1	15.5	29.6	19.1	6.9
Foreign Cost	49.4	11.5	19.9	13.2	4.8
Local Cost	21.7	4.0	9.7	5.9	2.1
Economic Cost	66.8	14.3	27.9	18.1	6.5
Foreign Cost	49.4	11.5	19.9	13.2	4.8
Local Cost	17.4	2.8	8.0	4.9	1.7

Note: Economic operation and maintenance cost is counted at 360 thousand pesos.

7.3. Economic Internal Rate of Return

Economic internal rate of return (EIRR) is computed at 14 percent as shown in TABLE D-10, Appendix D.

CHAPTER VIII. CONCLUSION

CHAPTER VIII. CONCLUSION

In compliance with the recommendation in the Main Report, in which staged development of the Capayas Irrigation Project has been discussed, possibility of staged development of the said project was studied in detail in this Supplementary Report.

As a result, the irrigation project of the Capayas system proves to have the stage development possibility as recommended in the Main Report, presenting a small project cost of 11.5 million pesos, the short implementation period of two and half years, and the economic internal rate of return (EIRR) of 14 percent.

These facts reveal that the stage development of the Capayas Irrigation Project will be economically feasible and technically viable, and early implementation of the Capayas irrigation system covering the area of 750 ha can be recommended as the Stage-I Project, prior to the full development of the Bohol Irrigation Project, Phase II.

The appurtenant project for the pilot farm and the domestic water supply to Ubay will be also recommendable to be implemented together with the Capayas irrigation project in order to introduce the agricultural development model to the farmers in the service area and to supply the domestic water to contribute the Ubay inhabitants.