3.9.3 On-farm Conditions

Small canal networks are provided in the paddy area, although the canal layout is not systematically arranged. Moreover, the location of these small canals is sometimes partially rearranged by the farmers. Most of these canal networks are connected with existing intake structures, such as weirs and pumps. In addition, farmers have installed some parts of these canals in the middle of paddy fields in an attempt to obtain return flow from paddy located in the upstream.

As for the drainage system, very few drainage canals can be seen in paddy. The canal networks mentioned above function as drainage channels. The main drainage system at present is plot to plot as is the irrigation system, and surplus water is drained into the nearest creek or river.

CHAPTER IV

THE PROJECT

CHAPTER IV

THE PROJECT

4.1 Constraints for Development

4.1.1 Present Constraints

(1) Agriculture

Gross cultivated area in the Project area is 7,670ha, of which 86.6% or 6,415ha is presently paddy. Out of total paddy, about 25% or 1,590ha is irrigated, while the remaining 4,825ha is rainfed. Except for those areas under impounding projects, paddy cultivation, in areas irrigated by pump and private weir as well as rainfed, is directly influenced by annual rainfall patterns, and stabilized supply of irrigation water for paddy cultivation in the area is urgently required.

Due to unstable and insufficient irrigation water supply, unit yield in irrigated as well as rainfed areas is low with an average of 2.16t/ha. Yield is especially low in dry season, when cultivation is completely dependent upon rainfall. In addition to the irrigation water deficit, difficulties in obtaining high yield by paddy varieties and the occurence of crop disease and insect infestation inhibit paddy productivity.

Although irrigation water supply conditions are severe as discussed above, present cropping intensity is relatively high at an average of 162%. Intensity is particularly high in the lower area which has a relatively abundant water source where triple paddy cropping is presently practiced. Cultivation of diversified crops after paddy harvest is limited to a small area.

Major crops other than paddy are sugarcane and coconuts. These crops are cultivated because topographical constraints and irrigation water deficit prevent cultivation of other crops. However, if stable irrigation water could be made available, the area could be converted to paddy or other upland crops.

Cultivated area per household is 2.4ha. Almost all households have paddy rather than upland fields. Average annual net reserve per household in the Project area is relatively low because of the low and unstable productivity of paddy. According to the farm economic survey, income of average farm households in the Project area is barely sufficient to maintain a livelihood, and hence inadequate for investment in farm improvements. Consequently, 70% of farm households are dependent on loans from private lenders for farming.

Agricultural support services centering on agricultural extension services in the Project area are comparatively well equipped and are being implemented under the KABSAKA Project. However, organizations to supply production loans and farming materials have not yet been established. Development of irrigation water supply, increased land productivity and stabilization of productivity are therefore urgently required.

(2) Irrigation

Out of 6,415ha of paddy fields in the Project area, about 25% is irrigated. Only the Serruco CIS and KABSAKA projects carry out systematic irrigation covering 532ha or 8.3% of the entire paddy area.

Of the irrigated area, 67% is irrigated by private pumps, weirs and impoundings. These private weirs have deteriorated and are not well maintained causing water stagnation during heavy rainfall. Most irrigation pumps are portable while command area per unit is limited. Impoundings are small-scale and amount to a total of only 19ha in two sites.

Density of rivers in the Project area is high, and the catchment of each river is small, resulting in a low discharge. Some of these rivers tend to dry up in the dry season. Rivers in the Project area are deeply eroded with lowered beds. Accordingly, required dam up height generally involves a high construction cost. Lack of systematic irrigation systems and facilities is thus attributable to the various factors above.

On-farm canals are underdeveloped due to rainfed cultivation and most paddy fields are irrigated by the plot-to-plot method. Drainage conditions in the area are generally good although the Eastern Area is poorly drained due to heavy soil texture.

(3) Roads

National and provincial roads in the area are generally well developed and maintained; however, farm roads are insufficient, especially in the paddy field. Various creeks and drains exist in the area and, despite temporary wooden bridges, the same present obstacles in the transportation of agricultural products. Paddy levees are utilized for passage through the fields.

Roads through paddy remain underdeveloped due to low productivity of land as farmers are reluctant to decrease land area by road construction. Land disposition is another complication as 43% of the area is cultivated by landless farmers. Furthermore, road construction requires a substantial investment from the farmer.

(4) Rural Water Supply

Water in rural areas is mainly supplied by public wells which are installed in barangays. Water supply from these wells is presently insufficient especially in the dry season because of drawdown of the ground water level. Poblacions in and around the area have waterworks systems; however, the supply area is limited. Each waterworks system has an expansion plan, though implementation of the same has been delayed because of difficulties in water source development.

(5) Power Generation and Electrification

The shift to alternative domestic energy sources is particularly being accelerated in the power sector where oil will be displaced mainly by geothermal and hydro (including minihydro) resources.

Presently, electricity is generated by four generators powered by diesel engines (two of which were being overhauled during the survey) of NPC at Dingle and transmitted through Duenasu and Passi to Sara. The distribution of electricity is operated and managed by ILECO II as the cooperative organization. The distribution line however, covers only limited areas along the national road. The proportion of total households in the Project area which are electrified is less than 10%. This low electrification ratio is due to scattered residential area, delay in transmission construction and high electric rates for area residents.

4.1.2 Development Constraints

(1) Insufficient Irrigation Water

The Project area has abundant land resources suitable for paddy cultivation and potential water resources. The present low productivity and low yield are the result of insufficient irrigation water, inadequate irrigation and related facilities, lack of cultivation funds, and incomplete agricultural support services. Of these, insufficient irrigation supply will be the deciding factor in future agricultural development in the area.

(2) Farm to Market Roads

Constraints which suspend development of a road network for agricultural production and marketing are farmers' reluctance to use land for roads due to low productivity of land and farmers' inability to cover construction costs.

(3) Insufficient Post Harvest Facilities

Rice production in the area exceeds local demand and surplus is exported to other areas. Post harvest facilities, however, are insufficient and there is a particular shortage of drying technology and facilities which lowers rice quality and increases loss during milling.

(4) Limited Water Resources

Appropriate water sources for rural water supply in the Project area are limited and the substantial construction cost required for the same inhibits rural water supply development.

(5) Hydropower Generation and Electrification

One constraint to the propagation of electric consumption in the area is delay of electric distribution due to lack of a generation station in the vicinity and the resultant high transmission construction cost. The low annual income of the rural residents limits their capacity to pay for electricity.

4.2 Basic Development Policy

The proposed Project aims to expand agricultural production and thereby increase income of area residents through the introduction of modern agricultural technology and stable year-round irrigation water supply. Furthermore, the Project is intended to promote improvement of living standards of local residents by introducing rural development such as a road network and rural water supply. Employment opportunities in the area will also be increased by implementation of the Project.

To fullfil the above objectives, the main component of the development Plan is irrigation development for 6760ha of agricultural land, mainly rice. This will be achieved through water resources development to provide a stable irrigation water supply and establishment of an irrigation system for effective utilization of water resources. In addition to irrigation development, supplementary components functionally related to the same such as road network development, domestic water supply, hydropower generation and community centers are incorporated into the Project.

A development plan and appropriate scale for each component was determined in accordance with the basic policy discussed above maintaining overall conformity. The Project comprises various components and the implementation scale is large requiring a large investment. A staged development plan to minimize initial investment was therefore studied and an apropriate plan developed in this report. A watershed management program, mainly consisting of reforestation, as an independent scheme to the Project was also roughly formulated to promote soil conservation and prolong reservoir life.

On the basis of the development policy discussed above, development components under the present Project can be broadly divided into two aspects, namely, (i) tangible components which will be economically evaluated in this Study and (ii) intangible components which are indirectly derived from the tangible components and are not economically evaluated.

4.2.1 Tangible Components

Under the present Project, five components were selected as tangible and studied for economic feasibility as follows:

a) Establishment of an agricultural development plan based on improvement and introduction of infrastructural facilities, i.e. irrigation and drainage facilities;

b) Development of a road network in the area effectively utilizing operation and maintenance roads for irrigation facilities;

c) Establishment of a plan for the Integrated Community Center which includes rural water supply and rice drying schemes;

d) Establishment of a plan for domestic water supplementation to the existing Sara Waterworks; and,

e) Development of electric energy by mini-hydropower which utilizes potential head in the irrigation water trans-diversion scheme.

Intangible components which will be studied in relation to the tangible components but excluded from economic feasibility analysis are:

a) Study and preparation of a rough plan for the watershed management program in the Catipayan dam catchment; and,

b) Study and preliminary assessment of the environmental affects in the area which will be produced by the development scheme especially by the construction of a large scale dam.

4.2.2 Basic Policy for Tangible Components

(1) Agricultural Development through Introduction of Infrastructures

Agricultural development through infrastructural improvememt is the main target under the Project.

The infrastructure development plan includes among others, effective and appropriate water resources development plan preparation, systematic and advantageous layout of irrigation and drainage facilities, and irrigation facilities planning in due consideration of effective use of inner basin water resources.

Through the fundamental infrastructures mentioned above, modern agriculture aimed at promotion of modern cultivation technology and heightening of cropping intensity and agricultural production will be more rapidly established. Furthermore in support of modern agricultural technology, an appropriate structure for farmers' organizations as well as agricultural support services and extension services will be provided.

(2) Development of Road Network

Anticipated rice production with Project implementation will triple the present amount. Accordingly, a large labor force and time period will be required for transportation of rice from paddy to the rice mill. On the basis of these conditions, development of a road network effectively utilizing O&M roads for irrigation facilities and also introducing connecting roads is planned.

The proposed road network will also facilitate farming activities, effective utilization of agricultural machinery as well as transportation and movement of rural residents.

(3) Integrated Community Centers

No systematic domestic water supply facilities exist in the rural areas. The Integrated Community Center will provide domestic water supply to rural areas by effectively utilizing the proposed irrigation facilities and community ponds. This will contribute to the improvement of the living environment. In addition, the Center will serve as a gathering place for local residents, becoming the center for rural communication.

In order to expand the functions given to the Center and to heighten the quality of rice and increase production, a rice drying yard was incorporated into the Community Center. Farmers' community centers thus have multipurpose functions including promotion of sports and recreation.

(4) Domestic Water Supply to Sara Waterworks

The proposed Catipayan dam and trans-diversion scheme which is located near the existing Sara domestic water supply pipeline can provide additional advantage to the domestic water supply plan for Sara Waterworks. Accordingly, this domestic water supply scheme was incorporated in the Project thereby increasing the effectiveness of the irrigation facilities.

(5) Hydropower Generation

Potential head which is accrued through the introduction of the trans-diversion scheme will be utilized to generate energy.

The relationships between each component discussed above are presented in FIG. - 2. This figure includes intangible components which are derived from the tangible components.

4.3 Assessment of Water Resources

4.3.1 Basic Policy

The components related to water resources development under the present Project are irrigation, Integrated Community Center, hydropower and domestic water supply. Irrigation is the main project component, while the remainder are considered supplementary. Accordingly, hydropower, Integrated Comunity Center, and rural water supply are planned for inclusion within the irrigation scheme.

Potential rivers for water resources development in the area are the Asue, Gubaton, Serruco, Catipayan and their tributaries. Basic policy for water resources development under the present Project is maximum utilization of water resources in the Asue Basin itself (the term Asue Basin in this report includes the Gubaton River basin) and water resources development in the Catipayan River basin to compensate potential insufficiencies in water supply inside the Asue Basin.

Utilization of water resources inside the irrigation area itself will facilitate effective implementation of Project components and may also allow for staged development of the Project.

FLOW CHART OF PROJECT COMPONENTS

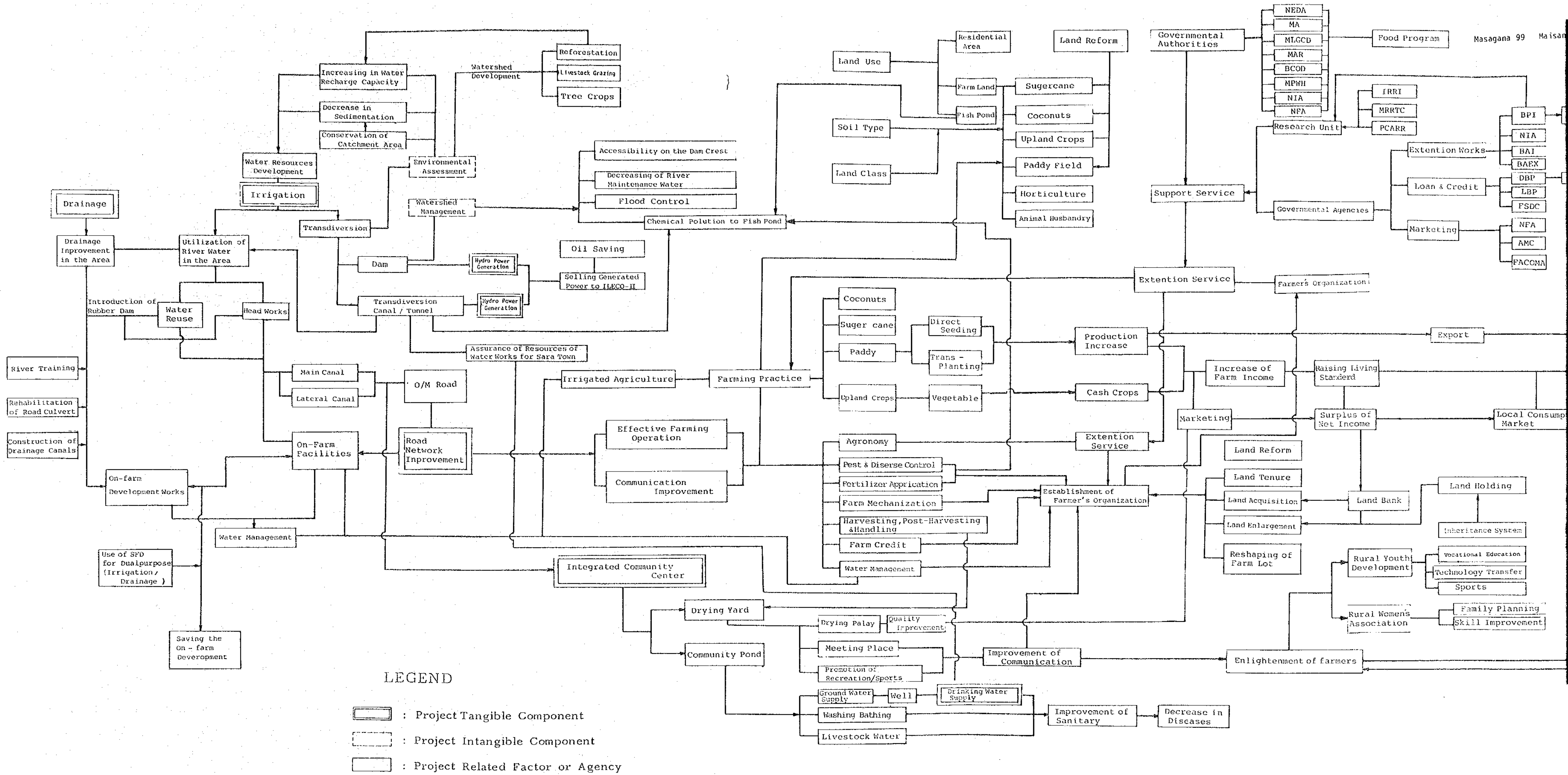
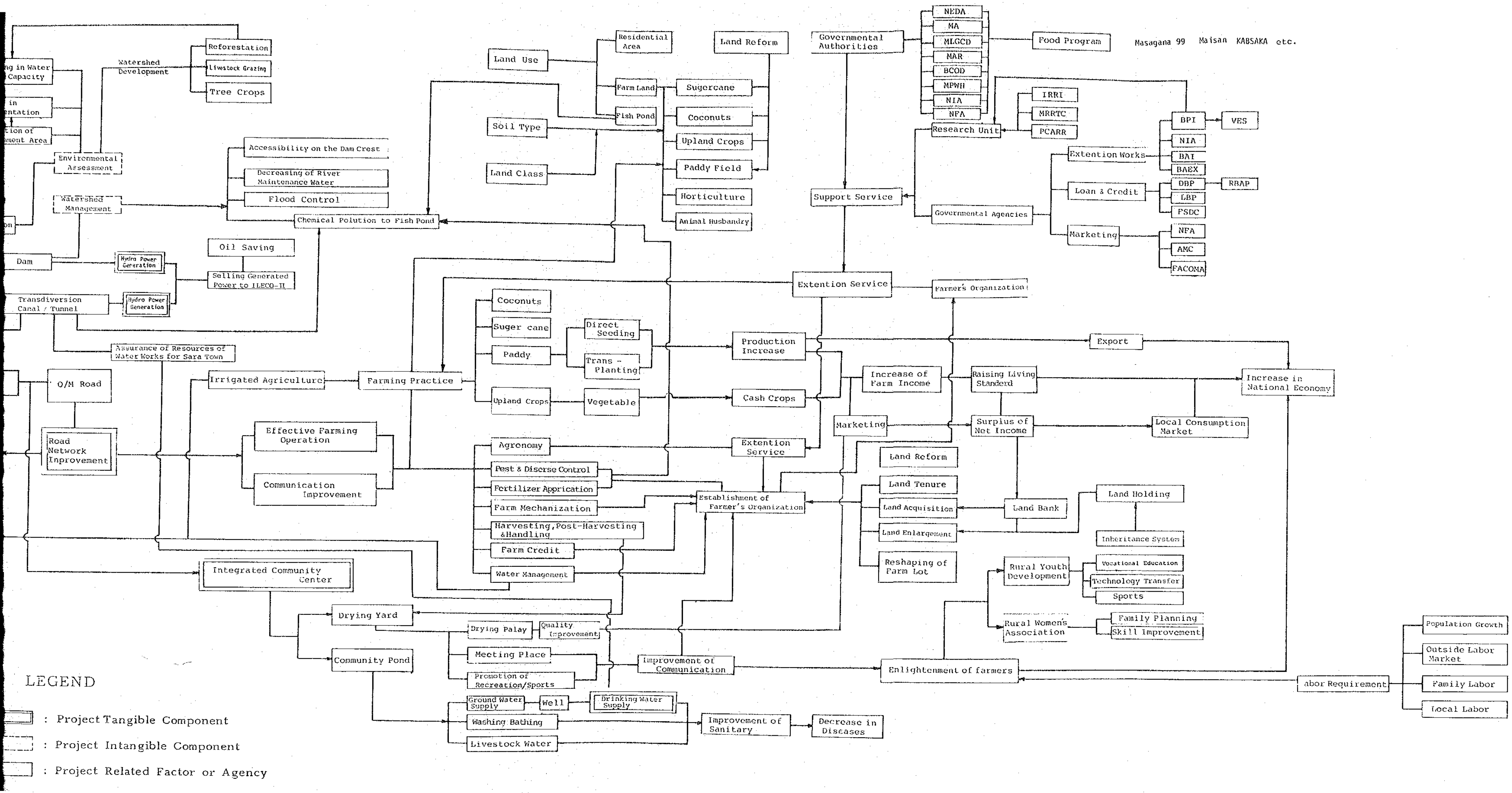


FIG. - 2

FLOW CHART OF PROJECT COMPONENTS



4.3.2 Optimum Development Scale

Based on the above policy, alternatives for water resources development, including the development of the same only inside the Asue Basin, were studied. Alternative study was conducted on the assumption of 200% paddy cultivation. The various alternatives are described below:

Alternative 1: Asue River Diversion Dam Plan

This plan only utilizes water resources inside the Asue Basin and does not include Catipayan basin development. The Asue, Gubaton and Serruco rivers are utilized by construction of diversion dams at appropriate sites.

Alternative 2: Serruco Dam Plan

A storage dam is to be constructed on the Serruco River upstream of the existing CIS diversion dam. This plan also proposes two diversion dams on the Asue and Serruco rivers.

Alternative 3: Asue/Catipayan Plan

In addition to water resources development in the Asue Basin, a storage dam will be constructed on the Catipayan River to supplement insufficiencies.

For Alternative 1, the optimum site for the Asue diversion dam was selected based on the discussions presented hereinafter. The Asue River has a total catchment area of 110km^2 at the mouth of the river; however, the confluence of tributaries is mostly concentrated in the mid to downstream portion, and hence the catchment area in the upstream portion is limited. Based on the relation between the topographically determined irrigable area discussed above and the irrigable area which is determined from the availability of river discharge, the optimum site was determined just downstream of the Padios Creek confluence giving a maximum irrigable area of 1,040ha.

The catchment increases significantly after the confluence of Dahis Creek and the Serruco River. Catchment downstream of the confluence points of Dahis, Padios and Serruco are 54.4km^2, 70.3km^2 and 116.0km^2, while the topographically determined irrigable area at each point is 1,470ha, 1,040ha and 1,000ha, respectively. In addition to the diversion dam at Padios, a diversion dam will be constructed on the Gubaton River. The existing Serruco diversion dam will also be utilized in this alternative.

Alternative 2 proposes a storage dam on the Serruco River in addition to diversion dams on the Asue and Gubaton rivers. In order to maximize the irrigable area, the diversion dam on the Asue River was proposed just downstream of the Dahis Creek confluence. The total irrigable area is 2,780ha, and water shortages in the area will be supplemented from the Serruco storage dam. The required effective storage capacity of the Serruco dam was calculated at 7.6 MCM.

Water resources inside the Asue Basin are insufficient for development of the whole Project area as discussed above. Accordingly, in addition to the Asue Basin, Alternative 3 proposes a storage dam on the Catipayan River to supplement insufficiencies in irrigation water supply by trans-diversion from the Catipayan water source.

Diversion dams will be constructed on the Asue and Gubaton rivers and the existing Serruco diversion dam will effectively utilize water resources inside the Asue Basin. For this plan, an irrigable area of 6,760ha and a required effective storage capacity of 21.2 MCM in the Catipayan reservoir were obtained from the water balance study.

Benefit cost ratio and net incremental benefit for the three alternatives were calculated as in the following table.

	Irrigable Area (ha)	Annual Benefit (₱ 10^6)	Cost (₱ 10^6)	Benefit/ Cost Ratio	Net Incremental Benefit (₱ 10^6)
Alternative 1	1,700	24.4	83.1	2.91	159
Alternative 2	2,780	39.8	339.2	1.16	55
Alternative 3	6,720	101.3	627.5	1.60	377

The B/C of Alternative 1 is the highest of the three. By Alternative 1 development however, only 1,700ha of the 6,760ha of the entire irrigable Project area is benefited. Consequently, development using only Asue Basin water resources is applicable to one quarter of the Project area, thereby creating discrepancies in living standards in the area.

Alternative 2 has the lowest B/C ratio with a relatively small irrigable area of 2,780ha. Another problem with this alternative is construction of the dam on diorite bedrock. Alternative 3 with the Catipayan dam, which irrigates the entire area, was therefore selected as the optimum development plan under the Project.

4.3.3 Optimization of Asue/Catipayan Development

The irrigation system under the present Project is proposed as shown below.

MAIN FEATURES OF THE PROPOSED IRRIGATION SYSTEM

Diversion Dam System	River	Catchment Area (km^2)	Command Area (ha)
Serruco 1/	Serruco	22.9	360
Gubaton	Gubaton	18.8	520
Asue	Asue	13.7	4,650
Bakabak	Asue	116.0	1,000
Catipayan Dam	Catipayan	44.2	190
KABSAKA Area 1/	-	-	40
	Total Area	215.6	6,760

1/ enriched benefit area

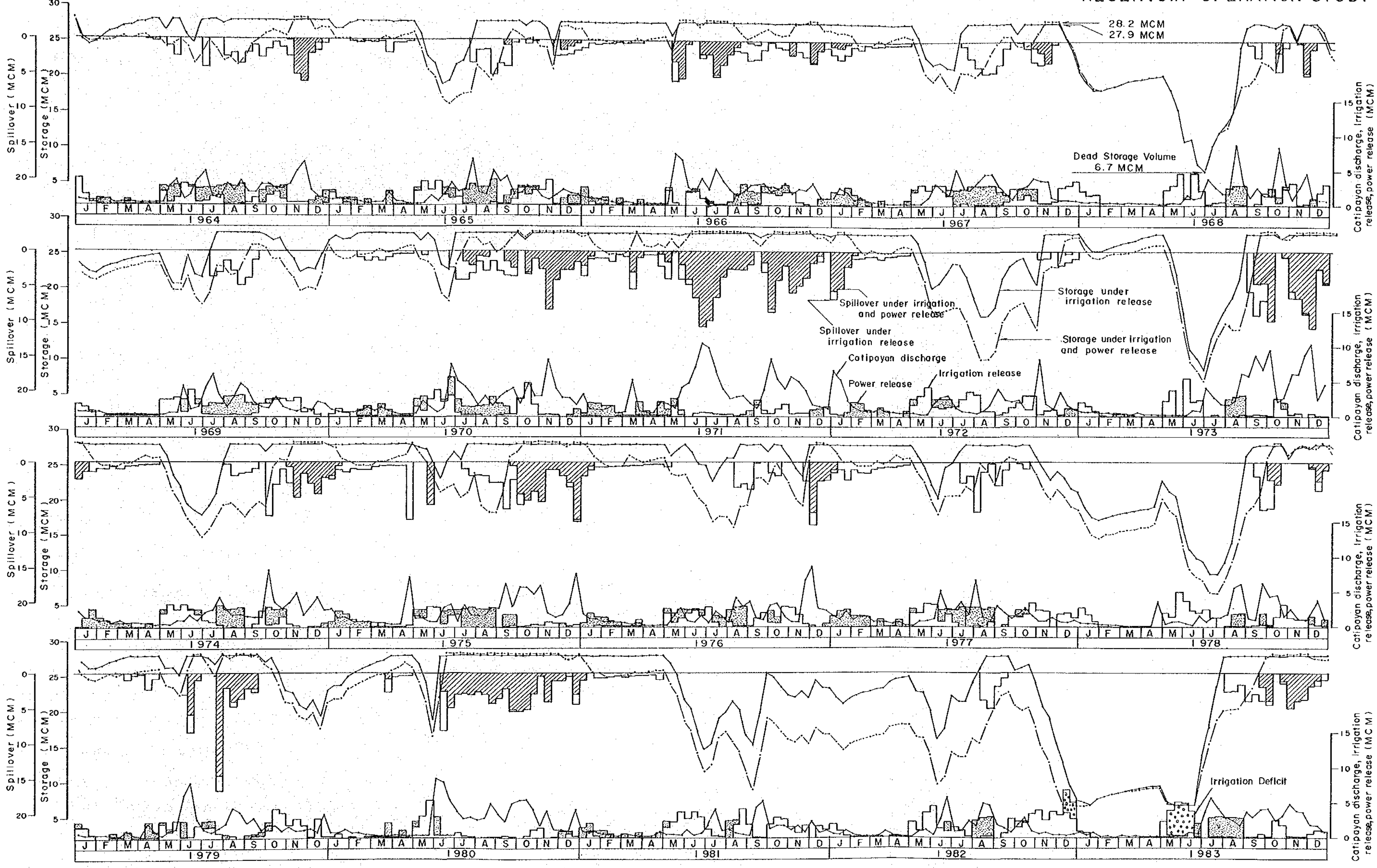
The proposed irrigation system was formulated to supplement water shortages as much as possible by effective utilization of the water resources of the Asue Basin.

The Serruco area is considered as enriched area under the Project, and the same was planned with an independent diversion dam system utilizing the existing diversion dam. This 360ha area was determined on the basis of 200% paddy cultivation with a 5-year return period drought, and no supplementation of water shortage from the other systems is considered. However, surplus water in the Serruco River can be supplied to the Gubaton and Asue South areas through the Serruco right main canal.

Required storage of the Catipayan dam was calculated by water balance study for the 20-year period from 1964-83 with a 10-year return period drought and varying commencement dates for 1st paddy cultivation (FIG. - 3). The standard year i.e. the year with the closest required storage capacity to the probable excessive value of a 10-year return period, varies according to variation in the cropping calendar. A minimum effective storage capacity of 21.2MCM was obtained for the 1st crop cultivation commencement date on May 1st with the standard year of 1968. For the Serruco area, June 1st was selected as the commencement date for 1st cropping from the study for an independent diversion dam scheme. Triple cropping of paddy starting on April 21st is applicable for the Bakabak area on the 10-year return period drought basis without increasing required storage capacity of the proposed Catipayan reservoir.

From the water balance study, the source of irrigation water for each diversion dam system was obtained and is summarized in the following table.

RESERVOIR OPERATION STUDY



SOURCE OF IRRIGATION WATER
(Sep. 1967 - Aug. 1968)

Unit: MCM
: %

Diversion Dam System	Total Diversion Water Requirement Without Rainfall	Rain-fall 1/	River				
			Serruco	Gubaton	Asue	Catipayan	R.F 2/
Serruco System 360ha	7.786 100.0	3.672 47.2	4.114 52.8	-	-	-	-
Gubaton System 520ha	10.852 100.0	5.305 48.9	0.760 7.0	4.301 39.6	-	0.486 4.5	-
Asue System 4,650ha	97.055 100.0	47.439 48.9	0.951 1.0	2.287 2.4	12.771 13.2	33.607 34.5	-
Bakabak System 1,000ha	27.923 100.0	9.900 35.5	-	-	17.047 61.1	-	0.976 3.4
Trans-diversion Direct Turnout 190ha	3.966 100.0	1.938 48.9	-	-	-	2.028 51.1	-
Total (6,720ha)3/	147.582 100.0	68.254 46.2	5.825 3.9	6.588 4.5	29.818 20.2	36.121 24.5	0.976 0.7

1/ includes irrigation loss (actual effective rainfall/irrigation efficiency)
2/ return flow
3/ does not include KABSAKA area

Reservoir operation for the 20-year period from 1964-83 for every 10-day period is presented in FIG. - 3, while detailed results of reservoir operation for the scheme not including domestic water and hydropower release are presented in the DATA BOOK. Major values of reservoir operation are presented below.

20-year average value (MCM)

- Catipayan river discharge (inflow): 72.288
- Rainfall-evaporation in reservoir : 1.034

- Irrigation release : 29.116
  (39,7% of inflow)

- Spillover : 44.205
  (60.3% of inflow)

- Irrigation water deficit : 0.800
  (2.3% of demand)

4.3.4 <u>Hydropower Generation and Rural Water Supply</u>

Hydropower generation and rural water supply under the Project are basically considered as supplementary components, and thus will be subject to the irrigation water diversion and irrigation facilities plan. Accordingly, the hydropower component was planned so as not to interfere with the the given storage capacity of the irrigation diversion plan.

Water which will be used in hydropower generation will be subject to irrigation water requirement. However, in cases where there is surplus water in the reservoir the same will be effectively utilized for hydropower generation. In order to effectively utilize reservoir capacity, the optimum restricted water level i.e. the water level above which reservoir water can be used for hydropower generation will be set monthly. After application of the restricted level, values of 7.4% at the dam site power station and 12.9% at the canal route power station were obtained for additional annual energy.

Rural water supply under the present Project includes water supply to Integrated Community Centers and to the existing Sara Waterworks System. After the study, water supply to Integrated Community Centers will be incorporated in the scope of irrigation water and Asue Basin river discharge. Supplementation from the Catipayan reservoir was proposed only for the Sara Waterworks System. Required supplementation for the said system is estimated at 0.0165 m^3/sec.

Reservoir operation with water release for hydropower generation under the conditions of the above restricted water level and supplementation to Sara Waterworks was studied. A gross storage capacity of 28.2MCM is required considering the water release for Sara Waterworks. Major values of reservoir operation are presented below:

20-year average value (MCM)

- Catipayan river discharge (inflow): 72.288
- Rainfall-evaporation in reservoir : 0.935
- Irrigation release : 29.116 (39,8% of inflow)
- Hydropower release : 20.170 (27.5% of inflow)
- Domestic water deficit : 0.240 (0.3% of inflow)
- Spillover : 24.079 (32.9% of inflow)

As shown above, to allow hydropower release with restricted water level means effective utilization of water which would spill over in the case with irrigation release alone.

4.4 Agricultural Development Plan

4.4.1 Agricultural Development Strategies

Several strategies are planned for the achievement of the Project as follows:

- establishment of suitable year-round irrigation system and stable water supply
- introduction of modern farming methods and enrichment of extension service
- diversification and stabilization of crop production, and increase in cropping intensity and production
- improvement of post-harvest system and other support services

4.4.2 Proposed Land Use

On the basis of present land use, land classification, topographic conditions, and water resources, a net benefit area of 6760ha (irrigated paddy plus diversitied crop area) was determined as the optimum scale. Details are tabulated below.

PROPOSED LAND USE

(Unit: ha)

Land Category	Present Land Use		Proposed Land Use	
Farmland				
Paddy Field	6,320		6,350	
Irrigated		1,590		6,350
Rainfed		4,730		0
Irrigated Diversified Crops	-		410	
Sugarcane	380		0	
Coconut	200		0	
Grassland	220		0	
Right of Way	-		360	
(Subtotal)	(7,120)			(7,120)
Others (Residential area, roads, creeks, etc.)	1,200		1,200	
TOTAL	8,320		8,320	

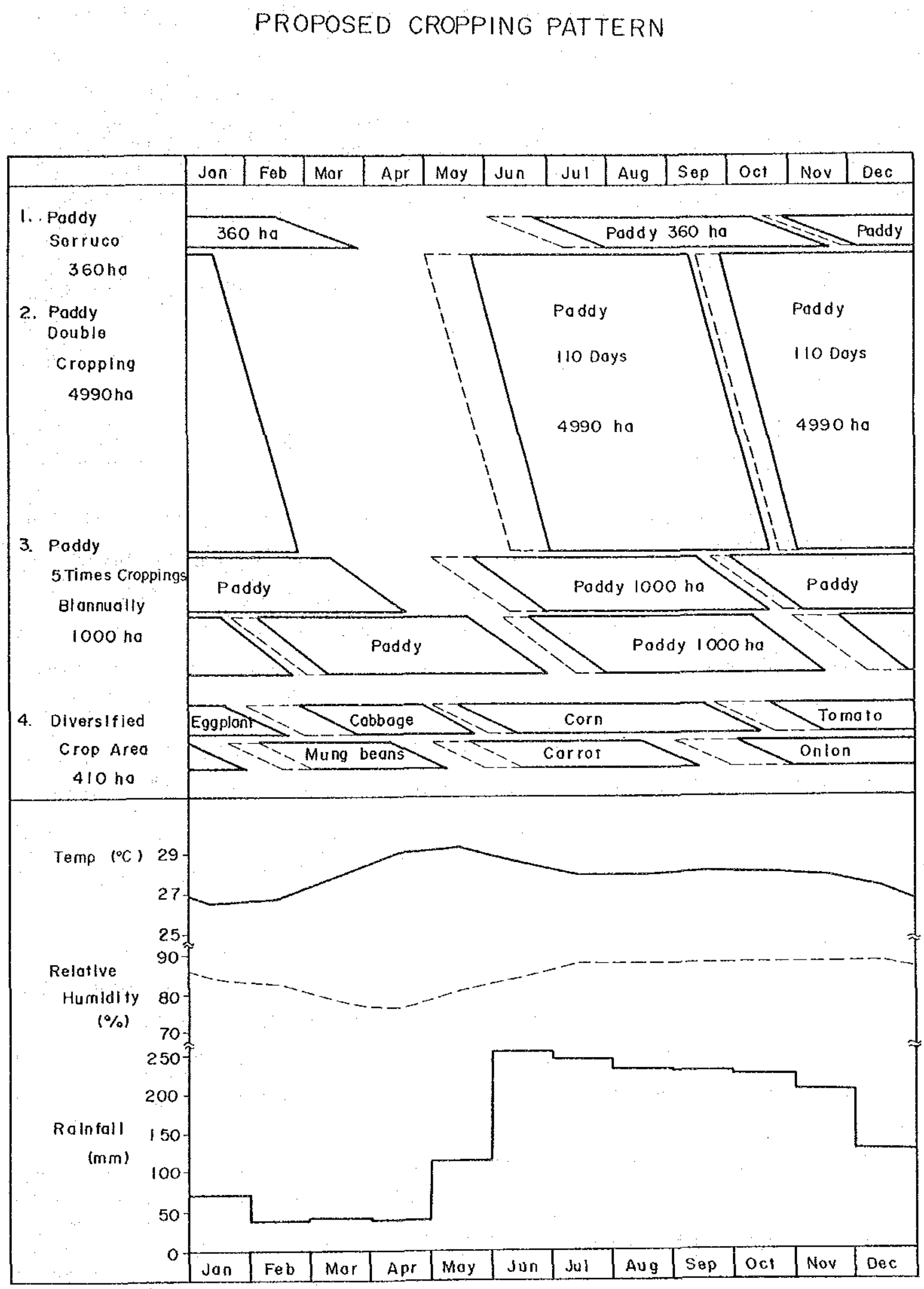
In this Project existing paddy was included as much as possible along with 350ha of existing upland crop area which can be converted to paddy. Total irrigated paddy field is 6,350ha, and 410ha of existing irrigable upland fields is proposed as a diversified crop area mainly for vegetable crops.

4.4.3 Proposed Cropping Pattern and Farming Practices

The cropping pattern was formulated on the basis of meteorological conditions, availability of water resources, agronomic conditions, and available labor force in the Project area as well as at the national level. Paddy was selected as the basic crop and vegetables, corn and mung beans as diversified crops. Paddy cultivation meets the national policy goals of self-sufficiency in food production and provides a source of profitable and stable livelihood for farmers.

The proposed cropping pattern is depicted in FIG. - 4. Double cropping of paddy starts from May in the major area, except for Serruco CIS where 1st cropping starts from June, due to use of a different water source ie. diversion dam without reservoir. In the Asue lower basin, 5 biannual croppings are proposed, as year-round irrigation water is available without dependence on the Catipayan dam reservoir, while in the diversified crop area the rotation of vegetables, corn, mung beans and fallow is proposed.

FIG. - 4


PROPOSED CROPPING PATTERN
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1. Paddy Sarruco 360ha
360 ha
Paddy 360 ha
Paddy
2. Paddy Double Cropping 4990ha
Paddy
110 Days
4990 ha
Paddy
110 Days
4990 ha
3. Paddy 5 Times Croppings Biannually 1000 ha
Paddy
Paddy 1000 ha
Paddy
Paddy
Paddy 1000 ha
4. Diversified Crop Area 410 ha
Eggplant
Cabbage
Corn
Tomato
Mung beans
Carrot
Onion
Temp (°C)
29
27
25
Relative Humidity (%)
90
80
70
Rainfall (mm)
250
200
150
100
50
0

The optimum scale of cropping area is presented in the table below.

CROPPING AREA

Crop	Area (ha)	Cropped Area (ha)	Cropping Intensity (%)
Paddy Irrigated	6350		208
1st		6350	
2nd		6350	
3rd		500	
Diversified Crops Irrigated	410		275
1st		410	
2nd		410	
3rd		308	
	6760	14328	212

Cropping intensities are 208% for paddy, 275% for diversified crops and 212% for the entire Project area. Proposed farming practices are based on the recommendations of BAEx, IRRI, BS, BPI, and PCARR. With respect to crop budget and irrigation water consumption, increased use of the transplanting method is proposed, as transplanting is more profitable than direct seeding.

The projected area rate of direct seeding and transplanting is 60:40 considering the present area rates of 75:25 in the NIA Region VI irrigation system, 50:50 in some areas of Luzon and 93:7 in the Project area.

4.4.4 Future Labor Balance

Future labor balance was analysed with 2000 as the base year. The labor force per household is estimated at 2.8 and the monthly available labor force is 347,180. The present number of draft animals was adopted as future labor balance while the rate of mechanization was estimated as follows:

	Plowing	Harrowing	Furrowing	Leveling	Threshing	Winnowing
Paddy	same as present	100%	–	0%	100%	same as present
Diversified Crops	100%	100%	0%			

After due consideration of the increase in the labor force requirement resulting from the introduction of advanced farming technology and the unit yield increase, labor force requirement per hectare was estimated. The average monthly total labor requirement is 34% of the available labor force. The month with maximum total labor requirement is February at 77% in paddy harvesting season. The monthly draft animal requirement is 4% on average and the maximum is only 17% in October.

Corresponding to the improvement of the farm road network in the Project, existing draft animals should be utilized more fully for transportation.

4.4.5 Anticipated Crop Yield and Production

(1) Crop Yield

The unit yields in future without Project and with Project were anticipated as tabulated below.

ANTICIPATED CROP YIELD

(Unit: t/ha)

		Present	Without Project	With Project
Paddy				
Irrigated	1st	2.59	2.8	4.6
	2nd	2.24	2.5	5.0
	3rd	2.24	2.5	5.0
Rainfed	1st	2.17	2.3	
	2nd	1.80	1.9	
Diversified Crops				
Corn		-		3.5
Mung Beans		-		1.0
Tomato		-		20.0
Cabbage		-		15.0
Onion		-		15.0

The assumed yields of paddy rice without Project represent a 5% increase in present yield for rainfed and a 10% increase in present yields for irrigated area. On the basis of unit yield data for the surrounding irrigation systems of NIA Region and others, the projected yield of paddy is 4.6t/ha for 1st crop and 5.0t/ha for 2nd and 3rd crops. The targeted yields of major diversified crops are 3.5t/ha for corn, 1.0t/ha for mung beans, 20.0t/ha for tomato, 15.0t/ha for cabbage and 15.0t/ha for onion, as shown in the above table.

Paddy production with Project is anticipated at 63,500t/year which is about 2.5 times the estimated production without Project. A post-harvest system for this production increase with minimum loss is discussed under Proposed Support Services. The anticipated production of other crops is shown in the table below.

CROP PRODUCTION IN THE BENEFIT AREA

	W/O Project		W. Project	
	Cropped Area (ha)	Production (t)	Cropped Area (ha)	Production (t)
Paddy	10,155	25,700	13,200	63,500
Irrigated	3,425	11,100	13,200	63,500
Rainfed	6,730	14,600	-	-
Sugar Cane	380	21,600	-	-
Coconut	200	9,600 (Nuts)	-	-
Tomato	-	-	718	12,300
Corn	-	-	205	700
Mung Beans	-	-	205	200

4.4.6 Farmers' Economy

In order to evaluate Project financial feasibility from the aspect of farmers, crop budgets and typical farm budgets were analysed under both with Project and without Project conditions. The maximum net income with Project conditions is ₱30,620 for tomato and the minimum is ₱2,910 for mung beans. The latter is important for said improvement and as a drought resistant crop. The net income of paddy is approximately from ₱4,000 to ₱5,300. The incremental benefit with Project compared to without Project is an average of ₱3,180 for direct seeded paddy and ₱3,540 for transplanted paddy.

4.4.7 Proposed Support Services

Various agricultural development programs at the national and regional levels have been implemented; however the majority of original targets have yet to be achieved. The main reason for this appears to be the lack of sufficient support services for agricultural development. Even after development of an irrigation system, the yield increase can not be realized without farm inputs and agricultural extension. Farmers' credit and a marketing system which is advantageous for farmers are also important for production increase and farm economy.

To achieve the final targets of the Project therefore, not only the implementing agencies but also many other related agencies should be involved in close cooperation.

(1) Agricultural Extension

Agricultural extension activities are essential to the promotion of new irrigation farming methods. Accordingly, the following items are planned.

a) Demonstration area to demonstrate farming technology and to instruct and stimulate farmers;

b) Improvement of transportation for visiting farmers;

c) Instruction of farmers in effective drying of products at the proposed drying yard;

d) Utilization of the proposed ICC for organizing and educating farmers; and,

e) Training of BAEx personnel in i) proper paddy cultivation under a systematic irrigation system, ii) coordination with other related agencies, iii) vegetable cultivation under irrigation, and iv) proper vegetable selection based on fluctuating vegetable marketablity.

(2) Effective Farming Operation

Farm mechanization, as stated in seciton 4.4.4 Future Labor Balance, will be promoted, with Project implementation as it is more effective than use of draft animals. If however, the number of available draft animals remains constant with Project a large surplus will occur as average demand for the same in only 4% and peak demand (in October) is 17%. Surplns draft animals can be utilized for transportation of farm inputs and produce with improvements in the farm road network under the Project. This will facilitate effective farm operation. To implement the same, proper instruction of farmers by BAEx staff will be required.

(3) Post-Harvest Facilities

The shortage of drying facilities for paddy, however, is a serious problem especially after harvesting in the rainy season. This situation results in substantial loss and decreased quality. Drying systems were studied and the optimum method was determined to be use of dry yards. The size and amount of the same were determined as follows:

Drying yard	12 x 24m
Number	151; one drying yard in each tertiary block

The capacity of existing rice mill facilities which are all private is estimated at 20,000t/year. With the production increase expected under the Project, capacity shortage is estimated at approximately 4,300t and expansion of rice mill facilities is urgently required.

If farmers' organizations operate rice mills, farmers themselves receive substantial benefit. However, since there are no functioning farmers' organizations, and thus no implementing agency, inclusion of a rice milling system as a component of the Project is difficult. Rice milling by the private sector to handle increased production should therefore be promoted.

(4) Farming Materials and Farmers' Loan Supply

Fertilizer supply is insufficient and this shortage may become more serious with demand increase. At the same time, existing farmers' loans are not easily available. Supply of farm inputs and farmers' loans by farmers' cooperatives would thus directly benefit farmers. MAF is presently aiming toward development of the cooperative system, as described hereunder.

4.4.8 Farmers' Associations and Cooperatives

For effective implementation and expansion of the Project, farmers' cooperatives are essential. MAF is presently reactivating Samahang Nayons; however, farmers' associations in the Project area are non-existant and organization of new cooperatives is difficult.

Instead, Irrigators' Associations (IA) will be organized to operate and maintain Project irrigation facilities. As Samahang Nayon are fundamentally a group of IAs, they will be organized and strengthened through project implementation. Simultaneously, the farmers' economy will be improved through irrigated farming under the Project, allowing farmers more time to work for farmers' associations. Thus establishment of farmers cooperatives after project implementation is recommended as the most appropriate time.

4.5 Irrigation and Drainage Plan

4.5.1 Basic Irrigation Plan Concept

A gravity irrigation system is proposed for the irrigation development plan of paddy in the Project area. The following measures for specific conditions are also considered in the irrigation plan.

(1) Diversion Dams

In order to reduce the required reservoir capacity in the Catipayan River, river flow and return flow in the irrigation area should be utilized as much as possible by constructing new diversion dams together with the existing Serruco diversion dam. Consequently, the following three diversion dams are proposed.

1) Asue diversion dam

In order to intake the diverted water from the Catipayan reservoir, the Asue diversion dam is proposed in Barangay Aguirre in the upstream Asue River. The Asue diversion dam can also intake water from the Asue catchment area. The location was decided among three alternative sites, on the basis of comparison and subsequent layout of the main canal.

2) Gubaton diversion dam

In order to cover a wider area, the Gubaton diversion dam site was selected to cover the upstream portion of the existing paddy area. Also, in order to supply surplus water to the Asue Area, the diversion site was located at elevation 17.5m.

3) Bakabak diversion dam

The diversion dam can utilize not only return flow from the upstream area but also flow from its own catchment in the Asue River. The location of the diversion dam site was considered in terms of the ratio of catchment area and topographically commandable area in order to utilize the available river flow as effectively as possible.

Consequently, the location was selected just downstream of the Serruco River confluence. All three diversion dams are proposed as automatic collapsable types, such as rubber dams, to avoid backwater effect in the upstream area during flooding.

(2) Interlinkage of the Main Canal

The proposed diversion dams or main canals should be interlinked with the Asue main canal to supplement the irrigation water deficit from the Catipayan reservoir. Moreover, the proposed main canals should be interlinked with each other to supply excess water when available. The Asue main canal leading from the Asue diversion dam will be extended to the Serruco and Gubaton irrigation area so as to supplement irrigation water to these areas when available river flow is insufficient.

In order to utilize river flow, diversion canals have been proposed in the Serruco right main canal and the Gubaton main canal. The diversion canals have been interlinked with the Asue main canal, so that mutual support systems among water supply networks will be established among the available water resources.

(3) Enriched Benefit Area

As for the existing Serruco Communal Irrigation System, about 400ha cannot be supplied with irrigation water from the Catipayan River. However, the lower portion (about 300ha), where the irrigation facilities are incomplete, can be covered by the Asue main canal. The upper 400ha can thus utilize Serruco River flow more intensively than in the original plan. In addition, on-farm development and extension services of the direct irrigation area can be performed in the upper 400ha. The area is, therefore, included as enriched benefit area.

Similar conditions have been considered for the KABSAKA Water Impounding Projects. The related projects are Castor WIP, Moto WIP and Bondolan WIP.

4.5.2 Irrigation Plan

(1) Design Water Requirements

1) Water requirements

Consumptive use

Data on daily pan evaporation were available at Barangay Aguirre from 1979 to 1984. The consumptive use for paddy was taken as 80% of the pan evaporation.

In order to find the maximum consumptive use for various durations, the analysis of maximum evaporations for one to 60-day durations was made with the observed data. The maximum consumptive use is 8.4mm/day for a 1-day duration decreasing to 5.8mm/day for a 60-day duration.

Considering the irrigation command area for each type of canal, the capacities for the quarternary and tertiary canals were decided on the basis of maximum daily consumptive use while the secondary canal capacities were decided on the basis of the maximum 10-day average value and main canal capacities were based on the maximum average consumptive use during the 40-day pre-saturation period.

Percolation rate

Percolation rates were adopted as a factor of soil classification in the paddy area. A weighted average of the percolation rates was used for the irrigation schemes and 1.5mm/day was decided as the percolation rate in the Project area.

Pre-saturation requirements

The presaturation requirements were estimated according to the following parameters:

Pre-saturation Period: 40 days

Pre-saturation Requirement:

	Wet season	Dry season
Land Soaking	87.5mm	75.0mm
Standing Water	20.0mm	20.0mm
Total	107.5mm	95.0mm

Maintenance Water:

Consumptive Use	6.1mm/day	6.1mm/day
Percolation Rate	1.5mm/day	1.5mm/day
Total	7.6mm/day	7.6mm/day

Effective rainfall

As for effective rainfall during crop growth, daily rainfall of 5.0mm or less is considered ineffective while rainfall exceeding 5.0mm is considered 100% effective. When effective rainf ll exceeds the daily water requirement, the surplus is stored in the paddy field and used the following day. Effective rainfall, however, is limited to 60mm/day due to over spill.

Growing stage requirements

Water requirement during crop growth has been computed as the sum of the daily consumptive use and the percolation rate.

2) <u>Irrigation efficiencies for each type of canal</u>

In order to estimate the canal seepage loss, the Moritz formula developed by USBR was adopted to determine the conveyance loss along each type of canal. The conveyance losses for the main, secondary and tertiary canals were determined at 3.0%, and 4.0% and 3.0%, respectively with an overall conveyance efficiency of 90%.

As for operation loss, overall operation efficiency can be assumed at 90% and this value is also applied to the main, secondary and tertiary canals, considering the number of gate structures along the canal. Field efficiency was adopted at 70% during wet season considering the effect of rainfall, and 75% during dry season.

Accordingly, each irrigation efficiency factor in accordance with the type of canal was decided as shown in the following table. The period from December to May is designated as the dry season and the rest as the wet season.

OVERALL IRRIGATION EFFICIENCIES

	Conveyance	Operation	Field	Total	Overall
Main	0.97	0.98	-	0.95	0.57 (0.61)
Secondary	0.96	0.97	-	0.93	0.60 (0.64)
Tertiary	0.97	0.95	-	0.92	0.64 (0.69)
SFD & On-farm	-	-	0.70 (0.75)	0.70 (0.75)	0.70 (0.75)
Total	0.90	0.90	0.70 (0.75)	0.57 (0.61)	

Note: The figures in brackets refer to the dry season.

3) Design water requirements

Net water requirements for the on-farm level together with those for the quarternary and tertiary canals are based on peak daily consumptive use, while net water requirements for secondary and main canals are based on peak 10-day and 40-day average consumptive use, respectively.

Considering the estimated irrigation efficiencies for each irrigation canal, the design unit water requirements were decided, and the results are as shown below.

Canal	Unit Design Water Requirement
Main	2.051ℓ/s/ha
Secondary	2.122ℓ/s/ha
Tertiary &SFD	2.242ℓ/s/ha

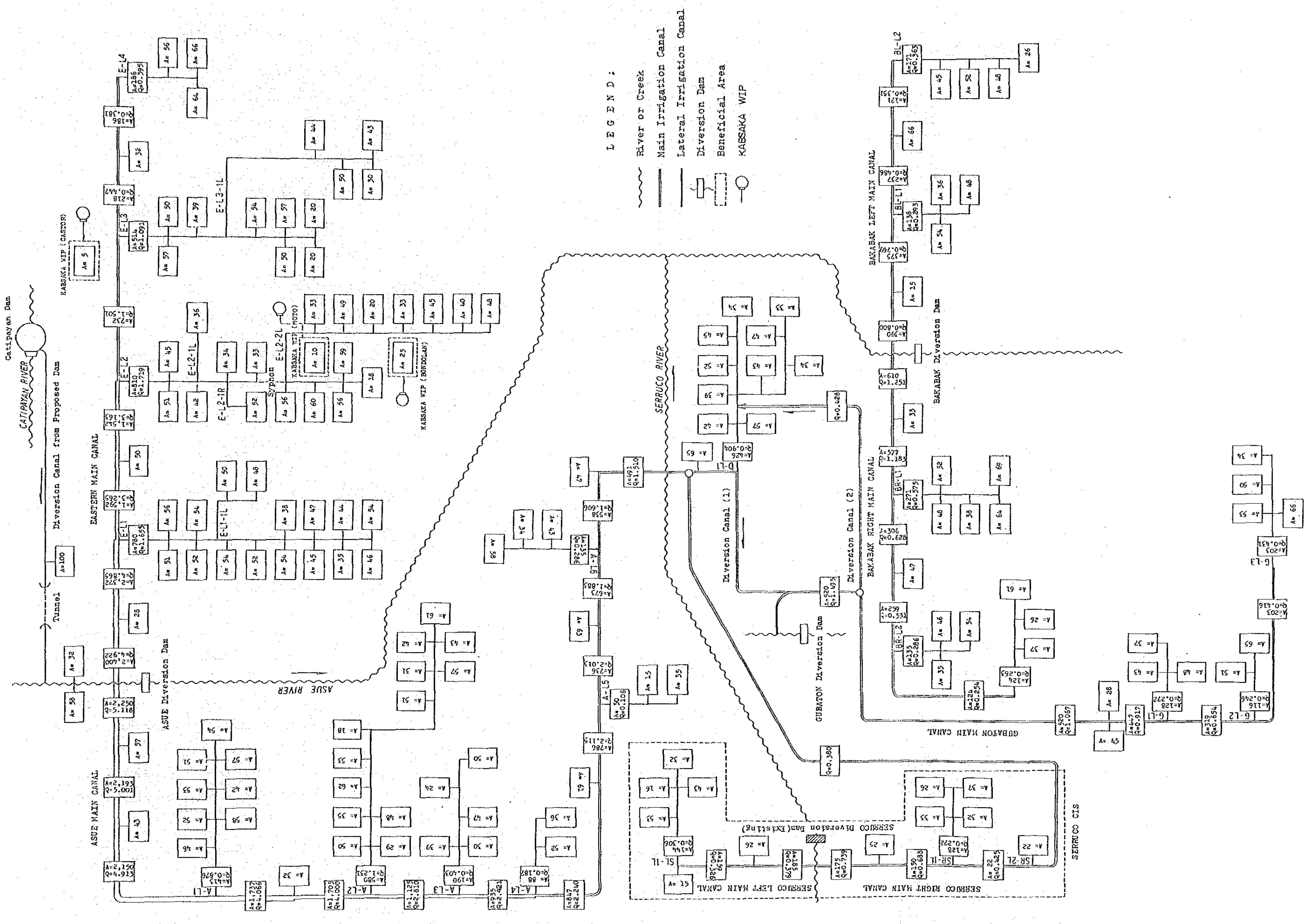
(2) Potential Irrigable Area

In accordance with the basic concepts and the selected proposed diversion dam sites, the layout of the main canals from the diversion dams were studied to maximize their command area. At the same time, interlinking of main canals was considered to enable exchange of surplus river flow and supplementary flow from the Catipayan reservoir.

The irrigation service area can be further divided into two types; direct irrigation area and indirect benefit area or the enriched benefit area of the Serruco CIS and KABSAKA WIP. The direct irrigation area can be further divided into three sections in accordance with the command areas of the proposed diversion dams, the Asue, Gubaton and Bakabak sections. The Asue section, moreover, is divided into the Asue Area, which is covered by the right main canal and extends along the Asue River, and the Eastern Area which is covered by the left main canal and mainly extends along the Hasohoy and Tabagay Rivers.

The proposed irrigation service area by diversion dam and main canal system are summarized in the following table and presented as a schematic diagram in FIG. - 5.

SCHEMATIC DIAGRAM OF PROPOSED IRRIGATION SYSTEM FIG. - 5



PROPOSED IRRIGATION SERVICE AREA

Unit: hectare

Diversion Dam	River	Main Irrigation Canal	Net Irrigable Area
Asue D.D.	Asue	Asue M.C.	2,250
		Eastern M.C.	2,400
		Subtotal	4,650
Bakabak D.D.	Asue	Bakabak Right M.C.	610
		Bakabak Left M.C.	390
		Subtotal	1,000
Gubaton D.D.	Gubaton	Gubaton M.C.	520
Trans-diversion Canal	Catipayan	Trans-diversion Canal	190
Subtotal			6,360
Enriched Benefit Area			
Serruco D.D. (existing)	Serruco	Serruco Right M.C.	175
		Serruco Left M.C.	185
		Subtotal	360
KABSAKA Water Impounding Area (Existing)			
		Castor WIP	5
		Moto WIP	10
		Bondolam WIP	25
		Subtotal	40
Subtotal			400
Total			6,760

(3) Design Capacity of Main Canals

The design capacity of each type of canal can be decided from the irrigation command acreage, adopting the unit design water requirement in accordance with the type of irrigation canal. As explained above, however, some of the main canal routes will also be used to supply water to the irrigation water deficit area. The obtained maximum replenishment water capacity occurs during the land soaking period. Therefore, the design water capacities for such canals should be decided on the basis of irrigation water duty plus maximum replenishment water capacity.

The design capacity of the main canals was decided as shown in the following table.

Name of Main Canal	Max. Replenishment Capacity (m^3/sec)	Irrigation Area (ha)	Irrigation 1/ Capacity (m^3/sec)	Total Capacity (m^3/sec)
Asue main canal	0.503	2,250	4.615	5.118
Eastern main canal	0	2,400	5.922	4.922
Bakabak right M.C.	0	610	1.251	1.251
Bakabak left M.C.	0	390	0.800	1.495
Gubaton M.C.	0.428	520	1.067	1.495
Serruco left M.C.	0	390	0.800	0.800
Serruco right M.C.	0.380	175	0.359	0.739
End of Asue main canal	0.503	491	1.007	1.510
End of Serruco right M.C.	0.380	0	0	0.380
Top of diversion canal (1)	0.503	0	0	0.503
Diversion Canal (1)	0.503	0	0	0.503
Diversion Canal (2)	0.428	0	0	0.428

1/ The design water requirement for the main canal is 2.051ℓ/sec/ha.

(4) Design Capacity of On-farm Facilities

At the on-farm level, main farm ditches (M.F.D) and supplementary farm ditches (S.F.D.) are proposed to facilitate the introduction of modern irrigation water management. In addition, the S.F.D. has two functions, irrigation and drainage.

Water management at the on-farm level includes not only simultaneous irrigation, especially during the land soaking period due to the high water requirement, but also rotational irrigation during the growing stage. Therefore, the design capacity of the S.F.D. should meet the maximum capacity of the above three functions, i.e. simultaneous and rotational irrigation and drainage.

Design capacity was calculated as presented in the following table.

DESIGN CAPACITY OF S.F.D.

Item	Simultaneous Irrigation during Land Soaking Period	Rotational Irrigation during Growing Period	Drainage Capacity in 10-year Return Period
Command area (ha)	10ha	10ha	10ha
Unit requirement	2,242ℓ/s/ha	1,790ℓ/s/hax5day 1/	5.0ℓ/s/ha 2/
Design discharge	22.42ℓ/s	89.5ℓ/s	50.0ℓ/s

Note: 1/ Daily maximum consumptive use is 8.4mm/day, the percolation rate is 1.5mm/day and the on-farm efficiency is 0.64, so that (8.4 + 1.5)/0.64/8.64 = 1.790ℓ/s/ha.

2/ The unit drainage discharge from paddy was obtained at 5.0ℓ/s/ha.

Accordingly, the design capacity of the S.F.D. was decided at 89.5ℓ/s. As for the M.F.D., the command area is about 50ha and the design unit water requirement is 2.242ℓ/s/ha. The S.F.D. will not be used for drainage purposes due to the alignment of the canal, and the design capacity was determined at 2.242ℓ/s/ha x 50ha = 112.1ℓ/s.

4.5.3. Proposed Drainage Plan

(1) Concept of Drainage Plan

As explained in section 1-3, typhoon Undang provided actual evidence of drainage problems in the field. The events of the typhoon clearly indicated several urgently required drainage improvements. Moreover, a sophisticated runoff analysis was introduced to anticipate drainage discharge analysis for conditions after project completion. The following basic concepts are proposed for the drainage plan.

1) Design probability year

A 10-year return period was adopted for designing the drainage facilities.

2) Existing weirs

Existing private concrete weirs sometimes exaggerate upstream flood damage and; therefore, they should be removed.

3) River training

Due to the steep slope of the existing river course main river training or straightening of the main river course is not advisable without construction of drop structures, except in the rather flat portion of the rivers such as the Hasohoy River or creeks.

4) S.F.D as drainage facilities

As explained in the concepts of the irrigation plan, the S.F.D is planned for drainage purposes as well. When existing creeks or rivers are not available near the S.F.D networks, new project drains or tertiary drains are proposed to discharge excess water smoothly.

5) Main drainage improvement works

Careful and intensive investigations were made to determine drainage problems in flood conditions during typhoon Undang. Based on the results the following three improvement works are proposed for implemention in such areas.

a) Re-excavation of existing creeks and rivers where existing capacity is insufficient.

b) Re-construction or rehabilitation of existing culverts under national or provincial roads.

c) New drainage canal construction where the existing creeks or rivers are not sufficient for drainage.

(2) Drainage System Networks

1) Schematic drainage networks

The catchment areas of the rivers in the service area were divided into sub-catchment areas according to topography and existing tributary and drainage systems. These sub-catchment areas were further sub-divided into two types of land use; paddy which have storage capacity, and slope area such as uplands, residential areas, sugarcane plantations, etc. The shapes of the sub-catchments are modified rectangles in accordance with the land use.

Cross-sections of existing rivers, tributaries and drains were surveyed at approximately 500m intervals. In accordance with the obtained cross-sections, the discharge-flow area relationships were derived based on Manning's equation, using a roughness coefficient of 0.03 and slopes of rivers. Flow area and discharge equations were fitted by the least squares method.

(3) Runoff Analyses for Drainage System

1) Rainfall Analysis

Design Rainfall

The incremental rainfall from one day to two days for a 10-year return period is 21.6mm which is about 10% of one day rainfall. Therefore, one day maximum rainfall (24 hours maximum) has been considered for drainage analysis rather than adoption of successive rainfall.

Several observed hourly rainfall patterns were examined for design rainfall. The pattern of design rainfall was estimated on the basis of the ratio between the observed and 10-year return period of rainfall corresponding to the maximum durations of one hour, 6 hours and 24 hours.

Effective rainfall

The runoff mechanization in paddy can be presumed from the hydraulic point of view and the cumulative rainfall to cumulative loss of rainfall were estimated. The same relationship was estimated for hilly and mountain areas in the surrounding service area. The overall loss in the Asue River can be estimated from the long term discharge records. The runoff ratio in the hilly area can be estimated by subtracting paddy loss from the overall loss.

2) Runoff analysis for hilly area

Method of runoff analysis

Most catchment runoff models for estimation of floods are based on empirical approaches and rely heavily on observed data to determine model parameters. Consequently, when no observed data is available or when the features of the catchment area are expected to change in future, empirical methods can be very difficult to adopt.

At present, the Asue Area has very few terminal drainage facilities in paddy fields. Under Project implementation, terminal drainage facilities will be provided to improve drainage conditions. Therefore the runoff model to be adopted for the Asue Area should be able to simulate such changes in the catchment area.

In order to meet the above requirement, the Kinematic Wave method, or Characteristic Curve method, an approach which utilizes hydraulic equations to solve unsteady flow in open channels, can be adopted to simulate overland and channel flows. However, runoff characteristics from paddy are somewhat different from overland flow because of the storage capacities in the paddy field. These storage characteristics must also be integrated into the model. Consequently, a runoff model incorporating these two features was established for runoff simulation analysis.

3) Design discharge for drainage facilities

Runoff analysis for 10-year and 25-year return periods were carried out in accordance with the schematic diagram of the river basin in the service area and the runoff model. The peak discharge for the specific runoff hydrograph for a 10-year return period occured at 24 hours from the beginning of rainfall at 1.8mm/hr which corresponds to 5.0ℓ/sec/ha in the paddy. Design unit discharge was, therefore, designated at 5.0ℓ/sec/ha.

The runoff analysis revealed that peak discharge varies due to the shape of the sub-catchment area, land use and slope. Specific discharge from the hilly area, therefore, can not be determined simply. The relationship between catchment area and peak discharge along the Asue main river was plotted, and the specific runoff varies from 22ℓ/s/ha to 14ℓ/s/ha in accordance with the size of catchment area. The 25-year return period can be adopted for designing culverts under national and provincial roads.

4) Design flood discharge for diversion dam

As for the design flood discharge for diversion dams, the 50-year return period with the hyetograph mentioned in the Hydrology Section, was adopted. A rubber type dam was selected for the diversion dam and the cross section of the dam site can be used as the deflated condition of the rubber dam in designing high water level for flood.

The same condition was adopted to estimate the design flood at the proposed diversion dam sites. The design flood at each diversion dam site is presented in the table below.

Diversion Dam	River	Catchment Area (km^2)	Design Flood (m^3/sec)
Asue	Asue	13.70	94.74
Bakabak	Asue	116.02	611.92
Gubaton	Gubaton	18.80	154.36

4.5.4 On-farm Development

(1) Objectives and Measures of On-farm Development Plan

1) Objectives

On-farm development can be categorized into the following main objectives.

Irrigation

To introduce modern irrigation techniques and efficient water management for rotational irrigation in order to attain timely water supply and control water supply in accordance with crop demand and growth.

Drainage

To drain excess water within a short period from the farm field and to reduce the ground water table in order to increase aeration of the crop root zone, facilitate the introduction of farm machinery and increase the efficiency of farm machinery in the field.

Farm Roads

To increase accessibility to farm plots and attain high efficiency of modern farming practices and efficient transport of farm input materials and products.

In order to attain successful on-farm development, and reduce land acquisition cost, existing small canals in paddy should be utilized as much as possible.

2) Countermeasures

Irrigation facilities

In order to reduce the number of drops, the SFD was aligned along the contour line and existing small canals in the paddy will be fully utilized. Furthermore, existing small ditches can be connected with the systematically arranged S.F.D. Irrigation water can thus be conveyed more effectively and the time required for water to reach each plot can be reduced.

Drainage facilites

The proposed interval between S.F.D is 200m along the contour line. The slope of existing paddy is approximately 1/300. Therefore, the difference in elevation between two S.F.D is an average of about 200m/300 = 0.7m. The lower S.F.D is able to intercept surplus water from the upper rotational unit. Accordingly, the S.F.D can be utilized not only for irrigation water supply but also for drainage of surplus water in the field.

4.6 Rural Development Plan

4.6.1 Road Network Plan

In this Project, a road network plan is included as a supplementary component to irrigation development based on present conditions especially lack of roads in the paddy area. The main focus is establishment of access roads for O&M roads of planned irrigation facilities and improvement of the farm-to-market connection. Accordingly, main O&M roads will be connected to national and provincial roads while branch roads will follow irrigation canals in order to increase the effectiveness of farming, transport of post-harvest produce, rural communication and agricultural support services. Scale of maintenance roads will be sufficiently wide to permit passage of vehicles.

On the basis of the considerations mentioned above, the road network plan under the Project is proposed as shown in FIG. - 6.

4.6.2 Integrated Community Center

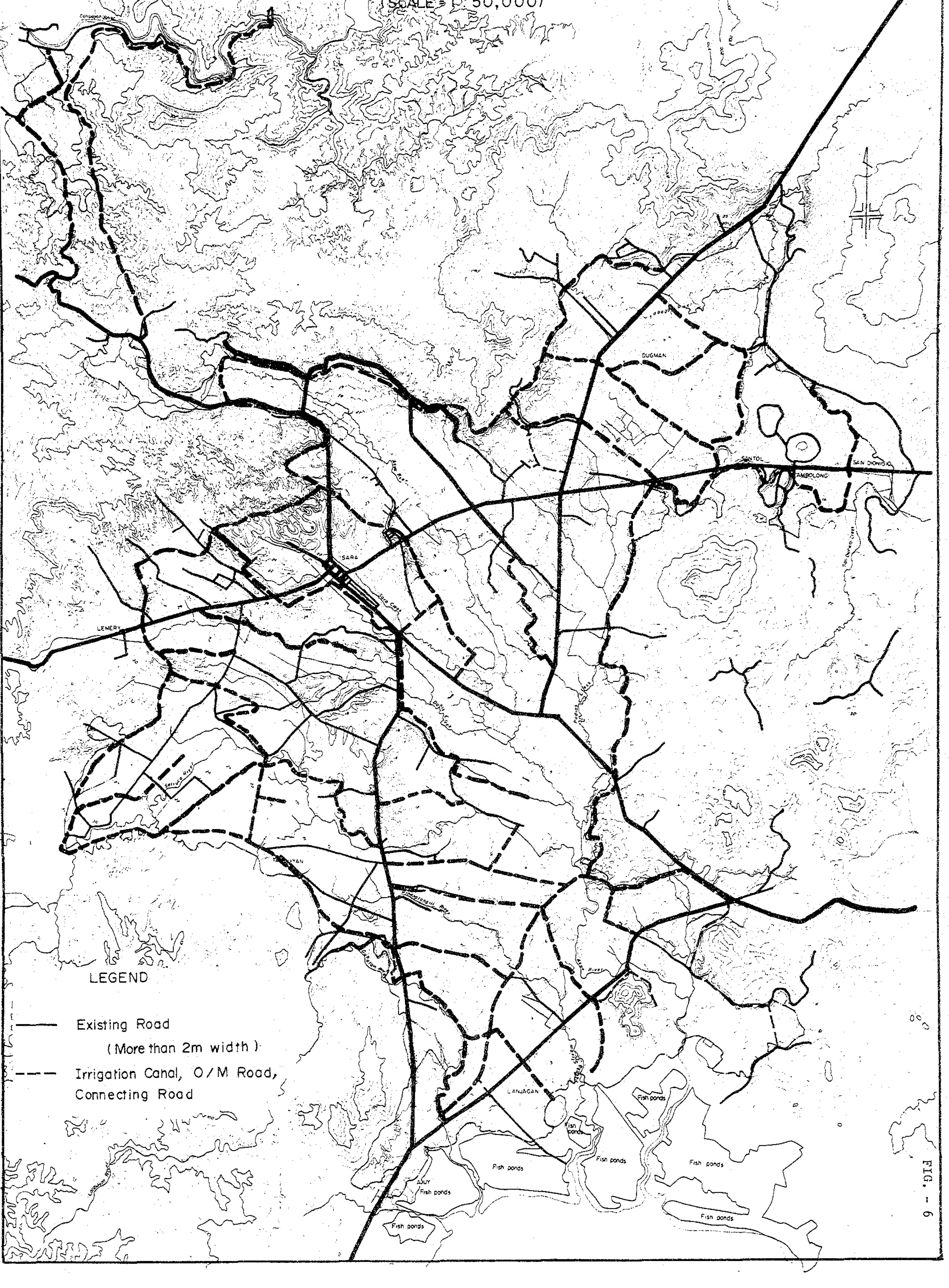
Water for domestic use in the Project area is supplied mainly by public wells which are installed in every village. Shortage, especially in the dry season in rural portions of the Project, often occurs, presenting a serious problem for local residents. This situation is due to limitation of tubewell water utilization by drawdown of the groundwater level in the dry season especially from March to May.

Under the Project, 18 barangays will be supplied with domestic water through the Sara Waterworks System. Other barangays, however, will continue to have domestic water shortage problems in dry season even after project implementation. The Project therefore proposes facilities which will provide domestic water by effectively utilizing irrigation facilities in view of basic human needs and equal social service provision as well as to improve living environment and sanitation conditions in the Project area.

FIG. - 6

EXISTING ROAD & PROPOSED ROAD NETWORK

(SCALE = 1 : 50,000)



In addition to provision of domestic water, multipurpose concrete yards mainly for rice drying will be included to meet future increase in rice production. In this manner, the agricultural and rural development components shown below are incorporated in the Project to create a center for the local people referred to as the Integrated Community Center.

Item		Function
- Shallow wells	:	Stable supply of domestic water
- Multipurpose pond	:	Recharge of groundwater for shallow wells
	:	Water supply for livestock
	:	Washing and bathing
	:	Fire fighting
	:	Barangay community space for appropriate irrigation water operation
- Multipurpose yard	:	Rice drying space
	:	Agricultural input and trading center
	:	Sports and recreation

As for domestic water, a supply of 100ℓ/day/person for the population of 27,400 was adopted for the plan.

4.6.3 Hydropower Generation

The electric demand in the Project area will be expanded and the generated energy under the Project is expected to be effectively utilized within the same. Under the Project, use of irrigation water for hydropower generation will be maximized from the viewpoints of effective use of natural resources.

Hydropower development under the Project is basically considered as a supplementary component, and thus it will be subject to the irrigation water diversion plan. Accordingly, the hydropower component has been planned so as not to interfere with the irrigation diversion plan. Water which will be used for hydropower generation will be subject to irrigation water requirement. However, in cases where there is any surplus water in the reservoir the same will be effectively utilized for hydropower generation.

A gross head of 81.6m between the normal High Water Level (EL.124.0m) of the proposed Catipayan dam and the tailrace water level (EL.42.4m) in the Asue Basin provides 2 sites which are technically possible for hydropower generation. One site is just downstream of the dam which would utilize the head between reservoir water level and water level at the outlet to the trans-diversion canal. The other site would utilize the elevation difference between the end point of the trans-diversion tunnel and the Asue River.

A hydropower plant at the dam called the dam site power station under the Project, will be installed utilizing intake facilities for irrigation, and water will be released through the generator to the trans-diversion canal. The hydropower plant scheme on the trans-diversion canal route, called the canal route power station under the Project, includes a head tank at the outlet of the trans-diversion tunnel and a penstock from the same point to the bottom of the mountain. Generated energy at the two stations will be transmitted by a transmission line to the presently proposed Sara substation under the ILECO II grid.

Power will be generated basically by released water for irrigation and overflow in the case of full reservoir capacity both at the dam site and canal route power stations. Stored water in the Catipayan reservoir, however, can also be effectively utilized for power generation by establishing a limited water level for the hydropower component. In this case, water released from the reservoir for generation only will be led through the dam site power station to the canal route power station utilizing the trans-diversion canal/tunnel. This means that the amount of discharge for generation at both stations will always be the same, and generation will be in order of priority by irrigation release, by spillover and by hydropower release above the restricted water level.

Optimum development scale has been evaluated at $3.0m^3/s$ for both the dam site power station and the canal route station. Firm energy cannot be expected because hydropower generation is basically by irrigation water release. Installed capacity and annual generated energy for the two stations are presented below.

	Unit	Dam Site Power Station	Canal Route Power Station
Maximum discharge	m^3/s	3.0	3.0
Installed maximum capacity	kW	650	750
Annual generated energy	MWh	3,225 1/	4,112 1/
Plant efficiency	%	57.5	63.4

1/ 1964-83 simulation average

4.6.4 Water Supply Plan

In due consideration of present conditions in the area, incorporation of a domestic water supply scheme is essential as discussed in 4.6.2 Integrated Community Center. In this Project, the domestic water supply plan is considered secondary to the irrigation development plan and will be designed so as to effectively utilize the proposed irrigation facilities.

The waterworks systems in Ajuy, Concepcion and San Dionisio are all outside the Project area and, due to the distance from the main irrigation facilities of the same, gravitv water conveyance is not economically feasible. In the Project, therefore, the Sara Waterworks System improvement plan will be reinforced and a plan for supplementation of the present water shortage will be formulated, although the plan will not include water supply to each household.

The target year for water supply to the Sara Waterworks was determined at 2003 AD. The projected population in the 18 barangays for the target year was assumed at 20,300. Out of this target population, 17,700 persons live in the Project area while the remainder live outside. The supplementary capacity for the Project was calculated at 1,424m^3/day (0.0165 m^3/sec) based on a unit supply capacity of 100 ℓ/day/person.

The Sara Waterworks has two supply systems, each of which has an intake upstream of the Asue River with a reservoir of about 0.3MCM. Under the Project, supplementary water will be conveyed to the existing Sara Waterworks pipe line through another pipe line from the proposed head tank for the canal route power station.

CHAPTER V

FACILITIES PLANNING

CHAPTER V

FACILITIES PLANNING

5.1 Dam and Trans-diversion

5.1.1 Main Features of Dam and Reservoir

The Catipayan dam is a major facility for realization of stable and year-round irrigation water supply which is the most important basic development policy under the Project. The dam and trans-diversion have been planned to supplement irrigation water shortages in the benefit area of the Asue River basin. An effective reservoir capacity of $21.5^{10^6}m3$ was established as the appropriate and most economical dam scale on the basis of the detailed comparative study discussed in section 4.3.

The dam will be constructed on the Catipayan River, the catchment of which is in the northern portion of the irrigation area. Based on comparative study of the three alternative dam sites including comparison of construction costs, the site was determined at site C about 200m downstream from the confluence of the Catang River. Features of the same are as follows:

- Gross Storage Capacity	28.2MCM
- Effective Storage Capacity	21.5MCM
- Design Sediment Volume	6.7MCM

Topographical characteristics of the dam site include a riverbed elevation of EL.83.0m, riverbed gradient of 1/110, riverbed width of 20m, left bank abutment slope of 20^o and hilltop elevation of EL.175m, and right bank abutment slope of 28^o and hilltop elevation of EL.180.0m. Main features of the dam are presented below.

- Dam Type	: Zone type rock fill
- Crest Elevation	: EL.129.5m
- Freeboard	: 2.5m
- Dam Height	: 48.5m (47.5m from riverbed)
- Dam Length	: 265m
- Crest Width	: 10m
- Embankment Slope	: Upstream 1:3.0, downstream 1:2.1
- Embankment Volume	: 796,000m^3

The required gross storage capacity of 28.2MCM was obtained through water resources development study. Design sediment volume was determined at 6.7MCM based on 1,500m3/km2/year and a 100-year return period. Design flood water level was determined at EL.127.5m by adding 3.0m of overflow depth to the normal high water level of EL.124.0m. Major characteristics of the reservoir are presented below.

- Catchment Area	: 44.2km^2
- Gross Storage Capacity	: 28.2MCM
- Effective Storage Capacity	: 21.5MCM
- Dead Storage Volume	: 6.7MCM
- Normal High Water Level	: EL.124.0m
- Design Flood Level	: EL.127.0m
- Low Water Level	: EL.109.0m
- Effective Depth	: 15.0m
- Reservoir Area at Normal High Water Level	: 2.10km^2

5.1.2 Preliminary Design of Dam and Appurtenant Structures

General layout, typical cross section and profile of the dam are presented in FIG. - 7 and 8.

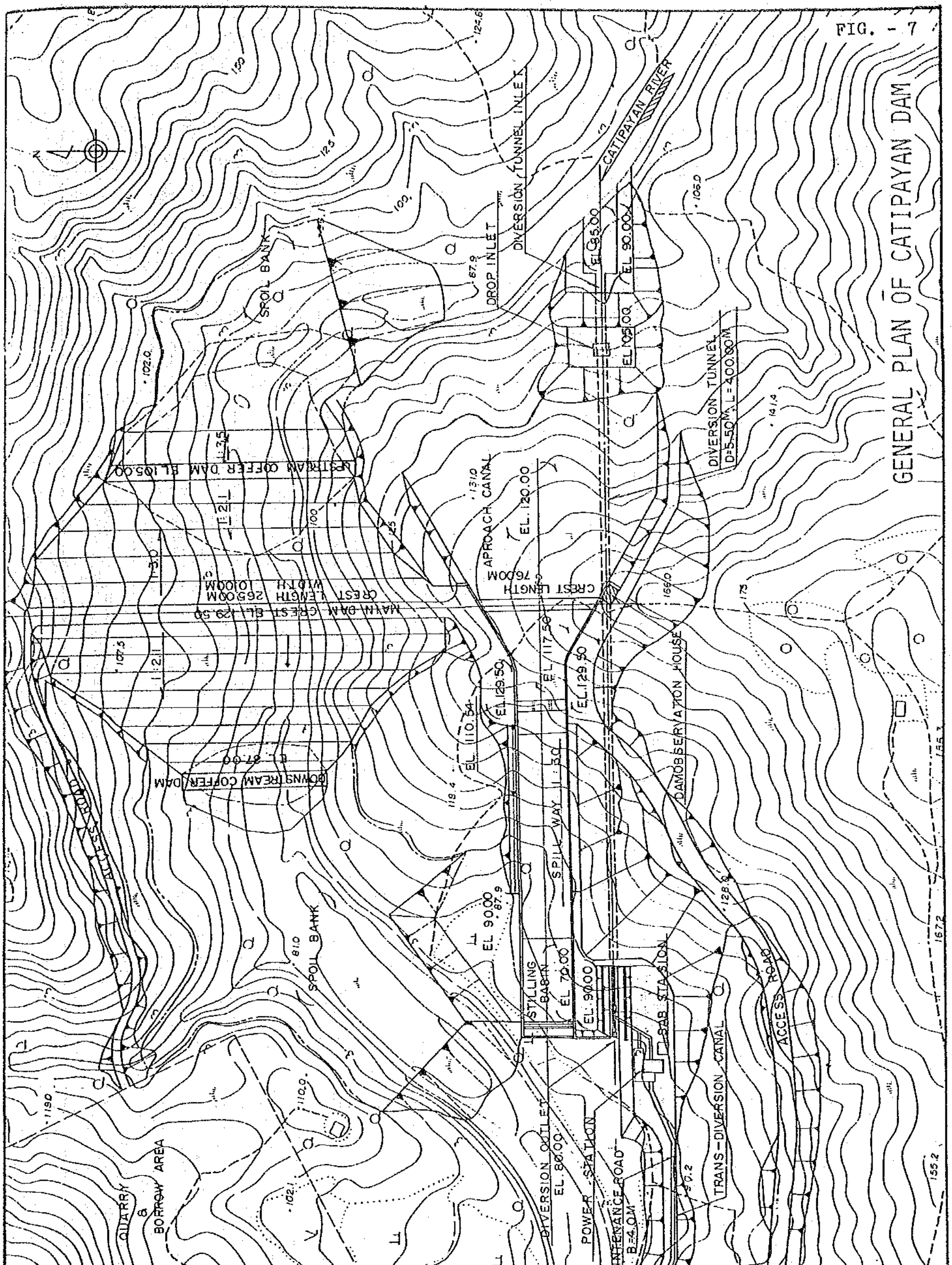
(1) Dam and Foundation

The topography of the dam axis has a comparatively large configuration factor of 5 and thus a fill-type dam is considered more suitable than a concrete type. Sufficient gravel required for concrete aggregate is not available within the site vicinity. Rock and earth fill materials required for a fill type dam however, are abundant near the site.

From the abundance of rock, semi-pervious and impervious materials and the quality of the same, and in consideration of the comparatively large scale of the proposed dam, a center core type rock fill dam, which is least subject to settling, is considered the most technically and economically suitable type.

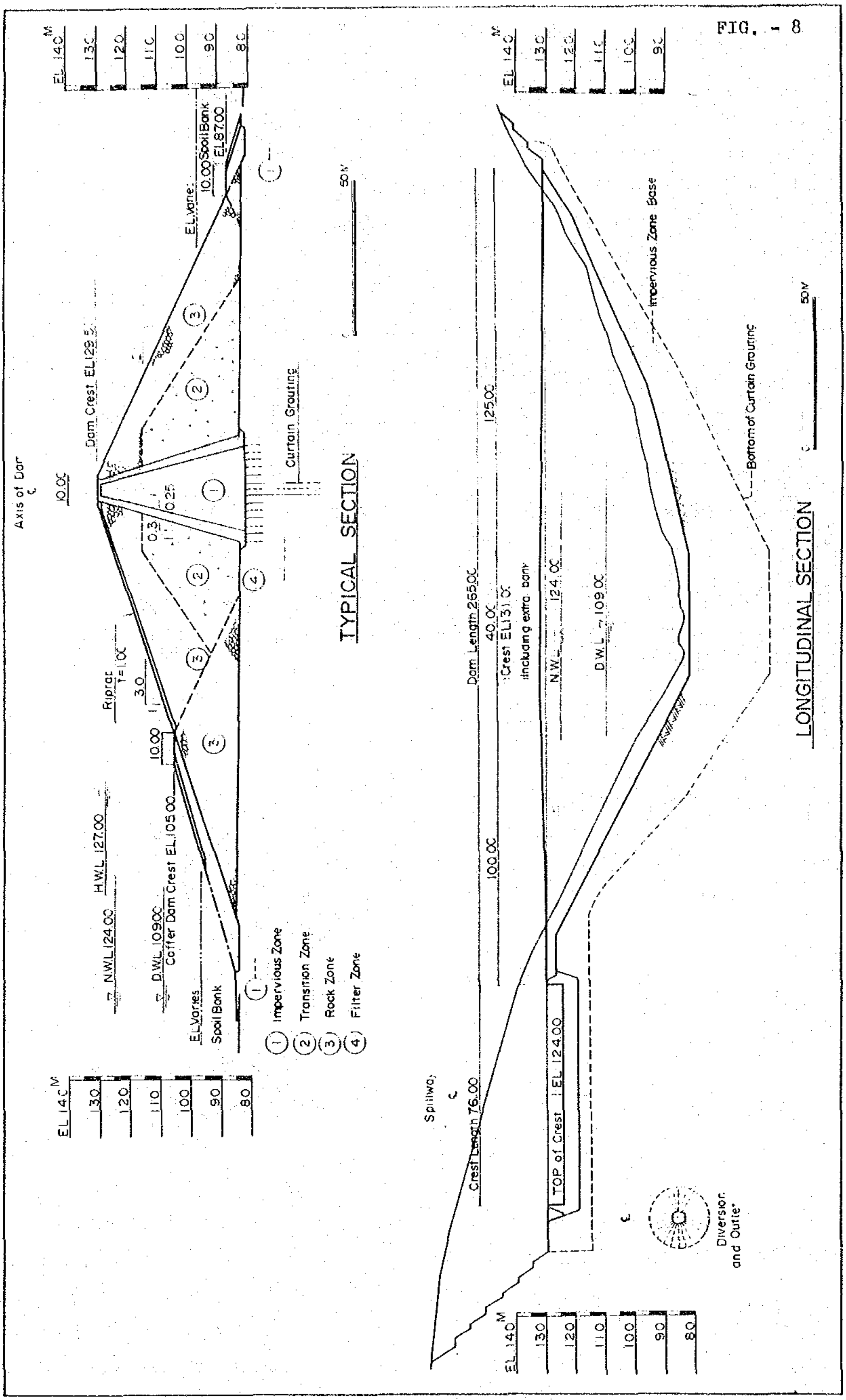
The bedrock of the site is composed of andesite and basalt pyroclastic rocks and outcroppings of the same occur in the riverbed. Although pyroclastic rocks are divided into various rock types, for the purpose of dam construction the same may be considered as one uniform rock foundation.

FIG. - 7



GENERAL PLAN OF CATIPAYAN DAM

FIG. - 8


TYPICAL SECTION
Axis of Dam
10.00
Dam Crest EL129.50
Curtain Grouting
Riprap t=1.00
10.00
H.W.L 127.00
N.W.L 124.00
D.W.L 109.00
Coffer Dam Crest EL105.00
EL Varies
Spoil Bank
EL Varies
10.00 Spoil Bank
EL87.00
① Impervious Zone
② Transition Zone
③ Rock Zone
④ Filter Zone
LONGITUDINAL SECTION
Dam Length 265.00
40.00
Crest EL131.00
including extra bank
N.W.L 124.00
D.W.L 109.00
125.00
100.00
Impervious Zone Base
Bottom of Curtain Grouting
Spillway
Crest Length 76.00
TOP of Crest EL 124.00
Diversion and Outlet
EL 140
130
120
110
100
90
80

Foundation treatment will consist of grout, with curtain grout applied to the center core and possibly consolidation grout on some portions above the dam crest. It is also necessary to allow for rim grout in the lower ridge section.

(2) Design Seismic Coefficient

Seismic acceleration at the dam site was calculated by S. Okamoto's formula on the basis of PAGASA earthquake records from 1915 to 1980. According to the said formula, maximum acceleration at the proposed dam site is 196gal, and the value for a 100-year return period is approximately 300gal.

The design seismic coefficient at the proposed dam site was thus determined at K = 0.18 adopting a reduction rate of 0.5. Using the coefficient, embankment slope was determined to satisfy a safety factor of 1.2 against surface slide. Furthermore, even in a case where observed maximum K = 196/980 = 0.2, a safety factor of 1.1 must be satisfied.

(3) Slope of Embankment

Slopes of the dam were determined at 1:3.0 for upstream and 1:2.1 for downstream using the above design seismic coefficient and material characteristics by application of surface slide and stability, and by the sliced slip circle method.

(4) Dam Crest Elevation, and Width Zoning

The larger of the following dam crest elevations, i.e. Normal High Water Level plus wave heights due to wind and earthquake versus Design Flood Level plus wave height due to wind, was adopted for crest elevation. The dam crest elevation was thus determined at EL.129.50m.

Impervious zone width was determined as 28m at the bottom considering construction conditions, available material volume, earthquake resistance and permeability.

(5) Service Spillway

On the basis of the comparative study of overflow, tunnel and compound dam spillways, a chute type spillway on the left bank with linear alignment was proposed considering topographical, geological and economic advantages. Excavated materials for spillway construction will be utilized for dam embankment.

No gate is provided for the spillway of the dam considering that the operation of a gate under such conditions is very difficult, resulting in substantial operation and maintenance costs, and improper operation of a gate will cause disaster in the downstream area.

Spillway design discharge was determined at $850m^3/sec$ considering the safety factor of 20% to a 200-year return period flood. As discussed in APPENDIX II under METEOROLOGY AND HYDROLOGY, a 200-year return period flood peak discharge of $703.7m^3/sec$ was calculated. Optimum crest length of the spillway was determined at 76.0m with the overflow depth of 3.0m in consideration of economic feasibility based on spillway overflow depth and dam height.

The effective hydraulic jump type was selected as an energy dissipator.

(6) Diversion Facilities

Tunnel type diversion facilities are proposed considering topographical conditions. The said facilities will be used as emergency outlet facilities from the reservoir after completion of the dam. A flood discharge of $360m^3/sec$ with a 10 year return period was adopted for design discharge.

The diameter of the horse-shoe type by-pass tunnel was determined at 5.5m with a discharge capacity of $207m^3/sec$. The crest elevation of the cofferdam was determined at EL.105.0m adding 1.60m allowance to the design flood water level of EL.103.4m.

(7) Intake Facilities

Intake facilities will be installed so as to utilize the by-pass tunnel. A drop inlet type intake with minimum intake level of 109m will be used and the intake will be connected with the by-pass tunnel via the shaft. A concrete plug will be installed at the dam axis from which discharge will be conveyed via a steel pipe (ϕ1,300mm) to a release pond (WL: 90.0m) directly below the dam at the powerhouse and canal terminus site. For safe operation of the dam, an emergency discharge facility will be installed.

5.1.3 Trans-diversion Plan

(1) Alignment

The proposed trans-diversion canal/tunnel will lead irrigation water from the proposed Catipayan dam to the Asue River basin. The capacity of the same is determined at 6.0m^3/sec and the required length of the canal portion is approximately 7.7km. Because the topography along the canal from the dam to the basin's divide has a climbing slope, and in order to keep a high elevation for tunnel planning and hydropower planning, the canal route was selected along the mountain skirts and foothills.

The trans-diversion structure is mainly an open canal though a tunnel will be planned to pass through the mountain dividing the two basins. Alignment of the route was made based on a 1/4,000 topographical map and site survey.

(2) Canal Type

Three canal types i.e. earth, lined and concrete flume were compared for the trans-diversion canal. Mountain slope along the trans-diversion canal is 1:1.5 to 3.0, with an average slope of about 30° in the cross-sectional direction of the canal presenting a disadvantage for a canal type with a long cut surface.

	Cost (million pesos)	Cut Slope[1/] Length	Bank Slope[1/] Length	O&M
Earth Lined	70	1.5	1.9	difficult
Concrete Lined	45	1.3	1.9	moderate
Concrete Flume	58	1.0	1.0	easy

1/ ratio to concrete flume

The results of comparison as presented below show that the concrete lined canal requires the minimum construction cost. However, the concrete flume canal is proposed for the trans-diversion canal considering the following.

a) The topography along the canal is greatly varied due to the mountain slope and foothills;

b) The route requires many curved alignments;

c) The cut bank slope of 1:1.5 is similar to the mountain's slope and hence the cut face length is quite long in the case of earth canals;

d) Earth and lined canals are subject to erosion, especially when located on mountain slopes while landslides will result in a high maintenance cost; and,

e) Cracking may occur in concrete lined canals due to unequal subsidence of embanked abutment.

(3) Tunnel and Release

The trans-diversion tunnel will pass through the mountain which divides the Catipayan and Asue basins. Required length of the tunnel is 472m with a diameter of 2R=2.15m and longitudinal gradient of 1/950.

5.2 Irrigation and Drainage

5.2.1 Diversion Dam

Three diversion dams were proposed on the Asue River and the Gubaton River. In order to avoid floods caused by backwater from the dams, an automatic collapsable type dam is recommended for economic feasibility and to prevent backwater.

The main features of the three diversion dams are tabulated in the following table.

Diversion Dam	River	B(m)	H(m)	Irrigable Area (ha)
Asue Diversion Dam	Asue	12.0	2.4	4,650
Bakabak Diversion Dam	Asue	27.6 x 2	3.0	1,000
Gubaton Diversion Dam	Gubaton	20.0	5.0	520

(1) Asue Diversion Dam

The location of the proposed Asue Diversion Dam is about 700m downstream from the existing bridge crossing the provincial road. Present river width is approximately 15m with a 1/550 slope and a meandering river course. River embankments do not exist on either side.

Flood discharges of the Asue River at the diversion dam were estimated at 71.69m^3/sec for a 25-year return period and 94.74m^3/sec for a 50-year return period by the Kinematic Wave Method. The design flood discharge for the Asue diversion dam was determined on the basis of a 50-year return period discharge similar to other national projects in the Philippines. High Water Level of the dam was determined at EL 33.8m with a 20% height allowance in the upper part of the dam. The rubber dam type was adopted.

Major dimensions of structural features are as follows:

- Bottom Length	12.0m
- Dam Height	2.4m
- Sill Elevation	Upstream EL. 30.9m Downstream EL. 29.9m
- Intake Water Level	EL. 33.3m
- Design Intake Capacity	Asue M.C. 5.118m^3/sec, Eastern M.C. 4.992m^3/sec
- Gate Type	Sluice gate
- Gate Dimension	Asue M.C. 2.0x1.4x2 nos. Eastern M.C. 2.0x1.4x2 nos.

(2) Bakabak Diversion Dam

The Bakabak diversion dam was proposed on the Asue River 250m downstream from the confluence with the Serruco River, which is a tributary of the same. Present river width is approximately 60m and slope is 1/700. The required water levels of both main canals are determined at EL 7.5m, and intake water level at EL 7.8m adding an intake loss of 0.30m.

Design flood discharges of the Asue River at the dam, which were analysed by the Kinematic Wave method in the same way as for the Asue Diversion Dam, are 471.76m^3/sec for 25-year return period and 611.92m^3/sec for a 50-year return period. Adopting the 50-year return period discharge as the design flood discharge, the high water level of the dam was determined at EL 8.4m.

Major dimensions of the structures are presented as follows:

- Bottom Length	27.6m x 2m
- Dam Height	3.0m
- Sill Elevation	Upstream EL. 4.8m, Downstream EL. 3.6m
- Intake Water Level	EL. 7.8m
- Design Intake Capacity	Bakabak R.M.C. 1.251m^3/sec, Bakabak R.M.C. 0.800m^3/sec
- Gate Type	Sluice gate
- Gate Dimension	Bakabak R.M.C. 1.5x1.0, Bakabak L.M.C. 1.0x1.0

(3) Gubaton Diversion Dam

The Gubaton diversion dam site is proposed on the Gubaton River 2km upstream from where it crosses the national road which runs from Iloilo to Sara. Present river width is approximately 20m and slope is 1/750. The riverbed is deeply eroded.

Required water level of the Gubaton main canal was determined at EL 17.5m, and intake water level at EL 17.8m adding an intake loss of 0.30m. Design flood discharge of the Gubaton River at the proposed dam site was estimated at 115.04m^3/sec for a 25-year return period and at 154.36m^3/sec for a 50-year return period by the Kinematic Wave method. Adopting the 50-year return period discharge as the design flood discharge, the high water level of the dam was determined at EL 18.4m.

Major features of the dam and intake structure are presented below.

- Bottom Length	20.0m
- Dam Height	5.0m
- Sill Elevation	Upstream EL. 12.8m, Downstream EL. 10.8m
- Intake Water Level	EL. 17.8m
- Design Discharge	1.495m^3/sec for Gubaton main canal
- Gate Type	Sluice gate
- Gate Dimension	1.5x1.2 for Gubaton main canal

5.2.2 Irrigation Canal and Appurtenant Structures

(1) Canal Alignment

After thorough investigation of the topographical conditions in the service area, layout of the canal network was plotted on a 1:4,000 topographical map. Particular attention was given to maximize acreage of irrigable land and maintain existing irrigation systems wherever possible. Proposed canal lengths including those for the Serruco area are 36,690m for main canals and 74,160m for lateral canals.

(2) Canal Section

From the economical point of view, earth lined canals were adopted for both main and lateral canals with trapezoidal section. The canal section was determined on the basis of Manning's formula (roughness coefficient n=0.025), and canal bed-depth ratio. A canal bed slope of 1:1.5 and freeboard of 40% or a minimum of 30cm were adopted.

(3) Canal Related Structures

Diversion and water measurement structures are designed as double orifice. Diversion of water above 1.0m^3/sec from the main to lateral canal however, will be by a head gate and parshall flume. Diversion from lateral to sub-lateral canals is designed to maintain a fixed rate using a fixed proportional divisor.

Construction of a check gate is planned to maintain a fixed water level for cases in which the discharge amount is below the designed value. A drop structure will be constructed to maintain the design bed slope. The vertical drop was adopted for small discharge, while the chute type structure was adopted for main canals. The wasteway incorporates a spillway to automatically drain overflow water.

An inverted siphon is planned for drainage canal crossings in consideration of the relationship between water level in the canal and probable water level in crossing the drainage canal, and in comparison of the flow amount in the irrigation canal and estimated flow in the drainage canal. A bridge is planned where the irrigation canal crosses the existing road. When the flow amount is small, a road cross pipe will be constructed in light of the economics of this approach.

According to the basic Irrigation System, main canals will be interlinked with each other in order to exchange irrigation water supply among the same. A combined structure with sluice gates is proposed at the confluence of main canals. When drainage flow is relatively small, an overchute to convey drainage water over the irrigation canal is planned rather than a drainage culvert in view of economy.

5.2.3 Other Structures

An inverted siphon of R.C. pipe was selected as the most economical type of structure to convey water from the Eastern Main Canal to the higher portion at EL.18.0m in the southern part of the San Dionisio-Santol Road.

Installation of one outlet gate was proposed to supply water for the 100ha area along the trans-diversion upstream from the tunnel inlet at EL. 83m. An outlet gate is also proposed for the 90ha area downstream of the canal route power station at EL. 42.5m.

At the south of the canal route power station, a maximum $5.8m^3/sec$ of water will be released into the upper stream of the Asue River in order to intake water at the Asue Diversion Dam. Improvement of 650m of the river course will be required to allow a discharge of $5.8 m^3/sec$. Concrete lining is proposed for this portion for a length of about 650m.

5.2.4 Drainage Facilities

Major drainage facilites are new canals, and improved courses of the Hasohay River, Padios Creek and San Dionisio Creek.

Proposed drainage canals were planned as trapezoidal earth canals with side slopes of 1:1.0 and a freeboard of 0.4H, and the cross section was determined based on maximum velocity of 1.0m/sec and a 10-year return period design discharge. Total length of newly constructed drainage canals is 21,500m. Improvement of portions of rivers in the eastern part of the area where extreme meandering occurs is planned. The total length of improvement works is 6,000m.

5.2.5 On-Farm Facilities

Irrigation water will be supplied to each rotation block composed of 5 rotation units of 10ha. On-farm facilities are proposed to introduce modern water management and farming practices to the farmers concerned.

For diversion to main farm ditches from lateral canals or directly from the main canal, a double orifice turnout is proposed. Service area per turn-out is generally 50ha, while design capacity of the main farm ditch derived from the turnout was calculated at 2.242/sec/ha. Proposed orifice size is 0.60 XO. 40m with ɸ18" RC pipe.

On-farm canals consist of two types i.e., main farm ditches (MFO) and supplementary farm ditches (SFD). MFD were planned for a canal top width of 0.4m, side slope of 1:1, maximum allowable velocity of 0.65m/sec, minimum velocity of 0.2m/sec and freeboard of 0.20m. For SFD, a canal top width of 0.35m and a side slope of 1:1 were adopted. In addition, SFD were planned as irrigation cum drainage canals.

5.3 Road Network

Major features of the proposed road network plan are shown in the table on the following page while the proposed road network is presented above as FIG. -6.

PROPOSED ROAD NETWORK

Unit: km

Item	O&M Roads for Irrigation	Connecting Roads	Total
Main road effective width: 4.0m	98.25[1/]	15.3	113.55
Secondary road effective width: 4.0m	12.6	-	12.6
Improvement of existing roads	-	6.0	6.0
Total	110.85	21.3	132.15

1/ Includes 16.11km of improved existing road in Serruco.

Related works for proposed road network development consist of 13 bridges and 6 pipe road crossings.

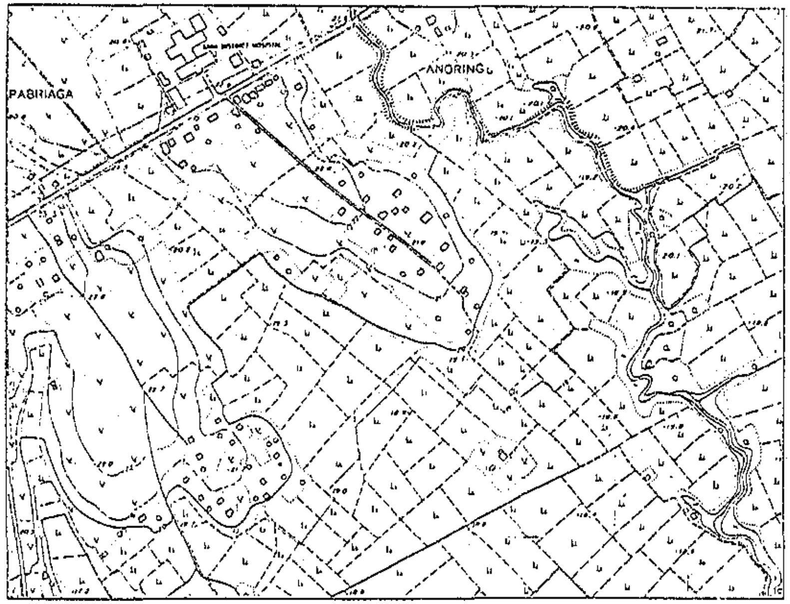
5.4 Integrated Community Center

Integrated Community Center facilities include a multipurpose pond, shallow wells and multipurpose concrete yard. Objective population for rural water supply is 27,400, and 100ℓ/day/person of water is designed to be supplied. Potable water required was assumed at 15ℓ/day/person and based on this amount one shallow well is planned for every 250 persons. Two shallow well units will be installed in each Center; thus one Center has a maximum potable water supply capacity of 500 persons. One multipurpose pond with a capacity of 150m^3 will be provided in every Center. This capacity allows storage of a 5-day water supply.

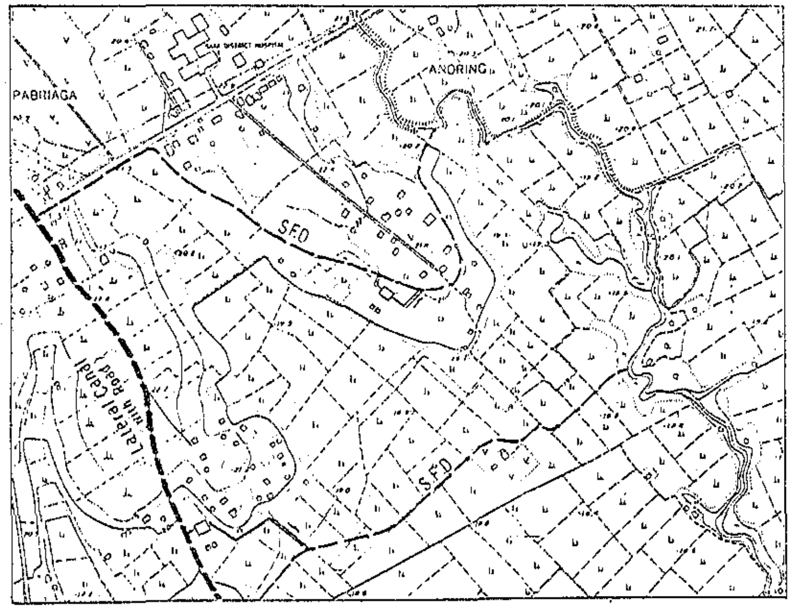
Dimensions of the multipurpose yard were determined based on rice drying capacity in the Project area after project implementation. A multipurpose yard is also planned in the area under the Sara Waterworks System. Accordingly, the 18 barangays under the Sara Waterworks System will be equipped only with a multipurpose yard.

The typical layout of an Integrated Community Center is presented in FIG. - 9, while major features of facilities are presented in the table below.

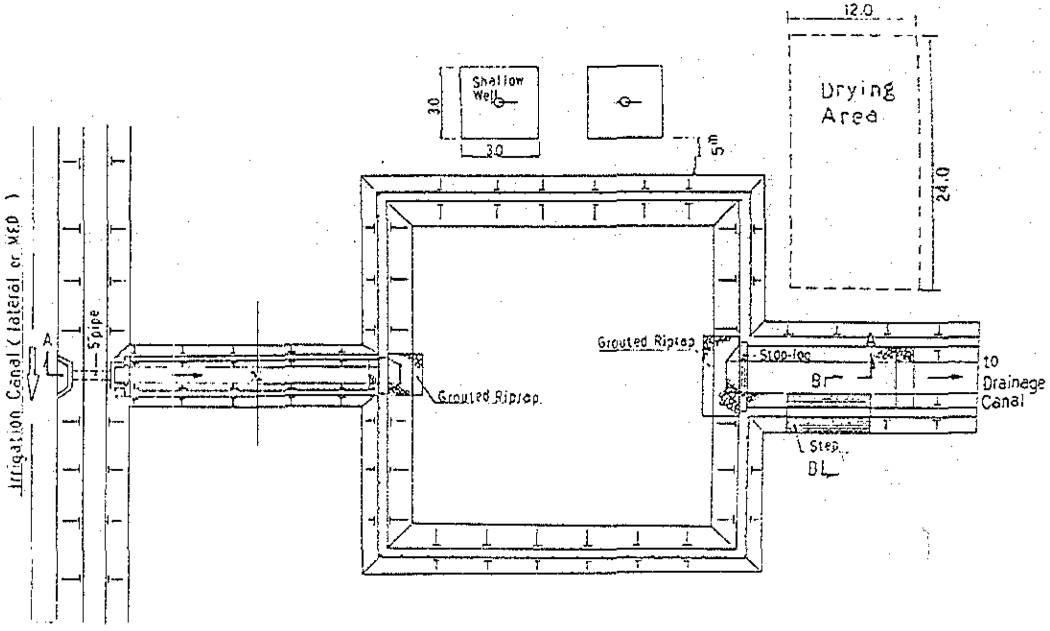
FIG. - 9



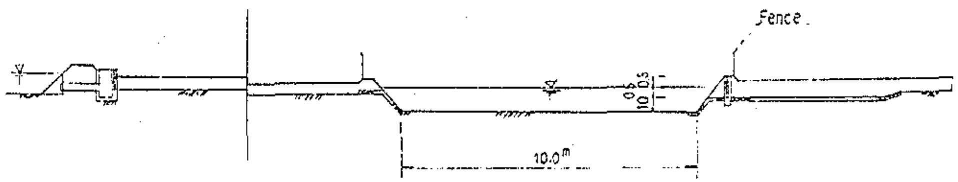
Without Project



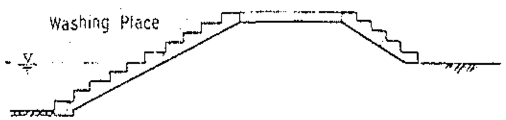
With Project



PLAIN



SECTION "A-A"



SECTION "B-B"

TYPICAL LAYOUT OF INTEGRATED COMMUNITY CENTER

MAJOR FEATURES OF INTEGRATED COMMUNITY CENTERS

ITEM	DESCRIPTION
1. Shallow well	Two units per ICC, 250 persons/well
2. Multipurpose pond	10m x 10m 1.5m depth
3. Multipurpose yard	12m x 24m = $288m^2$
ICC with shallow wells, a pond and a yard	100 sites
Multipurpose concrete yard	151 sites

5.5 Hydropower

5.5.1 Dam Site Power Station

The dam site power station will be installed utilizing the intake and release facilities and by-pass tunnel of the dam. The generator will be installed at the outlet of the by-pass tunnel and water will be lead to the generator through a 1,100mm dia. steel pipe which will be diverted from a 1,100mm dia. irrigation water release pipe. Water released from the generator will be led to the release pond, then diverted to the trans-diversion canal.

Main features and dimensions are presented in the following table.

MAJOR FEATURES OF THE DAM SITE POWER PLANT

Features	Type and Dimensions	
1. Leading Pipe		
- Steel pipe	1,100mm dia, L=30m	
2. Turbine and Generator		
- Turbine	Cross flow type	
	Max. intake water level	EL.124.0m
	Min. intake water level	EL.109.0m
	Tailrace water level	EL. 90.0m
	Max. gross head	34.0m
	Design discharge	$3.0m^3$/sec
	Turbine output	720kW
	Rated speed	215 r.p.m.
- Generator & transformer	Horizontal shaft synchronous three-phase	
	Capacity	730kVA
	Output	650kW
	Rated speed	900r.p.m.
3. Release Pond		
- Concrete box	3m x 5m x 2.5m depth	

5.5.2 Canal Route Power Station

The canal route power station will be installed in the upstream area of the Asue River basin. A head tank with a capacity of $180m^3$ and water level of EL. 82.50m will be installed at the outlet of the trans-diversion tunnel. Tailrace elevation is 42.5m, and gross head is thus 40.0m. The penstock which connects the head tank and turbine is a 1,100-1,200mm steel pipe, 428m long. Discharge will be led to the Asue River by a tailrace canal which is designed as a 158m long concrete flume canal.

A release will be installed at the head tank to discharge water when irrigation diversion water requirement exceeds generating water requirement, as well as to release surge water. A cross flow turbine is also proposed. Main features and dimensions are presented in the table on the following page.

MAJOR FEATURES OF CANAL ROUTE POWER PLANT

Features	Type and Dimensions	
1. Intake Facilities		
- Head tank	Capacity 180m^3	
	Two gates	
- Penstock	Dia 1,200mm L=273m	
	Dia 1,100mm L=155m Total 428.0m	
2. Turbine and Generator		
- Turbine	Cross flow type	
	Intake water level	EL.82.5m
	Tailrace water level	EL.42.4m
	Turbine axis elevation	EL.44.0m
	Gross head	40.0m
	Design discharge	3.0m^3/sec
	Turbine output	820kW
	Rated speed	240r.p.m.
- Generator	Horizontal shaft synchronous three phase	
	Capacity	840kVA
	Output	750kW
	Rated speed	900r.p.m.
3. Tailrace Conduit		
- Concrete flume canal	Width 2.0m L=150m	

5.5.3 Transmission Line

A transmission line will connect the two power stations and proposed ILECO II Sara Substation. Main features of the proposed transmission line are as follows:

- Total length 10.0km
- Voltage 13.2kV
- Cables 2/0 ACSR
- Insulators Porcelain
- Support Wooden pole

5.6 Domestic Water Supply

Proposed facilities for 0.0165m^3/sec of domestic water supply to the existing Sara Waterworks System are intake valve, pipe line and cleaning facilities.

(1) Intake Valve

Water will be diverted from the head tank installed at the inlet of the penstock for the canal route power station through a ϕ150mm manual sluice valve.

(2) Pipe line

The pipe line will be embedded from the intake to the existing main pipe of the Sara Waterworks System. The design capacity was determined at 0.0165m^3/sec while the diameter and the total length are ϕ150mm and 1,500m, respectively.

(3) Cleaning Facilities

Installation of a 1mm SUS mesh screen which can remove debris such as sand and weeds is planned just before connection with the existing pipe line.

CHAPTER VI

ORGANIZATION AND MANAGEMENT

CHAPTER VI

ORGANIZATION AND MANAGEMENT

6.1 Project Execution

The Project aims at river basin agricultural development with irrigation as the main component and supplementary components for rural development, i.e. road network development, hydropower generation, domestic water supply and integrated community centers.

NIA will be responsible for execution of the entire Project including pre-project planning and designing, as well as construction. For overall execution, NIA will appoint a Project Manager under the Assistant Administrator for Project Development and Implementation for the implementation of design and construction works.

The appointed Project Manager will be directly responsible for implementation of the Project and for coordinating the activities of all relevant agencies and farmers irrigators' associations. The said manager will be chief of the Project Construction Office which consists of the main office and 7 site offices. The proposed organization chart for the construction stage is presented in FIG. - 10. For smooth implementation and fruitful realization of effects, a coordinating committee under NIA consisting of the agencies related to electrification, rural water supply, road construction, etc. should be established.

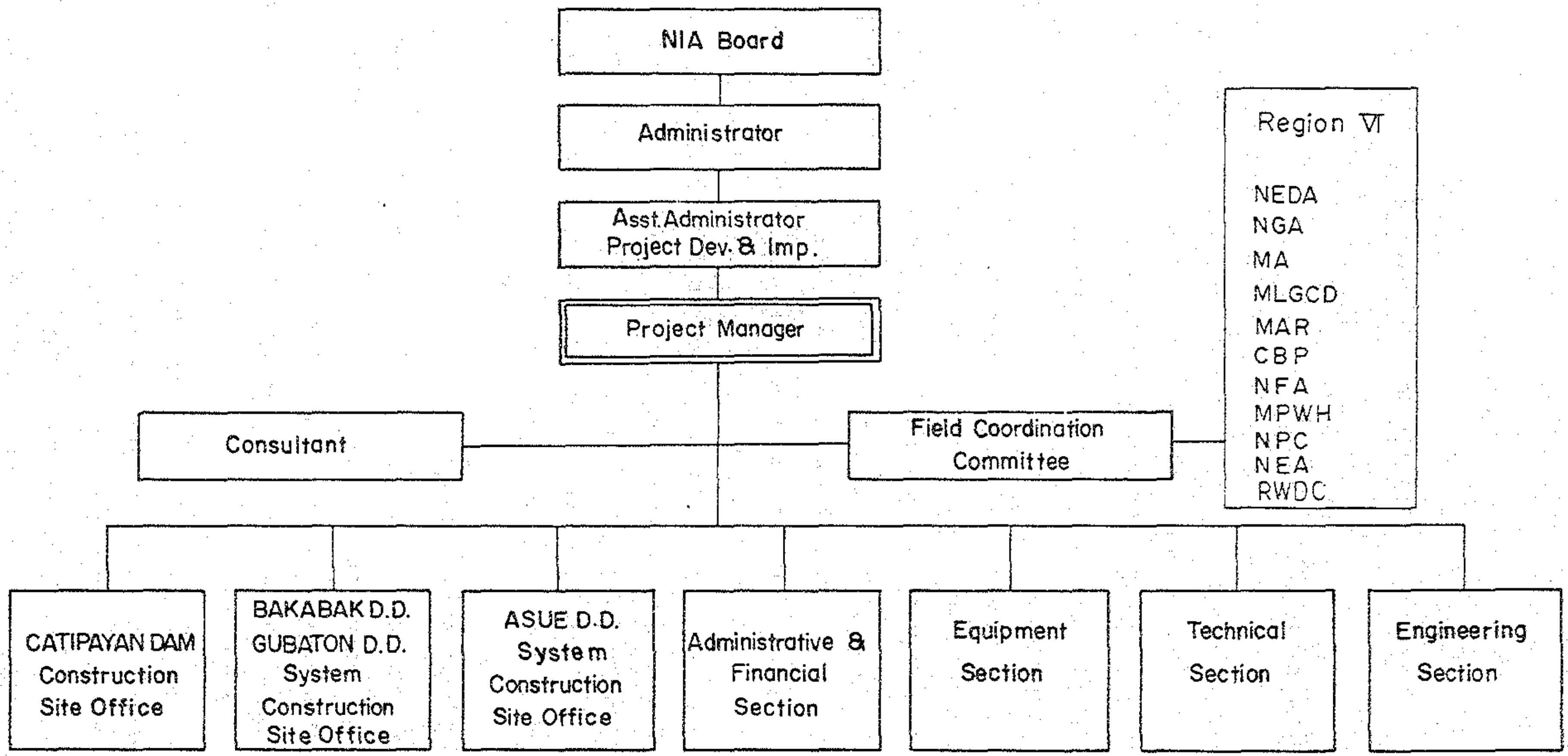
6.2 Implementation Schedule

On the basis of various conditions i.e. construction scale, capacity of construction machinery, capacity of procurement for equipment and materials, available labor force, annual workable days, etc., the implementation period was determined at seven years including a pre-project stage.

In the first year of the pre-project stage, detailed design, investigations and additional surveys will be conducted. Preparatory works such as construction of an access road, temporary works, land acquisition, etc. will commence in the second year. During the pre-project stage, completion of a cadastral map for the design of on-farm facilities and land procurement for facilities are recommended.

FIG. - 10

PROPOSED ORGANIZATION CHART FOR PROJECT EXECUTION



The construction schedule is proposed in consideration of smooth implementation, effectiveness and prompt realization of project benefit. The dam and related facilities for water resources development of the Catipayan River will be constructed from the first year of the construction stage. The works for irrigation and drainage such as irrigation facilities, drainage facilities, roads and on-farm facilities will be scheduled from the first year to the last year of this stage (FIG. - 11).

All main works and procurement of major equipment will be made on a contract basis. International or local contractors will execute construction works with machinery rented from NIA, and materials imported by the Government. Force account will be applied only to specialized works such as part of a survey or investigation. Construction works for on-farm facilities which may be conducted by local farmers under the direction of NIA, will also be executed by force account.

6.3 Organization for Operation and Maintenance Stage

6.3.1 General

During the D & M period, the Project Manager will be engaged in the said work under the Assistant Administrator for Operation of NIA. The components for rural development, i.e. roads, Integrated Community Center, hydropower station and domestic water supply will also be operated and maintained under the control of NIA. For the smooth management of the facilities and organizations, establishment of a management coordinating committee consisting of related agencies is recommended. In the initial stage of project development, NIA will be responsible for operation and maintenance of the diversion dams and main canals up to the turnout of the lateral canals. However, operation and maintenance will be gradually turned over to the farmers' organizations, i.e. irrigators' associations accompanied by training of the farmers. Irrigators' Associations will undertake operation and maintenance on a contract basis with NIA, and the association will be responsible for collection of irrigation water charges.

IMPLEMENTATION SCHEDULE FOR CONSTRUCTION

Item	Pre - Project Stage		Construction - Stage				
	1 st year	2 nd year	3 rd year	4 th year	5 th year	6 th year	7 th year
1) Dam							
Diversion Tunnel							
Coffer Dam							
Excavation							
Embankment							
Spillway							
Trans-diversion Canal							
Tunnel							
2) Hydropower Station							
3) Domestic Water Supply							
4) Irrigation and Drainage							
Diversion Dam			Bakabak D.D.	Gubaton D.D.	Asue D.D.		
Irrigation Canal							
Main Canal			5,780 m	8,430 m	8,380 m	6,160 m	1,120 m
Lateral Canal	Detail Design	Preparation Works	7,430 m	10,820 m	14,640 m	11,870 m	20,110 m
Drainage							
New Drainage Canal			6,400 m	5,300 m	2,500 m	2,100 m	5,200 m
Excavation of Creeks					1,500 m	4,500 m	
Drainage Structure					2 nos.	4 nos.	
Rehabil. for Up. of Asue R.					650 m		
Removal of Ex. Wiers							
On-Farm Development			1,360 ha	1,367 ha	1,403 ha	1,341 ha	1,289 ha
Facilities at H.P. Station							
5) Road (Excluding Service Road)							
New Road			6,750 m	1,350 m	900 m	2,400 m	3,900 m
Rehabil. for Ex. Road			3,700 m	800 m	1,400 m	100 m	
Related Structures			11 nos.	1 nos.	2 nos.	2 nos.	3 nos.
Enlargement of S. Road			2,160 m	1,910 m	5,620 m	2,910 m	
Along the Serruco CIS Canal			16,110 m				
6) Integrated Community Center			20 nos.	20 nos.	20 nos.	20 nos.	20 nos.
7) Dry Yard			31 nos.	30 nos.	30 nos.	30 nos.	30 nos.

6.3.2 Project Operation and Maintenance Office

With the progress of construction works, a part of the Project Construction Office will start functioning as an O & M Office. During these three years before the completion of the entire system, the Project Construction Office will be responsible for O & M activities.

The proposed organization chart for the Project O & M Office is presented in FIG. - 12. The Office will consist of 5 sections; namely, Administration, Dam and Reservoir, Agriculture Development, O & M and Collection Service and sections.

The proposed major roles for each section of the Project O & M Office are outlined below.

Administrative Section

The Administrative Section will be responsible for all administrative activities of the O & M Office.

O & M Section

The O & M Section will be responsible for the activities as outlined below:

a) estimation of the diversion water requirement and preparation of the water distribution schedule based on the cropping schedule obtained from farmers irrigators' associations (FIA) through senior water management technicians;

b) control and observation of the major irrigation facilities down to the turnout of on-farm ditches; and,

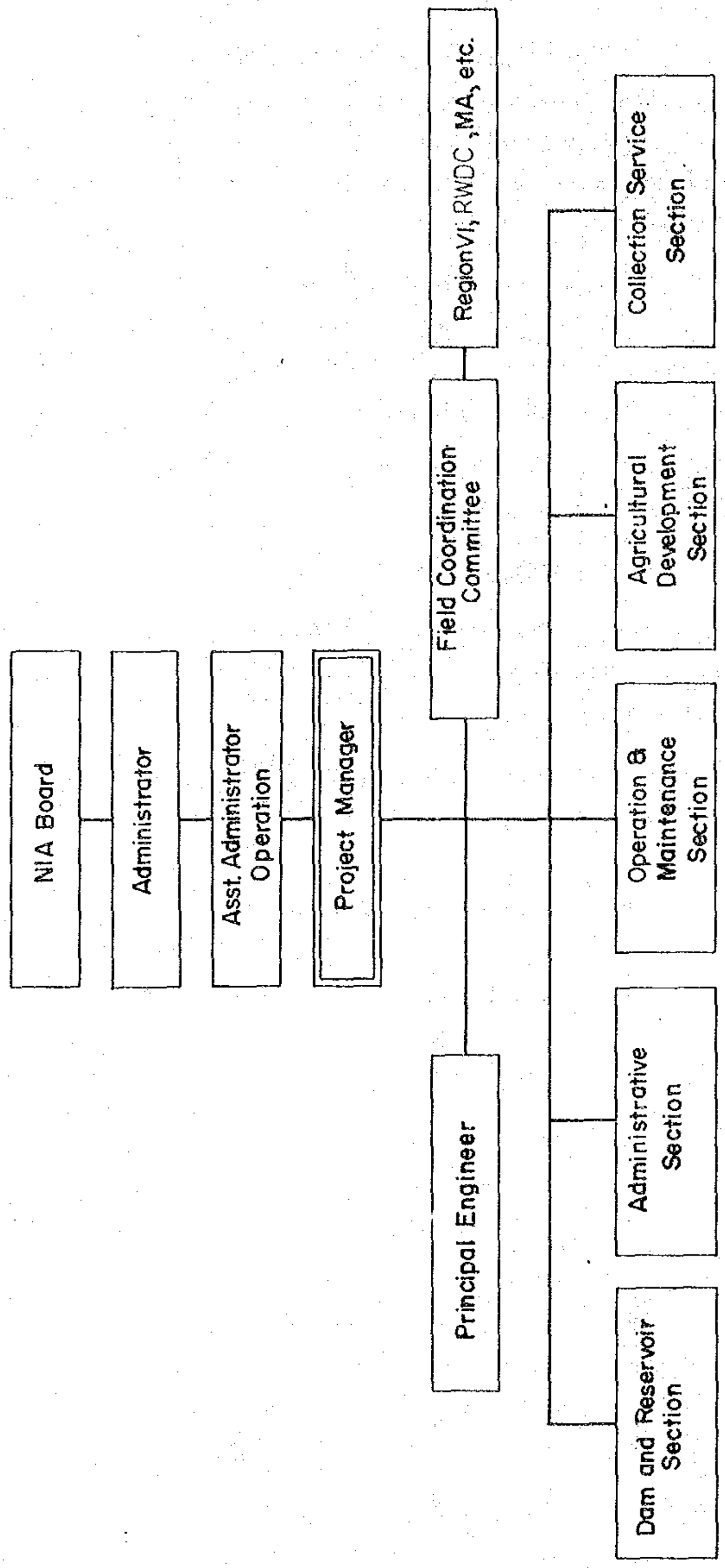
c) preparation of plans for and execution of maintenance and repair work for all major facilities such as irrigation and drainage systems, inspection roads, embankments, and all respective equipment.

Collection Service Section

The Collection Service section will be responsible for collecting irrigation fees through the federal FIA and for processing data on the said office's computor.

FIG. - 12

PROPOSED ORGANIZATION CHART FOR OPERATION AND MAINTENANCE



Agriculture Development Section

The Agriculture Development section will be responsible for assisting and advising farmers in the introduction of irrigated agricultural techniques at the farm level.

Dam and Reservoir Section

The Dam and Reservoir section will be responsible for water source management for irrigation as well as for power generation and domestic water supply.

6.4 Irrigators' Associations

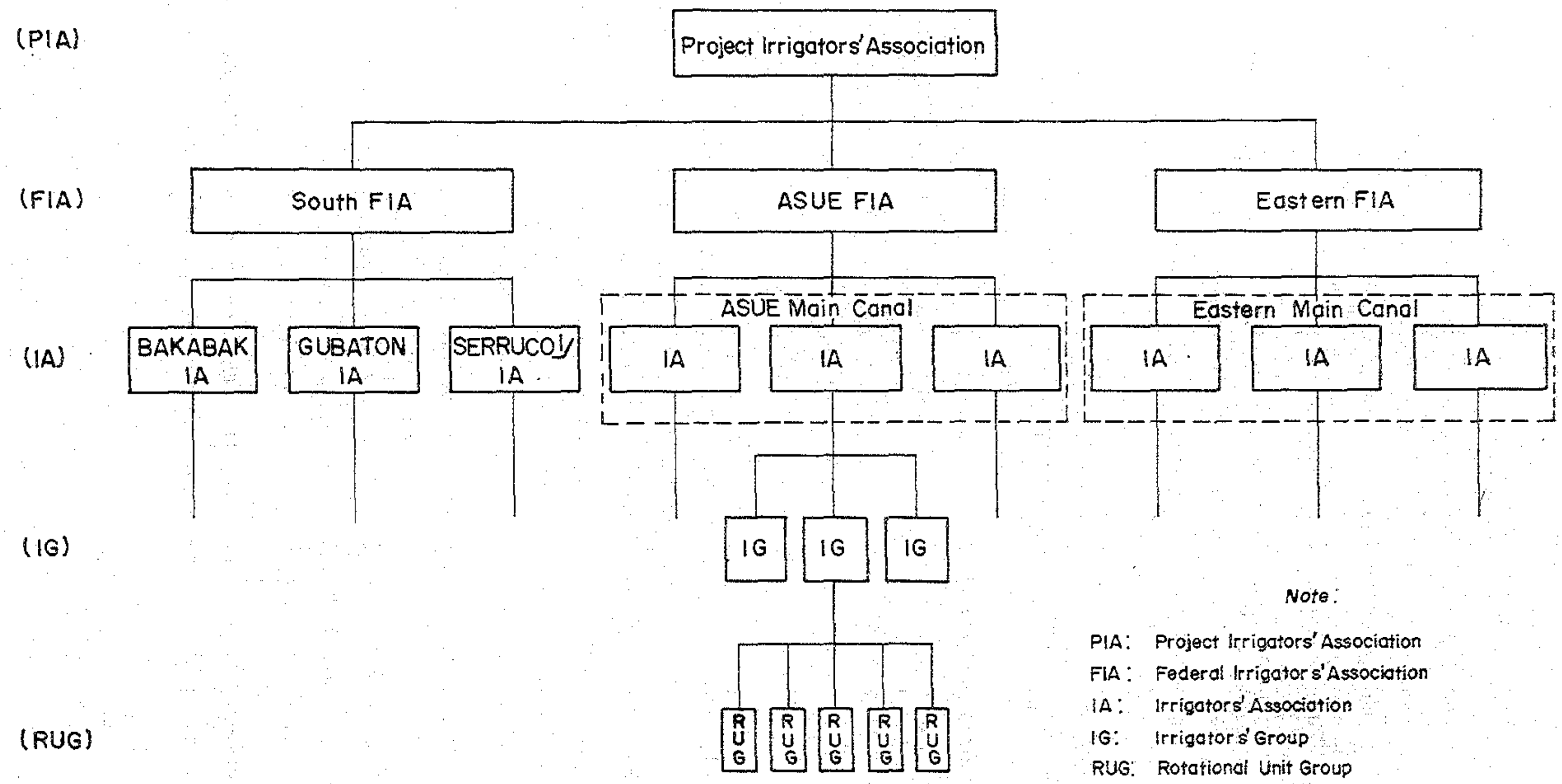
NIA is promoting and assisting in the establishment of irrigators' organizations by the farmers. Irrigators' associations under the present Project should be organized and managed for maintenance and expansion of irrigation facilities as well as for promoting agricultural development.

An irrigators' association will consist of one rotational unit group (RUG) with an area of approximately 10ha. Five rotational unit groups will form an irrigators' group (IG) with a rotational area of 50ha. Irrigators' associations (IA) will be organized by lateral canal system and/or small command area of the main canal with an area of 500 to 700ha. Moreover, irrigators' associations will be organized not only on the basis of the irrigation canal system, but according to the existing Samahang Nayon and barangay unit. Irrigators' organizations will be responsible for advising and training the maintenance staff to act for NIA in operation and maintenance of irrigation facilities.

The proposed organization chart for the irrigators' association is shown in FIG. - 13. The function of the organization is not only operation and maintenance of irrigation systems but also effective extension of agricultural activities, health care and sanitation activities in rural areas to promote the diffusion of rural development.

Furthermore, RUG and IA of existing CIS and KABSAKA impounding project areas will be preferably organized into the Project irrigators' associations.

PROPOSED FARMERS. IRRIGATORS' ASSOCIATION



1/: to be integrated into the new system.

FIG. - 13

CHAPTER VII

COST ESTIMATES

CHAPTER VII

COST ESTIMATES

7.1 General

Project cost consists of direct construction cost, land acquisition and compensation, O&M facilities cost, administration and engineering cost and physical and price contingencies. The following basic considerations were employed in this study.

a) Exchange rate used was US$ 1 / ₱ 19.00 / ¥ 240;

b) Major facilities will be constructed on the force account basis. Contract cost consists of direct cost, 10% overhead, 10% profit and 3% tax on the same, while force account cost consists of direct cost and 10% overhead;

c) All construction costs are estimated according to current market prices as of October 1984;

d) Physical contingency was estimated at 15% of the total cost, composed of direct construction, land acquisition, equipment and engineering administration costs; and,

e) Considering future cost escalation, price contingency was estimated as in the following table.

(Unit:%)

Year	Foreign Currency	Local Currency
1986	8.0	45.6
1987	9.0	12.0
1988	9.0	12.0
1989	9.0	12.0
1990	7.5	12.0
1991	6.0	12.0
1991	6.0	12.0

7.2 Project Cost Estimates

Accordingly, project cost for the original plan is estimated at ₱1,383,456 million. Details are shown in TABLE - 3, and summarized in the table presented on the subsequent page.

FINANCIAL CONSTRUCTION COST

(Unit: ₱ '000)

Item	Foreign Cost	Local Cost	Total
1. Dam			
a) Preparation works	2,040.0	1,360.0	3,400.0
b) By-pass tunnel	21,620.6	13,933.2	35,553.8
c) Inlet structure	283.9	181.0	464.9
d) Cofferdam	10,360.5	4,640.5	15,001.0
e) Excavation	34,270.5	14,069.3	48,339.8
f) Dam foundation treatment	7,288.0	4,976.7	12,264.7
g) Dam embankment	36,048.3	15,089.5	51,137.8
h) Spillway	28,229.4	33,384.7	61,614.1
i) Trans-diversion canal	31,193.6	53,607.8	84,801.4
j) Trans-diversion tunnel	3,117.6	1,824.3	4,941.9
k) Related facilities	16,351.7	3,545.3	19,897.0
Subtotal	190,804.1	146,612.3	337,416.4
2. Hydropower Station	35,951.5	6,196.0	42,147.6
3. Domestic Water Supply	965.0	223.0	1,188.0
4. Irrigation			
a) Preparation works	600.0	400.0	1,000.0
b) Diversion dam	29,340.0	13,474.0	42,814.0
c) Irrigation canal	24,843.7	41,998.0	66,841.7
d) Drainage	3,114.7	5,055.3	8.170.0
e) On-Farm	572.9	7,565.4	8,138.3
f) Structures for irrigation at power station	1,642.3	2,668.2	4,310.5
Subtotal	60,113.6	71,160.9	131,274.5
5. Roads	9,413.6	15,357.9	24,771.5
6. ICC	980.2	2,531.2	3,511.4
7. Drying Yard	1,837.4	3,208.6	5,046.0
Total	300,065.4	245,290.0	545,355.4
8. Land Aquisition (360 ha) (50 ha)	-	7,500.0	7,500.0
9. O & M Facilities	12,470.0	4,820.0	17,290.0
10. Administration and Engineering	43,600.0	21,400.0	65,00.0
11. Agricultural Extension	460.0		460.0
Total	356,595.4	279,010.0	635,605.4
12. Physical Contingency	53,489.3	41,851.5	95,340.8
Total	410,084.7	320,861.5	730,946.2
13. Price Contingency	205,617.6	446,892.5	652,510.1
TOTAL	615,702.3	767,754.0	1,383,456.3

PROJECT COST

Unit: ₱ 10^6

	FC	LC	Total
Financial Cost	356.595	279.010	635.605
Physical Contingency	53.489	41.852	95.341
Price Contingency	205.618	446.892	652.510
Project Cost	615.702	767.754	1,383.456

(1) Direct Construction Cost

Direct construction costs for work items are presented below.

DIRECT CONSTRUCTION COST

Unit: ₱ 10^6

Item	F.C.	L.C.	Total
1. Dam	190.804	146.612	337.416
2. Hydropower Station	35.952	6.196	42.148
3. Domestic Water Supply Facilities	0.965	0.223	1.188
4. Irrigation	60.114	71.161	131.275
5. Roads	9.414	15.358	24.772
6. ICC	0.980	2.531	3.511
7. Drying Yard	1.837	3.209	5.046
Total	300.065	245.290	545.335

(2) Land Acquisition

Costs of land acquisition were classified into two classes; agricultural land in the Project area and the hilly area in the Catipayan River basin, as tabulated below.

LAND ACQUISITION COST

Item	Area of Acquisition (ha)	Amount (₱ 10^6)
Agricultural land in the Project area	360	7.200
Hilly land in the Catipayan basin (including 4ha of paddy)	50	0.300
Total		7.500

(3) O & M Equipment

O&M equipment will be procured by the Government of the Philippines for the smooth operation and maintenance of facilities after completion of the Project. Requested O & M facilities and equipment cost was estimated at ₱ 17.29 million composed of F.C.₱ 12.470 million and L.C.₱ 4.820 million.

(4) Administration and Engineering Costs

The administration and engineering costs are estimated at F.C.₱ 43.6 million and L.C.₱ 21.4 totalling ₱ 65 million.

7.3 Annual Operation and Maintenance Costs and Replacement Cost

Annual operation and maintenance costs consist of staff salaries, materials and labor wages for repair and maintenance of Project facilities, and operation and maintenance cost for O & M equipment. The required cost was estimated at F.C.₱ 0.098 million and L.C.₱ 2.543 million, totalling ₱ 2.641 million.

Rubber dams, gates with accessories, and generators will be replaced once in 25 years and O & M equipment once in 10 years during a 50-year Project life.

7.4 Disbursement Schedule

The disbursement schedule for the original plan in accordance with the implementation schedule and Project cost is presented in the following table.

Financial Year	Foreign	Local	Total
1986	24,483.5	4,255.0	28,738.5
1987	35,327.0	31,223.2	66,550.1
1988	53,361.0	39,139.9	92,501.5
1989	39,545.6	31,364.6	70,910.2
1990	94,479.0	93,994.9	188,474.0
1991	143,911.7	101,520.5	245,432.2
1992	18,976.2	19,363.4	38,339.6
	410,084.7	320,865.5	730,946.2

CHAPTER VIII

PROJECT JUSTIFICATION

CHAPTER VIII

PROJECT JUSTIFICATION

8.1 General

The Project aims to enhance the living standards of beneficiaries in the Asue River basin and to rectify regional income disparities in the Philippines. To achieve the above two objectives, this Project, placing emphasis on irrigation, consists mainly of four plans; irrigated community centers, farm road network, hydropower plant and Sara Waterworks. The Project is one of the important regional development plans deeply related to the major governmental development policies delineated as follows:

- To increase agricultural productivity
- To provide opportunities for the unemployed and underemployed
- To correct economic growth disparities among rural areas

In this chapter, financial and economic analyses from the standpoints of private and national economy were carried out for project cost, operation and maintenance cost and benefits. Project cost and benefits were estimated by constant prices as of 1984.

8.2 Project Cost

Total Project construction cost for 6,760ha of proposed irrigation area is estimated at ₱730.95 million in financial value, which is equivalent to ₱108,000/ha and ₱590.52 million in economic value, which is equivalent to ₱87,000/ha. The tax for transfer expenditure is deducted from the local portion of the finanical project cost. This deducted finanical project cost was converted to the border price by multiplying by the conversion factor. The itemized conversion factors employed in the Philippines are those determined by the World Bank as follows:

- Standard Conversion Factor	0.820
- Conversion Factor for Capital Goods	0.865
- Conversion Factor for Consumption	0.840
- Conversion Factor for Electricity, Gas & Water	0.802
- Conversion Factor for Transportation	0.777
- Conversion Factor for Construction	0.827

From the above results, the conversion factor for each major work item is determined as follows:

- concrete work 0.622
- excavation work 0.574
- embankment work 0.507
- weighted mean of
- the above 0.568

This conversion factor is also applicable to the conversion for economic value of operation and maintenance cost. The proposed operation and maintenance cost per year reaches ₱2.64 million (₱390/ha) on a financial base and ₱2.20 million (₱325/ha) on an economic base. The cost of on-going pump irrigation in the Asue River basin, especi^lly in the lower reaches, is estimated at ₱1.28 million/year on a financial base and ₱1.15 million/year on an economic base. The implementation of this Project eliminates pump irrigation expenses.

On the assumption that the Project will be started in 1986, the variation of project cost is tabulated as in the following table.

Unit: 000₱

	Construciton Cost		O & M Cost		Total	
Year	Financial*	Economic	Financial	Economic	Financial	Economic
1986	28,739	26,730	-	-	28,739	26,730
1987	66,550	49,101	-	-	66,550	49,101
1988	92,502	75,855	744	703	91,750	75,152
1989	70,910	57,615	541	533	70,369	57,082
1990	188,474	148,701	541	533	187,933	148,168
1991	245,432	202,410	862	638	246,294	203,048
1992 -2035	38,339	30,108	1,366	1,055	39,705	31,163
1997 (every 10 years)	-	-	7,070	0,070	7,070	7,070
2012 (Total)	- (730,946)	- (590,520)	50,493	50,085	50,493	50,085

Note: *..... excluded price contingency.