4. 5 Agricultural Infrastructure Plan

4. 5. 1 Irrigation Plan

a) General

Regarding the irrigation development plan in the Study Area, staple and cash crops such as paddy, upland crops are proposed to be irrigated. Fruit trees will be planted in rainfed areas due to such restrictions as topography and elevation conditions. Generally, furrow irrigation method will be adopted for upland crops and vegetables.

Proposed irrigation component includes the water resources facility and irrigation canal system of up to 30 to 50 ha block, and on-farm facilities for effective utilization of the system. Operation and maintenance works of these irrigation facilities including water charge collection will be done by an Irrigator's Association to be organized in the Area.

b) Unit Water Requirement

The diversion water requirement (DWR) for irrigation is estimated based on the proposed two cropping calendars (refer to section. 4.4). DWR is the total amount of water diverted from a source for evapotranspiration, percolation, field loss, conveyance loss and operation loss, less effective rainfall in the field. In addition to the water for growing period mentioned above, water for nursery beds and land preparation are also required for paddy cultivation.

1) Crop Consumptive Use (Cu)

The estimate for crop consumptive use was conducted based on the FAO Irrigation and Drainage Paper No.24 owing to no available data observed. The evapotranspiration was estimated based on the Aborlan climate data (PAGASA, 17 years duration from 1977 to 1993) by applying the modified Penman method.

2) Percolation

Based on the field test, the field percolations for the dry and wet season are designed at 3.0 and 2.5 mm/day, respectively.

3) Water for Land Preparation

Soil saturation and submergence water during land preparation period in the paddy field are required for continuous 30 days before plantation. Further, the evaporation and percolation requirement during these period shall be taken into account. Consequently, 340 mm of land preparation water are adopted for the wet season. The area of nursery bed is five (5) percent of the paddy field and nursery bed will be made prior to 30 days of transplant of paddy. The water requirement for nursery is included with the land preparation water described above.

4) Effective Rainfall

The effective rainfall is the quantity of rain effectively used in the irrigation service area. Since there are no available data observed concerning effective rainfall, the estimate of effective rainfall is based on NIA's guideline for planning and design, such that the effective rainfall shall be less than 80 mm per 10 days.

5) Irrigation Efficiency

A part of the irrigation water will be lost during the conveyance and operation from the source to the field, and lost in the field at a rate depending upon irrigation method and field conditions. Referring to NIA's guideline for planning and design, and 7th Operation and Maintenance Plan, the irrigation efficiency is established as follows:

Items	Irrigation Efficiency	
Efficiency	For Paddy	For Vegetable & Upland Crops
Field	0.80	0.70
Conveyance	0.80	0.80
Operation	0.80	0.80
Overall	0.50	0.45

6) Unit Net Water Requirement and Diversion Water Requirement

The following three (3) cropping patterns are introduced to the beneficiary area.

Type	Wet Season	Dry Season
Type 1	Paddy	Vegetable & Upland
Type 2	Vegetable and Upland crops (Full season)	
Type 3	Tree crops(Full season)	
(The former two (2) types are to be irrigated)		

The net water requirement, and average diversion water requirement per 1,000 ha considering effective rainfall and irrigation efficiency, for the two (2) typical cropping patterns are as follows;

Net Water Requirement and Average Diversion Water Requirement

(Unit: MCM/1,000 ha)

Month	Rainfall	Type 1		Type 2	
		N. W	D. W	N. W	D. W
Jan.	0.35	0.96	1.60	1.13	1.97
Feb.	0.15	1.12	2.18	0.67	1.21
Mar.	0.33	0.64	1.18	0.08	0.13
Apr.	0.44	0.02	0.02	-	-
May	1.25	-	-	-	-
Jun.	1.63	1.91	1.44	0.32	0.03
Jul.	1.88	2.48	1.13	0.92	0.28
Aug.	1.73	2.02	1.26	1.17	0.48
Sep.	1.81	1.66	0.86	0.63	0.14
Oct.	2.12	0.26	0.00	0.04	0.00
Nov.	2.83	0.06	0.00	0.31	0.02
Dec.	1.29	0.49	0.45	0.92	0.97
Total	15.81	11.62	10.12	6.19	5.23

Note: N.W : Net water requirement
D. W: Diversion water requirement

c) Irrigable Area

The irrigable area will be determined taking into account soil suitability, topography and irrigation system in the Study Area.

Since the Study Area has undulated topography, the area of steep slope and water resources sites are omitted from the proposed beneficiary area

as reported in section 4.3. The area above 40 m MSL mostly consists of lands with steep slope of more than 8% because of topographical condition. The irrigable area therefore shall be selected below 40 m MSL. Based on the topographical map with a scale of 1/4,000, the canal land and unsuitable area for agricultural farm shall be subtracted from the applicable area of irrigation below 40 m MSL, resulting in the gross irrigable area of 590 ha as shown below;

Applicable area for irrigation :	895 ha		
* Irrigable area	590 ha		
- Type 1 crops		430 ha	(Wet season paddy + Dry season vegetable and upland)
- Type 2 crops		160 ha	(Vegetable and Upland)
* Non-irrigable area	305 ha		
- Type 3 crops		90 ha	(Tree crop)
- Forest, etc.		215 ha	

d) Average Diversion Water Requirement

Based on the irrigable area mentioned above, the average diversion water requirements are estimated in order to formulate the water resources development. The net irrigable area employed is equivalent to 90% of the gross irrigable area subtracting lands for road and irrigation systems. The average annual diversion water requirements are as follows;

	Cropping Pattern		
	Type 1	Type 2	Total
(1) Net Area (ha)	387	144	531
(2) Average annual D.W.R.			
• 200% of Cropping Intensity			
Unit Water Requirement (MCM/1,000 ha)	10.12	5.23	
Total Water Requirement (MCM)	3.92	0.75	4.67
• 130% of Cropping Intensity			
Unit Water Requirement (MCM/1,000 ha)	5.94	1.60	
Total Water Requirement (MCM)	2.30	0.23	2.53

4. 5. 2 Drainage Plan

a) General

The removal of excess irrigation water and rainfall from the soil surface is necessary to prevent crop damage. The drainage plan will be formulated with the following concepts.

① The natural streams and rivers in the Study Area shall be utilized for drainage systems as much as possible.

② The capacity of drainage canal will be designed under the conditions with runoff coefficient of 80% and two (2) days drainage period for the maximum daily rainfall with a five (5) years return period referring to NIA's planning guideline.

b) Drainage Module

In accordance with the concepts described above, the design drainage module is determined as follows;

Design rainfall	:	138.6 mm/day (Probably rainfall with a return period of five (5) years)
Drainage module	:	80 % of the design rainfall for two (2) days drain = 55.4 mm/day (= 6.4 lit/sec/ha)

4. 5. 3 Farm-to-Market Road Plan

The farm road system is necessary for farming and marketing works. The DAR has planned a road system with the right of way of ten (10) and 20 m in width. The road alignment for the Tagumpay area is based on the DAR farm lot alignment plan. For the outlying area, the road alignment proposed will take into consideration topographic condition and lower investment cost. In addition to this plan, operation and maintenance roads will be provided along the canals. These roads can be utilized as farm road system. The proposed road widths of the main farm-to-market road and farm-to-market road are eight (8) and six (6) m, respectively, based on the other plan. According to NIA's standard for canal maintenance road, the four (4) m width of maintenance roads (3 m width of gravel pavement) would be applied taking into account the scale of canal system maybe equivalent to the lateral canal system at the national level.

4.6 Water Resources Development

4.6.1 Potential Water Resources Sites and Its Development Type

There are such water resources development types as storage dam type, diversion dam type and mountain stream diversion type, and gravity intake and pumping intake from the viewpoint of intake method.

Based on the topo-map with a scale of 1/50,000 and field investigations,0 six (6) potential water resources sites, four (4) sites at the Inagawan river, namely site A, B, C, and D at the Inagawan river, and two (2) sites at the Pinagsaluran river, namely site E and F, were preliminarily nominated taking into account storage capability and simplicity of design. (refer to Figure 4.6.1)

Site A and B are considered to be good potential sites because of effective storage capacity and wider watershed area. But in addition to the construction of the storage dams at each site, the introduction of diversion dam at Site D will be required for water utilization at these sites due to its far distance from the beneficiary area. In this connection, the construction of the storage dam at the Inagawan river will affect the vast reserved forest due to long construction period, and may cause environmental problem in the basin. Further, construction of both facilities, storage and diversion dams are not economical in these sites. Therefore, these two (2) sites were excluded from the potential water resources sites.

Based on the topo map with a scale of 1/4,000 and field reconnaissance survey, the development type applicable for each of the preliminary sites selected were identified as follows:

River	Site	W.A (sq.km)	Development Type
Inagawan River	Site C	110.7	Gravity Intake, Diversion*1
	Site D	118.1	ditto
	Site LD	118.5	Pumping Intake, Diversion
Pinagsaluran River	Site E		
	Site E	14.5	Gravity Intake, Storage Dam
	Site E1	15.0	ditto
	Site EuM	13.9	Gravity Intake, Mountain Stream Diversion*1

W.A; Watershed area.
*1 : with small storage capacity

4. 6. 2 Construction Conditions

The topographical and geological conditions, inclusive of construction materials are important factors for the selection of potential water resources sites. A summary of the conditions of the proposed sites are presented below; (refer to Appendix E.1 and E.2)

a) Geography

Sites C, D and LD are located at the immediate downstream where the Inagawan river flows from the mountain area to the hill area. They are planned at the point of approximately 100 m, 700 m and 1,100 m as Site C, D and LD, respectively, from the final wide meander point of the Inagawan river towards the downstream direction. (refer Figure 4.6.2)

The topographical condition of Site C is composed of a V-shaped valley with steep slopes and cliffs at both abutments. Site D has a similar topographical condition as that of Site C, except that valley width is broad, about 180 m. The left side abutment of Sites C and D forms a thin ridge, which is attributed to the effective erosion of the meandering area. Site LD has a steep slope at the left abutment and with gentler slope at the right abutment characterized by broad valley, about 200 m in width.

Sites Eu and El are located at the Pinagsaluran river. Site Eu is located at about 700 m from Site El towards the upstream direction along the Pinagsaluran river. The left side abutment of this site has steeper slope while the right side abutment presents somewhat gentler slope. The neighboring area is characterized by small hills, sporadically scattered. The proposed site El is located just at the upstream of the place where the Pinagsaluran river flows into the hill area. The left side abutment of this site has steeper slope with fan shaped features at the foot place, while the right side abutment has somewhat gentler slope. (refer to Figure 4.6.3)

b) Geology

- Site C

Field reconnaissance reveal, however, a continuous outcrop of hard schist belonging to the Inagawan Metamorphics along the river side

and a part of both abutments. Based on this, it can be inferred that the highly weathered zone at both abutments are less than five (5) m deep while the alluvial deposit at the river bed are less than five (5) m thick, indicating that geological conditions are excellent for dam foundation as compared with Sites D and LD.

- Site D

Base rock of this site is composed of member of the Inagawan Metamorphics. The highly weathered zone is five (5) to six (6) m deep while the moderately weathered zone, about ten (10) m thick at the right abutment. Fresh rock zone is identified at depths of about 15 m. Coefficient of permeability of highly weathered zone and moderately weathered zone indicate $n \times 10^{-3}$ to $n \times 10^{-4}$ cm/sec, respectively.

At the river area, unconsolidated sand and gravel layer which corresponds to the alluvial and diluvial deposit is found to be presented up to 20.5 m of the borehole bottom. Coefficient of permeability of this layer is $n \times 10^{-3}$ cm/sec which shows high permeable characteristic. Based on this findings, it can be presumed that special foundation treatment (diaphragm method etc.) for dam construction will be necessary to prevent seepage flow.

- Site LD

Base rock of this site is underlain by member of the Mt. Beaufort Ultramafics and the Stavely Range Gabbro. Geological conditions as to weathered zone are inferred to be similar to that of site D. At the flood plain, the same predominant sand and gravel layer, alluvial and diluvial deposit, are also identified up to 25.5 m. Coefficient of permeability of this layer is $n \times 10^{-3}$ cm/sec, also, indicating a highly permeable characteristic. Particular attention should therefore be paid to the prevention of seepage flow into the foundation when either dam or weir are proposed to be constructed.

- Site Eu

The base rock of Site Eu is made up with the Inagawan Metamorphics and the Mt. Beaufort Ultramafics, mainly situated at the right abutment. Findings show that at the left abutment and near the top of a small hill at approximately the mid-area of both abutments, overburden deposit are observed at the depth of about four (4) to seven (7) m. The highly weathered zone are identified at the depth of about 1.5 m, and fresh rock zone at the depth of about 13 to 14 m. The moderately weathered zones are found to be four (4) to nine (9) m thick. On the other hand, at the right abutment, overburden deposit and

highly weathered zones are identified as thin layer with total thickness of 1.5 m. The moderately weathered zone has a thickness of about six (6) m as a whole. Fresh rock is present at depth of about seven (7) m. Furthermore, the thickness of alluvial deposit (recent river deposit) at the Pinagsaluran river and its tributaries is inferred as less than 5 m. Coefficient of permeability of the overburden deposit and the highly weathered zone is n $\times$ 10^{-3} cm/sec while that of the moderately weathered zone and fresh rock zone is n$\times 10^{-4}$ cm/sec.

From the engineering geological viewpoint, it has been pointed out that geological condition for dam foundation of this Site is excellent as compared to Site El.

- Site El

Base rock consists of member of the Inagawan Metamorphics, the Mt. Beaufort Ultramafics and the Iwahig Formation. The sand and gravel layer as recent talus deposit and the Iwahig Formation are widespread at the foot area of the left abutment, with a thickness of about 29 m. At the river bed of the Pinagsaluran river, the sand and gravel layer as recent river deposit and the Iwahig Formation are also defined with a total thickness of 19 m. These sand and gravel layer indicate a coefficient of permeability of n$\times 10^{-3}$ to n$\times 10^{-2}$ cm/sec, indicating a highly permeable characteristic. The thickness of the weathered zone is not clear. However, at the right abutment, it can be inferred that weathering condition is similar to that of Site Eu, based on the findings of the results of neighbor borehole, No. E5.

Taking both the large-scale distribution and high permeable characteristic of sand and gravel layer into consideration, it is concluded that this site is not advantageous for dam construction because of the need to include special foundation treatment (diaphragm method, special grouting method and blanket method etc.) which would involve large cost to prevent seepage flow.

c) Conditions of Borrow Area and Characteristics of Embankment Material

Borrow area A is situated at the right side of the downstream area of Site El. This borrow area is generally characterized as gravelly clay, gravelly silt and clayey sand facies (GC, GM and SC as soil type). Finding shows that the soil materials have good grain size distribution curve as a whole but large amounts of fine parts are observed in the grain size. Soil materials in this area have large compaction effect,

with impermeable characteristic and large shearing strength on the condition that compaction are satisfactory carried out. The feature described above suggests that soil materials derived from borrow area A can be used as core material for dam embankment. (refer to Figure 4.6.3)

Borrow area B is situated near Site Eu while borrow area C at the foot of the left side abutment of Site El. At borrow area B, there are a variety of soil materials identified, mainly composed of gravelly clay, gravelly silt, clayey sand and silt (GC, GM, SC and MH as soil type). Furthermore, at borrow area C, soil facies observed are gravelly clay and gravelly silt (GC, GM as soil type). They have good grain size distribution curve as a whole, similar to that of borrow area A though indicating a more rich coarse grain size. The result of compaction test is 1.64 to 1.77 kg/sq.cm as maximum dry density, which indicate large compaction effect as soil material. Taking these soil feature into consideration, it is presumed that the soil materials of these borrow area have sufficient shearing strength for random material.

Borrow area D is located along the Pinagsaluran river of the downstream of Site El. The material of this borrow area is characterized by rich gravel and sand (GW, GC and SW as soil type) which can be used as filter zone for fill-dam. Furthermore, borrow area E is situated at the terrace plain near the confluence point of the Inagawan and Pinagsaluran rivers. Riprap material and some coarse aggregate for concrete, in sufficient quality as well as its gravel size, can be collected from this borrow area.

Concrete aggregate can be borrowed from sand and gravel layer along the Inagawan and Pinagsaluran river-beds after screening such materials.

d) Topographical Conditions

Site C:
- Site with five (5) dam span and height rate is located at the most upstream place formed with the narrowest shape among the nominated water resources sites.
- The river-bed elevation is 23.5 m, lower than that of the beneficiary area, so that the application of gravity intake requires a high dam construction.

Site D:
- Site with eight (8) dam span and height rate is located at about 500 m downstream from Site C.
- The riverbed elevation is lower, 21.2 m MSL as Site C. The application of gravity intake is required to build a high dam.

Site LD:
- Site is located downstream farther, about 500 m from Site D with the riverbed elevation of 19.5 m MSL.
- Other conditions are as same as the Site D

Site Eu:
- Site forms a wide and inverse trapezoid shape with 30 dam span and height rate, as to be applicable for fill-type dam.
- There exists the Pinagsaluran river at the left portion, its tributary at the middle and a creek at the right along the dam axis. The lowest river bed elevation is 34.5 m MSL, where a gravity irrigation for the proposed beneficiary area would be advantageous.

Site El:
- Site is located downstream of the confluence of the Pinagsaluran river and its tributary has a better effective storage capacity than that of Site Eu. The site forms a wider and inverse trapezoid shape with 35 dam span and height rate, as to be applicable for fill type dam like Site Eu.
- The lowest river-bed elevation is 29.0 m MSL, applicable for a gravity irrigation method when considering the sedimentation level.

4.6.3 Water Balance Study

In order to establish the optimum scale of the water resources facilities, the water balance study for potential water resources sites were carried out on a 10 day basis for the duration of 17 years. (refer to Appendix C.3)

a) Conditions

The water demands include 15 lit/sec/100 sq.km of river maintenance water and 430 lit/sec of water right for the existing irrigation system in addition to the irrigation water requirement for the project. Furthermore, the water losses of evaporation from reservoir surface of 70 % of pan evaporation and seepage loss in reservoir of 0.05 % per day of storage in the reservoir are taken into account in the water balance study. The water balance study was carried out based on the proposed cropping calender shown in section. 4.4.

b) Results of Water Balance Study

The case study for water balance for each site was made with varying cropping intensity and shortage time during 17 years. In the Philippines, once in five (5) years of shortage time is acceptable for the reservoir operation study, so to apply three (3) times shortage during 17 years for this study is considered applicable. The results of water balance study in the case of 590 ha irrigable area with double cropping (200 percent of cropping intensity) are summarized as follows;

Site	Watershed (km^2)	Annual Av. Runoff (MCM)	Annual Water Requirement R. M (MCM)	W. P (MCM)	I. W (MCM)	Effective Storage (MCM)
(Inagawan River)						
Site C	110.7	99.3	0.5	13.6	4.3	0.21
Site D	118.1	105.9	0.6	13.6	4.3	0.20
Site LD	118.5	106.3	0.6	13.6	4.3	0.20
(Pinagsaluran River)						
Site Eu	14.5	13.0	0.1	-	4.3	1.65
Site El	15.0	13.5	0.1	-	4.3	1.61

(Note) R.M : River Maintenance
W.P : Water Permit of Existing Irrigation System
I. W ; Irrigation Water

In addition, Site EuM is a preferable site for a small scale water resources development such as mountain stream diversion works. The site which has 0.20 MCM effective storage capacity at the maximum due to topographical restriction, is available for the following irrigable area under three (3) times shortage for the duration of 17 years.

Wet season :	Paddy 430 ha + Upland crops	160 ha =	590 ha
Dry season :	Upland crop and vegetable		177 ha

Figures 4.6.4 and 4.6.5 show the results of water balance study.

4. 6. 4 Proposed Water Resources Plan

a) Dimension and Construction Cost

The facility dimensions and construction costs for each potential water resources based on the results of water balance study mentioned above are proposed and estimated, in accordance with the design concept stipulated in section 5.1 and the estimated method in section. 5.7. (refer to Table 4. 6. 1)

b) Site Evaluation

The selection of optimum water resources site for the project shall be made from various viewpoints such as irrigable area, easiness of construction, environment, economical construction cost including operation and maintenance cost. (refer to Table 4.6.2.)

The table indicates that implementation of Site EuM which has lower cropping intensity among the potential water resources sites, only 130%, is judged to be viable because of its good condition. In case of double cropping (200% cropping intensity), two (2) sites, Site LD (diversion type dam with pumping intake at the Inagawan river) and Site Eu (storage type dam with gravity intake at the Pinagsaluran river) have higher priority for water resources development for the project. However, the latter site, Site Eu is presently judged to be more advantageous site from the viewpoint of operation and maintenance.

c) Proposed Water Resources Plan

The Tagumpay settlement area which has a large share of the proposed irrigable area in the Study Area, has already been distributed to the farmers. However, many of these farmers have not yet settled in the area, since they cannot cultivate the land due to the absence of water resources and

irrigation facilities. In order to ensure success of agrarian reform which is one of important national program, introduction of irrigation facilities are urgently required.

The farmers beneficiaries are simple people, not familiar with irrigated farming. The introduction of irrigation facilities which would immediately require double cropping cultivation with high construction cost, would not be very effective at this time. It is for this reason that the water resources development plan for the Study Area shall be proposed to be undertaken in stages.

The mountain stream diversion type at Site EuM would be proposed during the first stage due to considerations of economical construction cost and immediate effect. The second stage development will consist of the construction of the reservoir project at Site Eu.

Table 4. 6. 1 Alternative Plan of Water resources Sites

Site		Site Eu	Site El	Site D	Site C	Site EuM	Site LD	Remarks
(1) Intake Type		Gravity w/Reservoir					Pump w/Weir	
(2) Water Resources								
a) River Name		Pinagsaluran	Pinagsaluran	Inagawan	Inagawan	Pinagsaluran	Inagawan	
b) Watershed	(km^2)	14.5	15.0	118.1	110.7	13.9	118.5	
c) Riverbed Elevation	(m)	34.5	29.0	21.2	23.5	34.5	19.5	
(3) Reservoir								
a) Required E. Storage	(MCM)	1.65	1.61	0.20	0.21	0.20	0.20	
b) Sediment Volume	(MCM)	0.44	0.45	2.36	2.21	0.11	-	
c) Dead Volume	(MCM)	0.44	0.45	2.36	2.21	0.11	0.06	
d) N.W.L (MSL)	(m)	54.00	46.50	40.00	42.50	45.00	25.50	
e) L.W.L (MSL)	(m)	46.00	37.80	39.00	42.00	41.00	21.50	
f) W. Surface at N.W.L	(ha)	29	28	33	31	8	9	
(4) Major Feature of Dam/Weir								
a) Dam Type		Filltype Dam	Filltype Dam	Concrete Dam	Concrete Dam	Filltype Dam	Concrete Weir	
b) Dam Crest Elevation	(m)	58.00	50.50	44.00	47.00	50.00	31.50	
c) Dam Height	(m)	28.0	25.5	46.0	30.0	20.0	14.5	
d) Dam Crest Length	(m)	875	868	355	155	239	221	
e) Design Flood Discharge	(c.m.s)	430	440	1,600	1,550	420	990	
f) Intake Discharge 1	(c.m.s)	0.84	0.84	0.84	0.84	0.84	-	
Intake Discharge 2	(c.m.s)	-	-	0.45	0.45	-	0.45	
(5) Major Feature of Pump								
a) Type of Pump		-	-	-	-	-	Vertical Pump	
b) Design Head	(m)	-	-	-	-	-	ø450×3sets	
c) Design Discharge	(c.m.s)	-	-	-	-	-	0.84	
d) Output of Pump	(KW)	-	-	-	-	-	190×3 sets	
(6) Approx. Direct Construction Cost								
a) Dam/Weir	(M.P)	437	607	1,514	483	169	188	
b) Leading Canal	(M.P)	7	4	38	62	7	38	
c) Pump	(M.P)	-	-	-	-	-	116	
d) Total Construction Cost	(M.P)	444	611	1,552	545	176	342	

(Note) Intake Discharge 1 : Discharge for the project
Intake Discharge 2 : Discharge for the existing project & river maintenance flow
Conditions:
Irrigable Area (ha) 590
Type I Area (ha) 430 (Paddy + Upland crop)
Type II Area (ha) 160 (Vegetable + Upland crop)

Table 4. 6. 2 Evaluation Table of Potential Water Resources Sites

	Site Eu	Site El	Site D	Site C	Site EuM	Site LD
Watershed (km^2)	14.5	15.0	118.1	110.7	13.9	118.5
Intake Type	Gravity Intake					Pumping Intake
Cropping Intensity	200%				130%	200%
App. Construction Cost (MP)	444	611	1,552	545	176	342
App. O & M for Pump Cost (MP)	-	-	-	-	-	77
(Evaluation)						
- Irrigation Conditions	5	5	5	5	1	5
- Construction Conditions	3	1	1	1	5	3
- Environment Conditions	3	3	1	1	5	5
- Construction Cost	3	3	1	3	5	3
- O & M Conditions	5	5	3	3	5	1
Total Score	19	17	11	13	21	17
Ranking	2	3	6	5	1	3

(Evaluation Criteria)

Item	Score	Contents
Irrigation Conditions	5	200% cropping intensity
	3	200 ~ 15% cropping intensity
	1	less than 150% cropping intensity
Construction Conditions	5	Short construction period, reliable construction
	3	Two to three years of construction term, many unknown factors for construction
	1	Long construction period, more than three years, unreliable and/or difficult construction
Environment Conditions	5	Less or few effect to the surrounding natural resources such as river water and forest
	3	Rather large effect
	1	Large effect
Construction Cost	5	Lower construction cost
	3	Medium construction cost
	1	Higher construction cost
Operation and Maintenance Conditions	5	Economical and easy O & M
	3	Intermediate
	1	Expensive and difficult O & M

Figure 4.6.1 Location Map of Possible Sites for Water Resources Development (Scale 1:50,000)

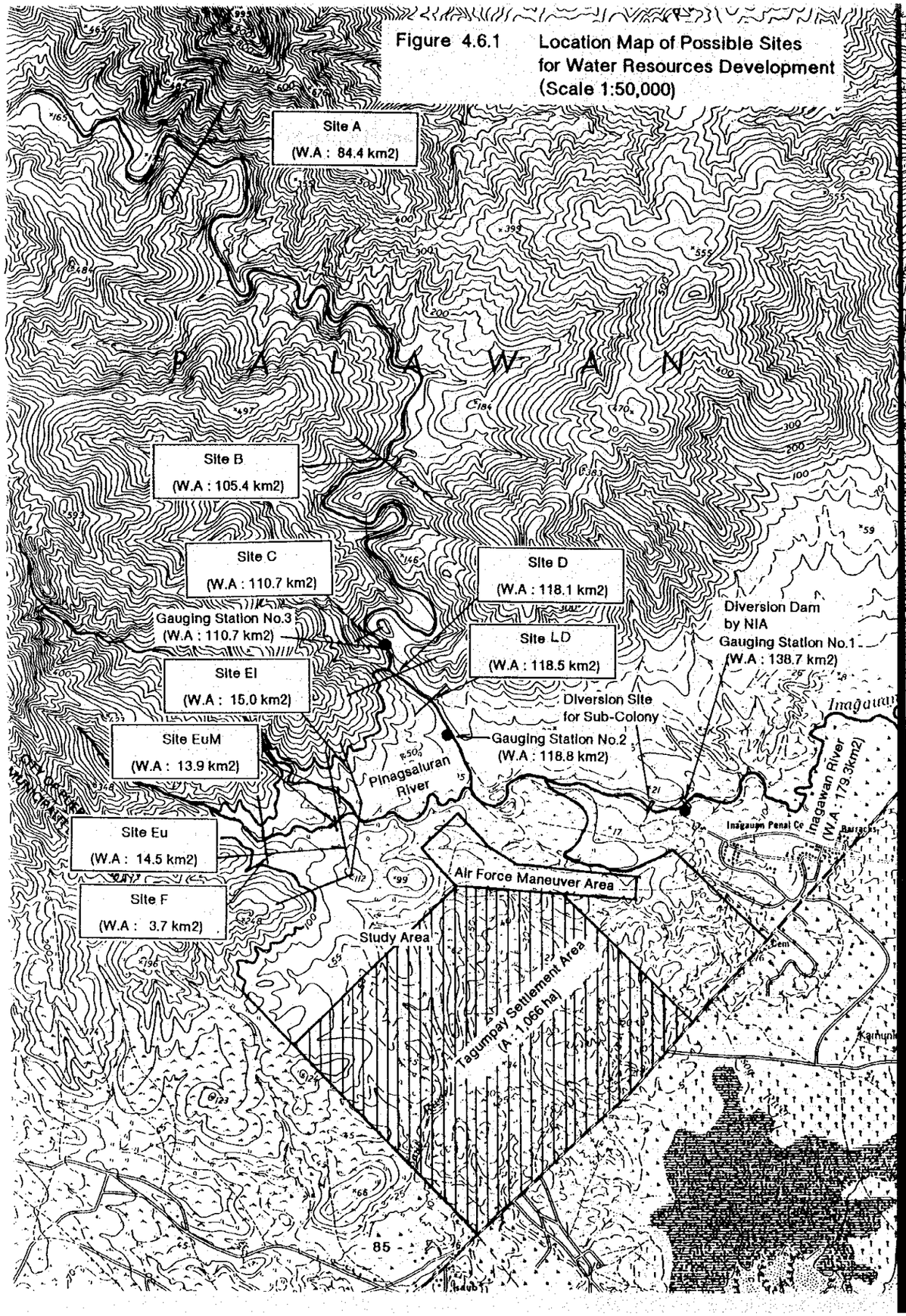
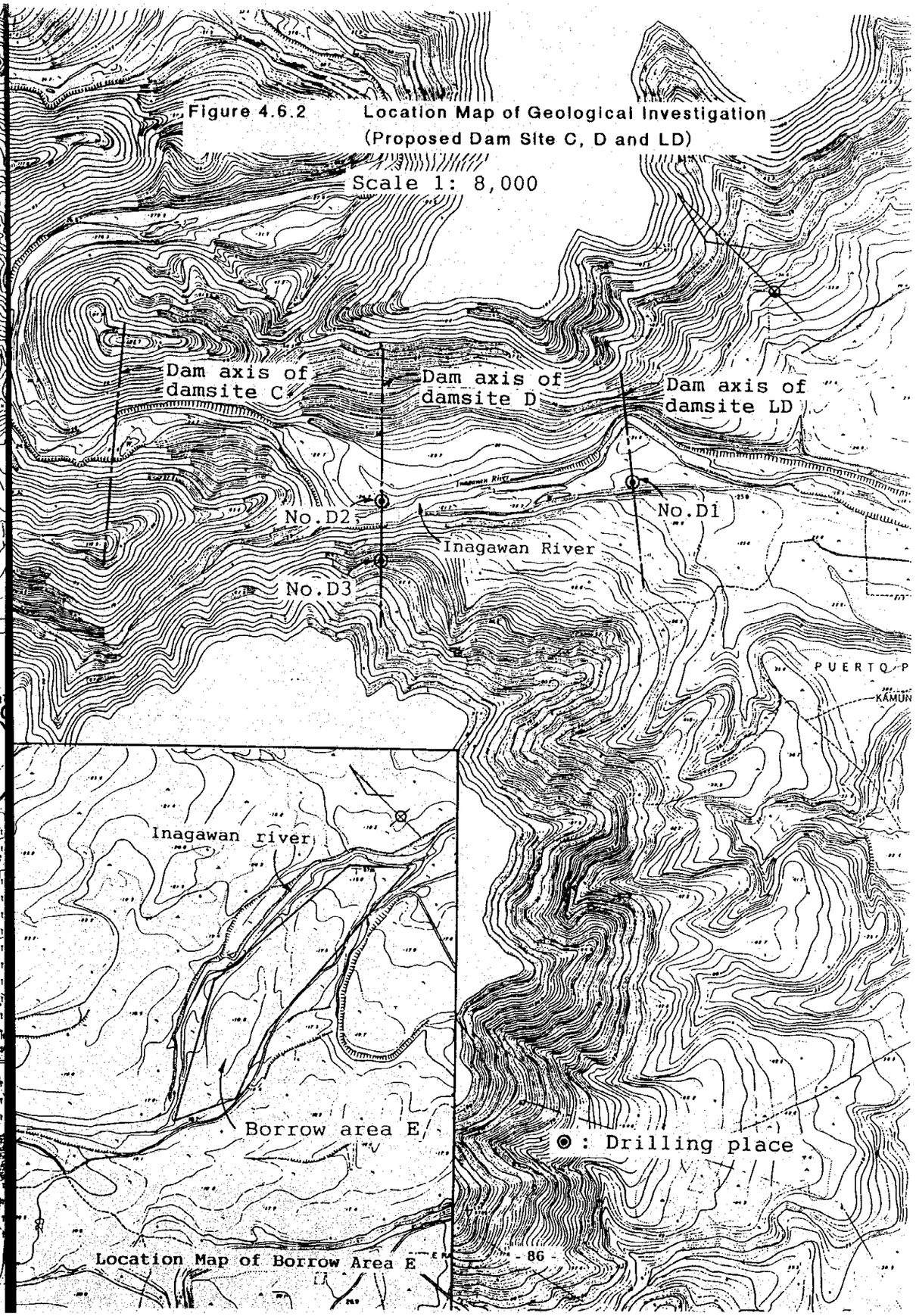


Figure 4.6.2 Location Map of Geological Investigation (Proposed Dam Site C, D and LD)



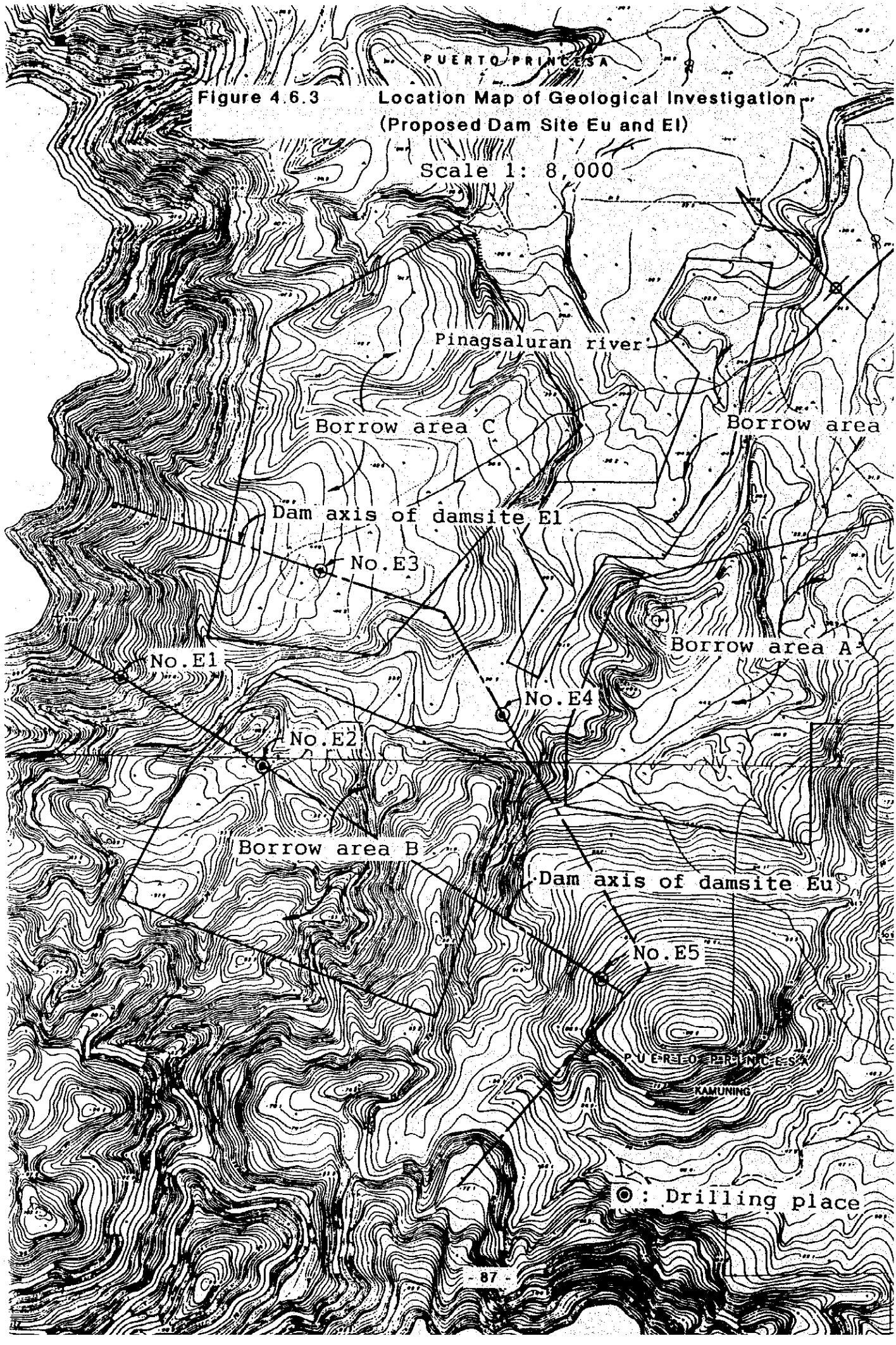


Figure 4.6.3 Location Map of Geological Investigation
(Proposed Dam Site Eu and E1)

Scale 1: 8,000

Figure 4.6.4 Result of Reservoir Operation (Site EuM)

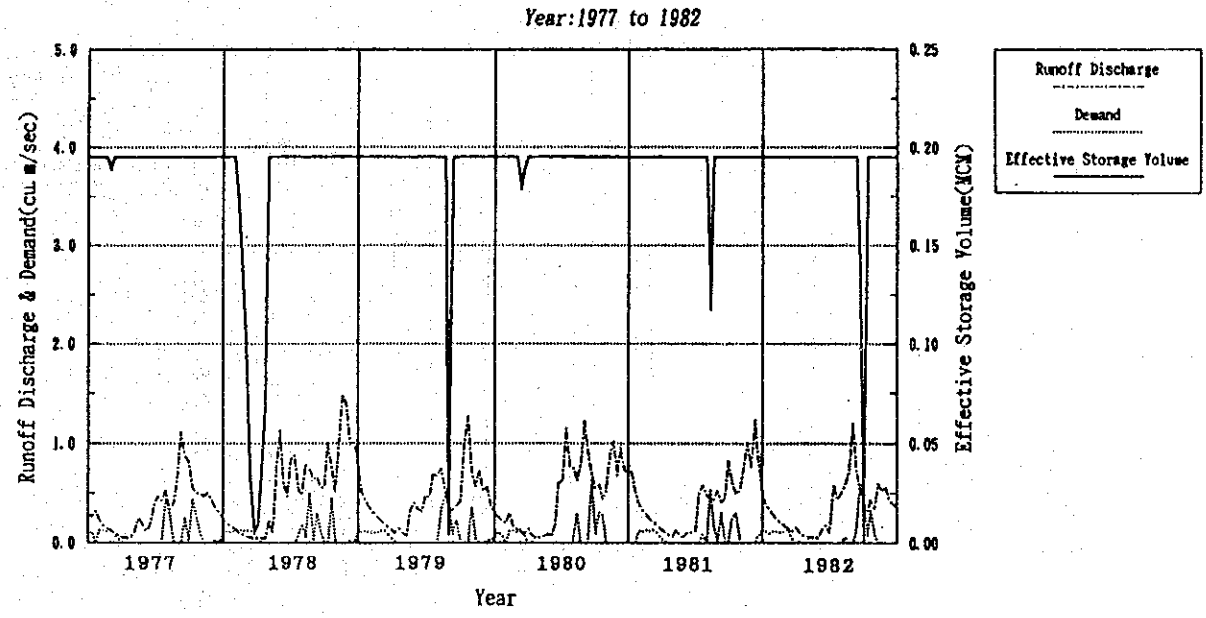


Figure 4.6.4 (Cont'd)

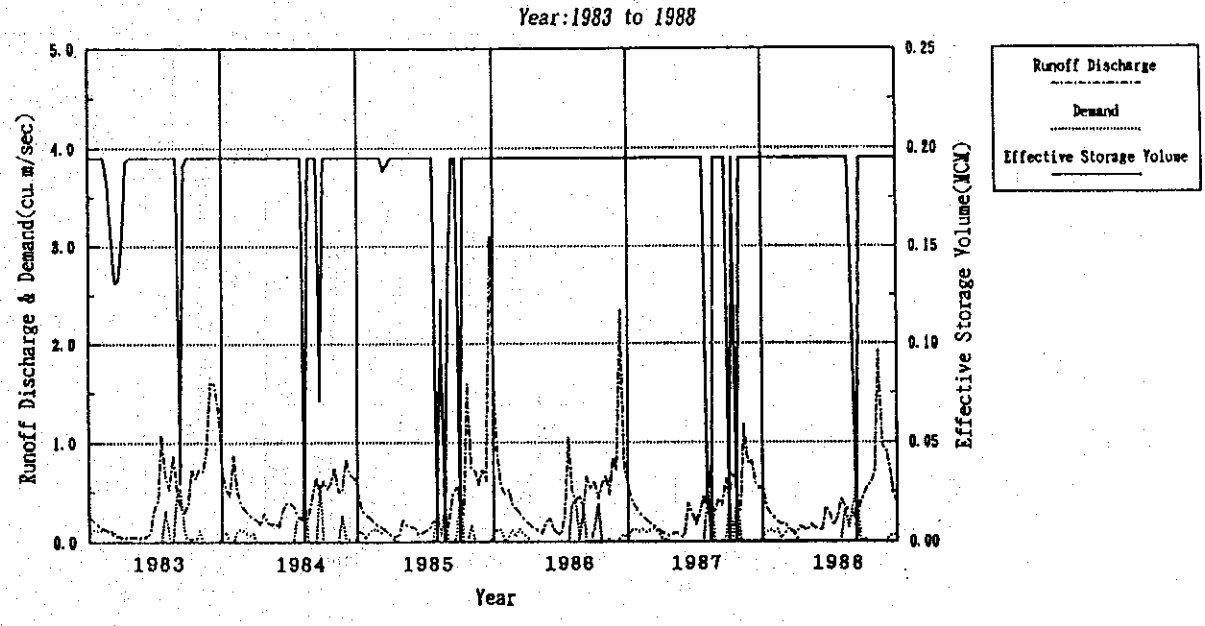


Figure 4.6.4 (Cont'd)

Year:1989 to 1993

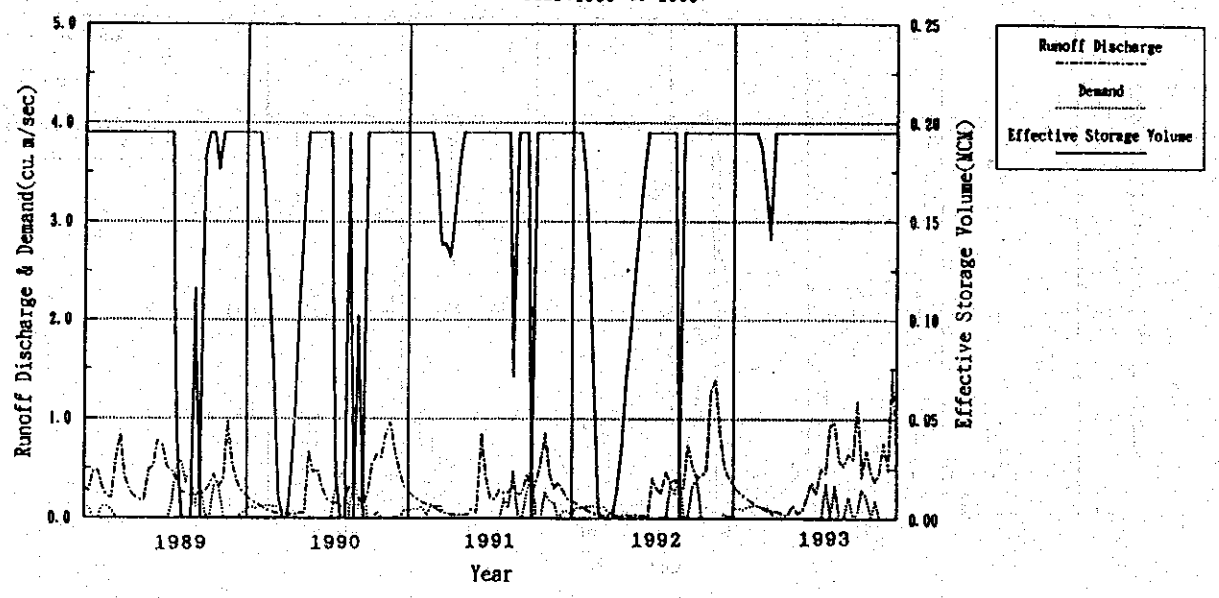


Figure 4.6.5 Result of Reservoir Operation (Site Eu)

Year:1977 to 1982

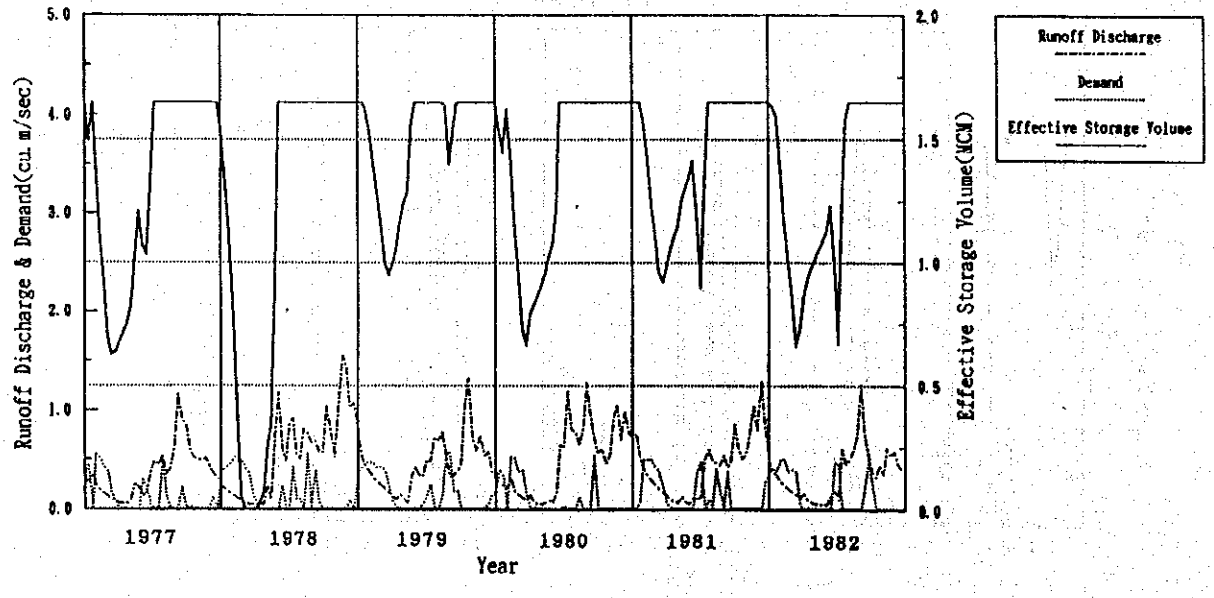


Figure 4.6.5 (Cont'd)

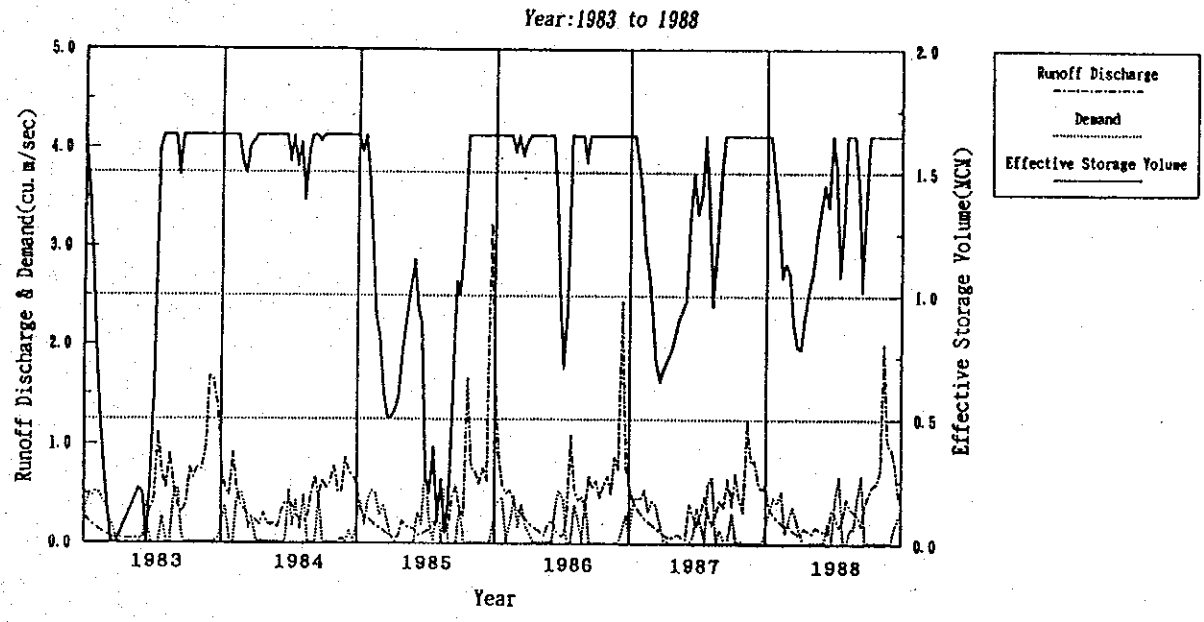
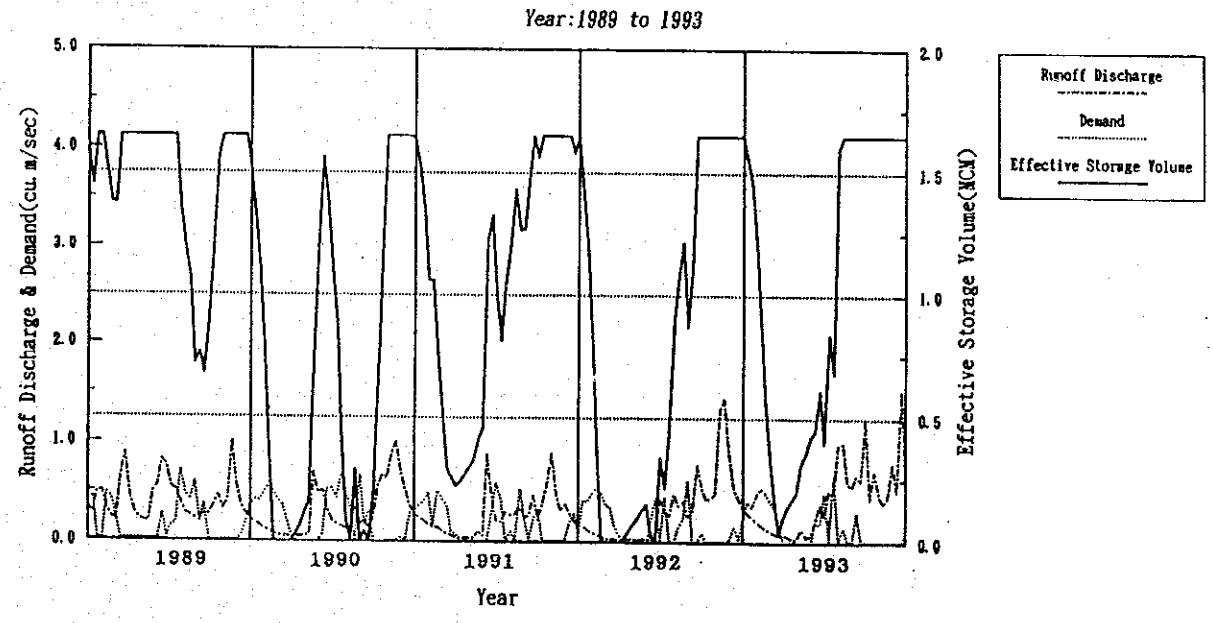


Figure 4.6.5 (Cont'd)



CHAPTER 5. THE PROJECT

CHAPTER 5. THE PROJECT

5.1 Water Resources Facility

5.1.1 Facility Plan

a) Reservoir Plan

1) Reservoir Capacity

The effective storage of each site was estimated based on the results of water balance study and the reservoir capacity and area of each potential water resources site were measured based on the topographical map with a scale of 1/4,000. (refer to Appendix F)

2) Sediment Volume

Sedimentation in the reservoir depends upon such various conditions in the watershed as topography, soil and geology, vegetation, rainfall, riverbed slope, etc. In and/or near the Study Area there are no available data for sedimentation. At present, serious soil erosion problem due to rain will not occur because of the dense vegetation in the watershed, but at the right bank of the Inagawan river where Eocene turbidities are formed, a heavy rain will cause erosion problems under the condition of poor vegetation in the area.

Based on previous studies, the specific sediment volume for the Pinagsaluran river basin and Inagawan river basin were assumed to be 300 and 200 cu.m/year/sq.km, respectively. Thus, the design period of 100 years of sediment accumulation for the reservoir is applied. Site EuM is also planned with a sand sluiceway at the right river course, thus, the design period of 25 years of sediment accumulation will be employed.

3) Design Water Level

Based on the effective storage volume and sediment volumes computed, the normal water level (NWL) and low water level (LWL) for each water resources site were determined from its reservoir capacity and area curve as follows:

		Site Eu	Site EuM
E. Storage	(MCM)	1.65	0.20
Sediment V	(MCM)	0.44	0.11
Dead V	(MCM)	0.44	0.11
Total Storage	(MCM)	2.09	0.31
NWL	(MSL)	54.00	45.00
LWL	(MSL)	45.60	41.00

b) Design Concept

1) Seismic Force

The main parts of the Philippines excluding Palawan island are enclosed within the Philippine trench and East Luzon trough at the east side, and North Luzon trough, and the Manila, Negros, Sulu and Cotabato trench at the west side. Philippine fault and Mindanao fault with north-south direction run across the middle portion of the enclosed zone. Frequent earthquakes have occurred in the enclosed zone within the western and eastern trenches and troughs. Based on the report on the Estimates of Regional Ground Motion Hazard in the Philippines, PHIVOLCS, peak horizontal ground acceleration on rock foundation for a 10% probability of being exceeded in 50 years belongs to non-affected zones and those for soft soil to not more than 0.30 g zones at Palawan island.

Based on earthquake data (within the area between 117 to 112 degrees of east longitude and 8 to 13 degrees latitude, 34 years duration from 1960 to 1993 not less than 3.4 surface wave magnitude) collected, ground motion analysis was made. The results indicate that the peak horizontal ground accelerations in the Study Area are small, only 3.7 E-5g. It is, therefore, acceptable to apply the minimum design value of 0.05 g of earthquake force K in the structural design.

2) Design Flood Discharge

The flood discharge with a 100 years return period is generally applied, based on the dam design flood discharge of NIA and DPWH. Since there are no available data on long term runoff for flood analysis within and outside the Study Area, the design flood discharge is assumed based on ①flood formula derived from DPWH's design guidelines criteria and standards, ②design flood discharge based on NIA's existing diversion dam, and ③rational method based on the Aborlan daily rainfall data.

	Site Eu	Site EuM	
Watershed (km^2)	14.5	13.9	
Discharge (m^3/sec)			
1)	430	420	
2)	140	140	
3)	200	190	
Max. Discharge	430	420	(Applied)

*1: applying occasional formula

3) Dam Type

The dam type shall be determined taking into account such various conditions as topography, geology, available construction materials, construction method, environment, safety structure and economy in addition to objective and scale of facility.

(Site Eu)

- Dam span and height rate of the site are quite large, 30, hence concrete type dam is not economical.
- The foundations of site are not suitable for high concrete dam due to thick weathered bed rock and overburden layer.
- There are sufficient borrow areas for embankment materials near the site.

From the above reasons, the fill type dam is recommended for the site.

(Site EuM)

- Site EuM is almost located along Site Eu axis.
- There are two rivers across Site Eu axis, the Pinagsaluran river (9.8 sq.km watershed) which is located at the left portion and its tributary (4.1 sq.km watershed) located at the middle portion. The dam crest elevation of Site EuM must be less than the top elevation of the middle bank which exists between the two rivers mentioned above, in order to minimize the construction cost of the facility.
- The spillway structure with concrete type will be provided on the left side river, the Pinagsaluran river, which forms a narrow valley with fresh bed rock under the condition of lower 45.0 m elevation, and while on the right river, the fill-type dam will be provided due to long crest length.

4) Freeboard, Slope and Crest Width

(Freeboard)

A 2.0 m freeboard from the high water level is adopted for the fill type dam for protection from over topping.

(Slope of Dam)

The results of embankment material investigation and laboratory tests indicate the properties of each material as follows:

Core Materials;

The materials are composed of GC, SC, CH and MH in the unified soil classification, of which, GC and SC materials are predominant. The materials have such properties as 20 to 50% of field moisture content, 1.2 to 1.8 ton/cu.m of maximum dry density, 2 to 4 ton/sq.m of cohesion and 26 to 30 degrees of internal friction angle, $n \times 10^{-6}$ to 10^{-7} cu.m/sec of permeability coefficient, and 17 to 46% of plasticity index. The core materials are, therefore, judged to be comparatively good with such characteristic as high density, imperviousness, strong shearing strength, cohesiveness and easy construction.

Random Materials;
The materials belong to GC, SC, SM and SW in the unified soil classification containing more sand and gravel particles than core materials. The materials which have 10 to 30% field moisture content and 1.4 to 1.9 ton/cu.m of maximum dry density are expected to be stronger than the core materials in the shearing strength.

Filter Materials;
The properties of materials, which can be borrowed from the river deposit of the Pinagsaluran river, are GC to GW with 2.7 specific gravity in unified soil classification. Before banking the materials at the filter zone, clayey and silty materials shall be screened from the filter materials.

Riprap Materials;
The boulders from the diluvial terrace along the Inagawan river are used as riprap materials. Judging from the boring core samples which are classified as sand stone, amphibolite and peridotite with 2.5 to 3.1 ton/cu.m for bulk specific gravity, 0.7 to 8% of absorption and 2 to 6% of soundness, the quality of riprap materials will be judged better than the boring core samples.

Since the properties of embankment materials are considered to be good in addition to the weak earthquake force in the Study Area, the slopes of upstream and downstream of a fill dam will be employed to be 1 (V) to 2.80 (H) and 1 (V) to 2.30 (H), respectively, referring to the serious designs and data.

5) Dam Crest Width

About 8.0 m of the crest width for a fill dam is applied based on previous studies and considering operation and maintenance.

c) Major Features

Based on the topographical maps with a scale of 1/1,000 and the design concepts described above, the preliminary design for each water resources site were carried out. (refer to Table 4.6.1 and Drawings Dr-2 to Dr-6)

5.1.2 Water Management Plan

a) Concept of Water Management Plan

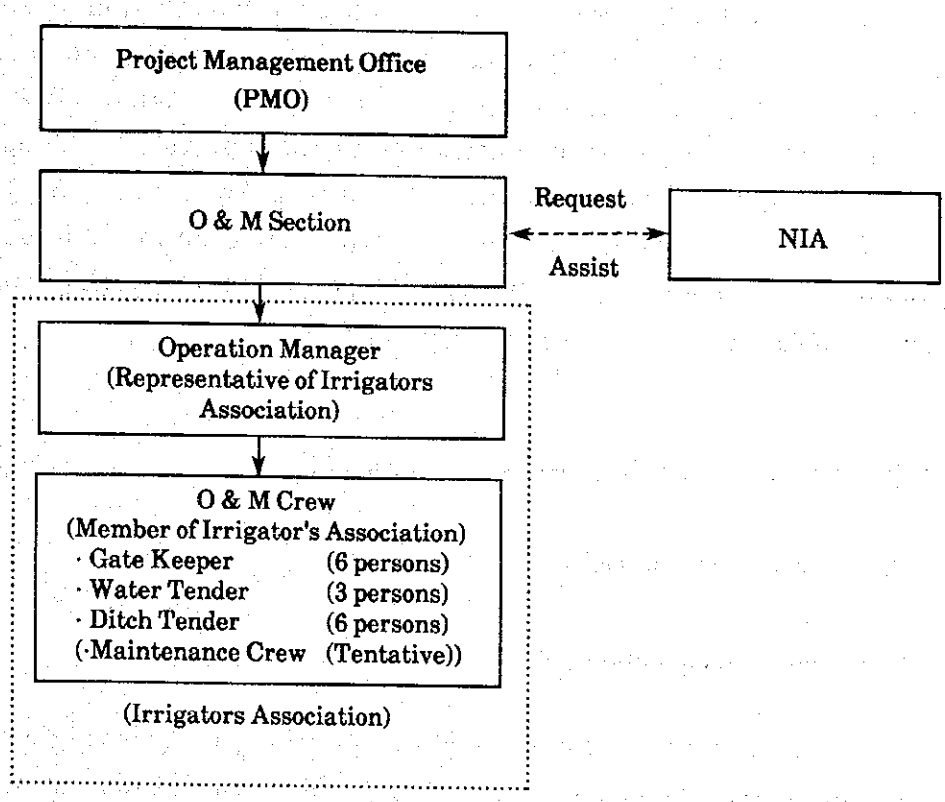
Water management plan will be established for the purposes of effective utilization and rational distribution of limited water resources, operation in case of emergency, prevention of disaster, and saving O & M cost.

The water management for the project will take into account the following matters;

- To predict the reservoir conditions such as storage water volume and water level, and to forecast the Pinagsaluran river runoff at the time of maximum water requirement.
- To identify planting areas by crop type and to estimate irrigation water requirement on a 10 day basis during the irrigation term.
- To establish education and training system and organization of government agencies and beneficiary farmers regarding water management.
- To carry out operation and maintenance works including collection of water charge under Irrigators Association, except large repair and rehabilitation works for facilities which will be done by the government agencies concerned.

The lead executing agency of the Project is the DAR, hence, even after the completion of the Project, the DAR, through the PMO shall continue to monitor the activities of the Project. After completion of the Project, an Operation and Maintenance section may be added to the existing support staff of the PMO, to monitor, assist and evaluate the activities and progress of the farmer's organization tasked with the operation and maintenance of the project facilities. (refer to Chapter 6)

Since the water resources and irrigation facilities will be turned over to the farmer beneficiaries through the Irrigators Association (IA), the operation and maintenance of the facilities will be the responsibility of the IA. The DAR, through the PMO will monitor the activities and progress of the IA and will provide the necessary assistance to the IA. Specifically, the IA will be under the supervision of the O&M section. The organization chart of the water management for the project is proposed as follows:



5.1.3 Water Resources Facilities and Watershed Conservation

It is possible that any kind of proposed water resources facilities, like reservoir, borrow areas, etc., will most likely affect the natural condition of the watershed area. However, since the scale of the proposed facilities in this development plan are small, the influence may be minimal. Furthermore, in order to lessen the effect to the watershed, countermeasures are necessary. To attain therefore, a sustainable irrigation for the proposed area, the illegal cutting of trees should be banned. Hence, countermeasures such as, education of farmers, execution and reinforcement of tight watch on logging and kaingin

by responsible agency, strict execution of law, provision of additional acts or laws on the illegal outing of trees, should be undertaken.

Together with the construction of the reservoir, countermeasures against animals and plants, driftwood and floating sweepings, change of river discharge, unstable side slope of a watering area, will be needed. The execution of the operation and maintenance works for clearing the obstructions, securing the river maintenance flow, detailed geological investigation of the reservoir area and stabilization analysis are proposed as countermeasures. Within the Study Areas, preserved animals and plants are not found. However, more detailed survey are recommended to be carried out during the next stage to determine and confirm its presence. The cutting slopes of temporary roads to be constructed and traces of borrow pit areas should be maintained, vegetated and/or rehabilitated by replanting, slope protection works, conversion to agricultural land, etc. (refer to Appendix F-4).

5.2 Agricultural Infrastructure Facility Plan

5.2.1 Irrigation Facilities Plan

a) Proposed Irrigation System

Two (2) kinds of irrigation systems, the gravity irrigation system and the pump irrigation system are considered in the Study Area. From the economic and technical point of view, gravity irrigation system is generally more economical in terms of operation and maintenance cost. The pump irrigation system including the lifting of water to the canal from the water source is costly. Other problem related to the pump irrigation system is the maintenance of the equipment when maintenance service is not carried out on time. Since the operation and maintenance works of the pump facilities will be undertaken by the proposed Irrigators Association to be organized, composed of farmer beneficiaries with low educational level and low level of skills and technique, it would be difficult for the IA to maintain and operate a pumping irrigation system. Also, since the irrigation area is located far away from the bigger market and the farmer beneficiaries have not yet acquired the necessary skills and technique of crop cultivation, high value crops will not be introduced.

In this case, profit alone from farming will not be able to shoulder the operation and maintenance cost, if pump irrigation system is introduced.

Considering the above, the gravity irrigation system is more suitable and favorable at present. After the skills and knowledge of the beneficiaries, however, have improved and the market and other related conditions becomes more suitable in the future, the pump irrigation system may be introduced in the area.

b) Proposed Irrigation Area

The irrigation canal will be aligned at a portion higher than the irrigation area under the gravity irrigation system. The water level of the irrigation canal at the beginning point is designed at about 40 m MSL, considering the intake water level of the water resources facility. The proposed main canal is aligned at the foot hill at the elevation of about 40 m. Five (5) lateral canals are proposed branching off from the main irrigation canal to irrigate the area.

The area located near the eastern boundary and at the east side of the AFBR, can not be irrigated by this irrigation system because of the need to construct big structures to cross the valley. If one of the proposed lateral irrigation canals can pass through the AFBR, the area could be irrigated by gravity with cheaper investment cost. At the southwest edge of the Study Area, the elevation of the area is also higher than the water level of the irrigation canal. This area was not therefore included in the proposed irrigation area. (refer to General Development Plan)

An irrigation area of 590 ha is therefore determined as mentioned in section 4. 6. An irrigation block composed of 30 to 50 ha would be irrigated by one turn-out which is composed of the main and lateral canals. The system of direct irrigation from the canals will not be proposed.

c) Proposed Irrigation Canal System

The canal system consists of a main irrigation canal and five (5) lateral canals. (refer to General Development Plan)

- Main irrigation canal

  The main irrigation canal will be aligned along the hill side with an elevation of 40 m MSL. The total length of the canal proposed is 4.21 km. The main irrigation canal will have concrete lining to prevent seepage loss and grass growth.

- Lateral Irrigation Canal

  Five (5) lateral canals with the total length of 10.5 km, branching from the main irrigation canal are proposed to irrigate the areas between valleys. Lateral-B canal has a longer distance of 4.23 km because the canal will pass through the undulating and rolling areas. To minimize construction cost and for easier maintenance of the canals, an earth type canal will be proposed.

d) Design of Canal

1) Irrigation Area by Canal

Based on the canal alignment, the irrigation area was measured on the detailed topo-map with a scale of 1/4,000. (refer to Figure 5.2.1)

2) Unit Design Discharge (q1 and q2)

The unit design discharge is determined without considering the effective rainfall on the irrigation area because rain is not stable for farming. The unit design discharge differ by cropping type as Type-1 area : q1 = 1.850 lit/sec/ha (on 21, July), and Type-2 area : q2 = 0.882 lit/sec/ha (21, July).

3) Design Discharge (Q)

The following equation was applied to calculate the design discharge of the canal.

$$Q = (q1 \times A1 + q2 \times A2) \times 0.9$$

Where:

A1 : Irrigation area of Type-1 (ha, gross)
A2 : - do - Type-2 (ha, gross)
0.9: rate of net irrigation area

4) Diagram of Irrigation System

The irrigation area and design discharge by canal are indicated in the flow diagram of the proposed irrigation system attached hereinto. (refer to Figure 5.2.1)

5) Typical Cross Section of Canal

The irrigation canal with a side slope of 1.5 (H) : 1.0 (V) will be trapezoidal in shape with a bottom width of 80 to 120 cm and 30 to 80 cm for the main and lateral canals, respectively. The canal depth including free board of about 30 cm (due to small design discharge), ranges from 70 to 100 cm at the main canal and 40 to 70 cm at the lateral canals. The longitudinal slope of the main and lateral canals are 1/2,000, and 1/600 to 1/1,200, respectively. (refer to Figure 5.2.2 and attached Drawings)

e) Appurtenant Structures

An operation and maintenance road with a width of 4.0 m and paved with gravel is proposed at one side of the canal. Various kinds of appurtenant structures, such as, drainage crossing, road crossing, diversion and turn-out, check, drops are proposed on the canal system for better conveyance, operation and control of discharges. As for the drainage crossing, the overchute type, with reinforced concrete pipe and diameter of more than 600 mm placed at the bottom of the drainage canal is proposed, in case the discharge of the drainage canal is less than 4.0 cu.m/sec. On the other hand, a siphon type structure will be proposed to cross the bigger and wider river/stream which has a design discharge of more than 4.0 cu.m/sec.

5. 2. 2 Drainage Facility Plan

The existing streams and creeks will be utilized as drainage canal to improve poor drainage conditions. At the depressed area at the center of the Study Area, the drainage canal is proposed to reduce stagnant water, which becomes the breeding source of mosquitoes, the intermediary of malaria. The canal can play very important role in the improvement of the environment. Therefore, two (2) drainage canals are proposed at the depressed area.

a) Canal Alignment and Length

The canals will be aligned at the depressed area and will have a total canal length of 1.8 km.

b) Typical Cross Section of Canal

The proposed drainage canals shall be earth canal to minimize construction cost and for easy maintenance. The drainage module of 6.4 lit/sec/ha for the design is applied. The trapezoidal shape canal with a side slope of 1.0 (H) to 1.0 (V) will be applied due to economical considerations and easy construction. The bottom width and depth of the proposed canal will be from 30 to 100 cm and 60 to 80 cm, respectively. The free board designed is at about 20 to 30 cm. The minimum velocity of 40 cm/sec is applied to prevent sediment and grass growth in the drainage canal. (refer to Figure 5.2.3 and General Development Plan)

c) Appurtenant Structures

Road crossings with reinforced pipe of 600 to 1,000 mm are proposed in the Study Area. The existing structures which have smaller capacity, will be rehabilitated in the plan.

5.2.3 Farm-to-Market Road Plan

a) Road Alignment

To haul necessary outputs/inputs into/from the field, the farm-to-market road is essential. The operation and maintenance road along the proposed irrigation canal will also function as farm-to-market road. The road alignment in the Tagumpay area will follow the road alignment plan made by the DAR. In the outlying area, the farm-to-market roads will also be aligned in order to minimize on construction cost and volume such as cut and fill, and to avoid, as much as possible, river crossings. To prevent road surface erosion caused by rainfall and for easier passage of vehicles, the maximum road slope is designed at less than eight (8) percent.

b) Typical Cross Section and Length

The road widths of 8.0 (road way width 6.0 m) and 6.0 (road way width 4.0 m) are proposed for the main farm-to-market road and farm-to-market road, respectively. To prevent the incidence of muddy road surface, which has a tendency to interrupt traffic, an embankment type of a road is proposed. At the cut portion and at portions with higher elevated areas than the road surface, side ditches are proposed to prevent scouring and sliding of the road shoulder. The proposed length of the road are 11.8 km for the main farm-to-market roads and 29.2 km for the farm-to-market roads. (refer to Figure 5.2.4 and General Development Plan)

5.2.4 On-Farm Facility Plan

On-farm facility is one of the irrigation facilities that will distribute irrigation water to each farm plots. Without it, full benefits of irrigation could not be attained. These normally consists of turnout, main farm ditch, supplementary farm ditch, division box, farm drain, cross culvert, check and drop, and farm road.

An irrigation area is normally divided into a rotational area of about 25 to 50 ha to be provided with a gated turnout. The average size of each rotational area is determined according to topography. Rotational area are further subdivided into rotation units of about 7.0 to 10.0 ha with one (1) division box for each rotation unit and an end check at the end of each farm ditch. (refer to attached Drawings)

A rotational area along Lat. E was typically laid out based on a 1/4,000 topo map and the following are the summary results.

a. Location	Lat. E
b. Area	
- Gross	25 ha
- Irrigated	22 ha
c. Major On-farm Facilities	
- Main Farm Ditch	500 m
- Supplementary Farm Ditch (m)	2,300 m
- Farm Drain (m)	900 m
- Turnout	1 unit
- Division Box	3 units
- Drops	3 units
d. No. of Rotation Unit	3 units
Average area per unit	7 ha

Figure 5.2.1 Diagram of Proposed Irrigation System

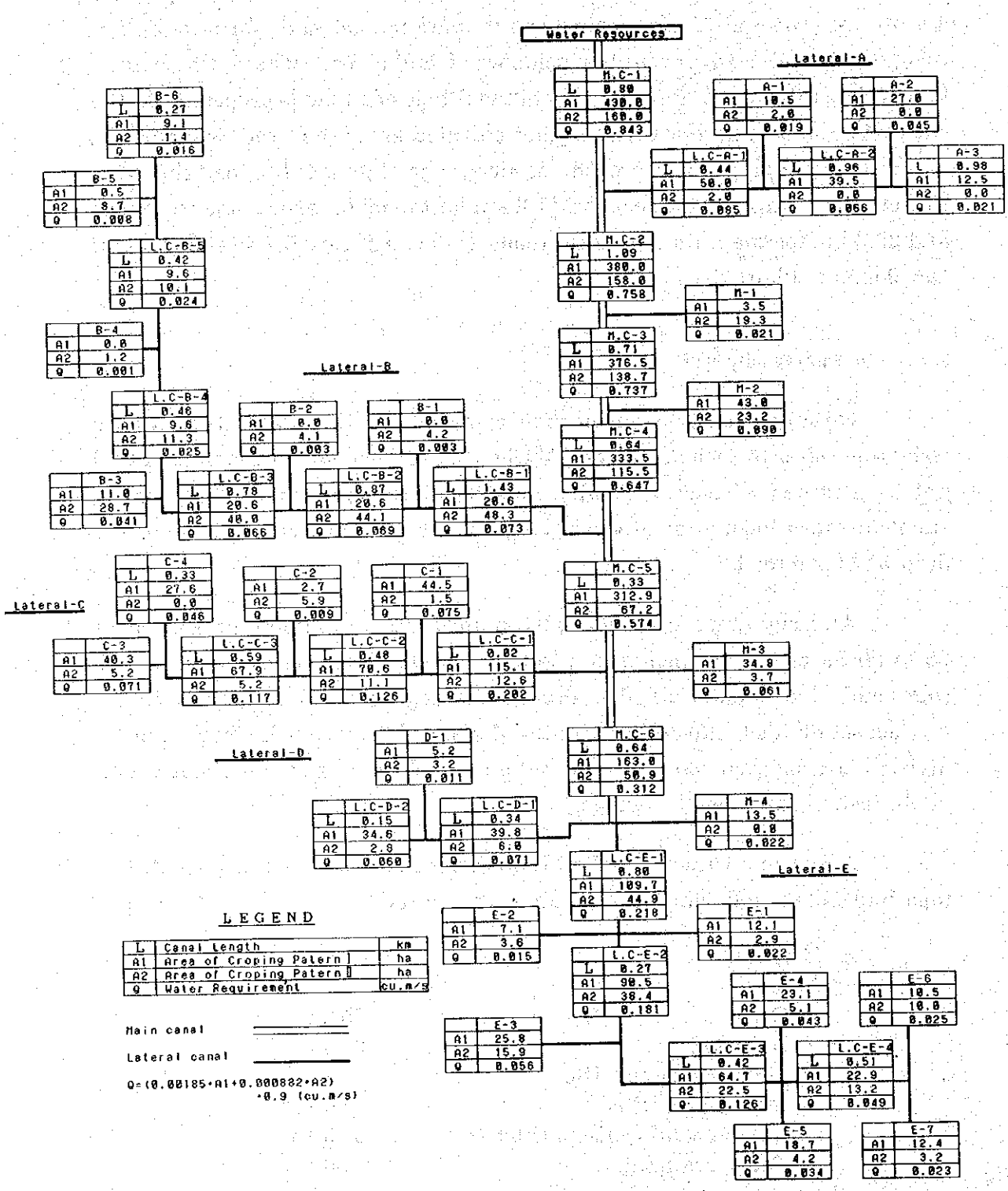
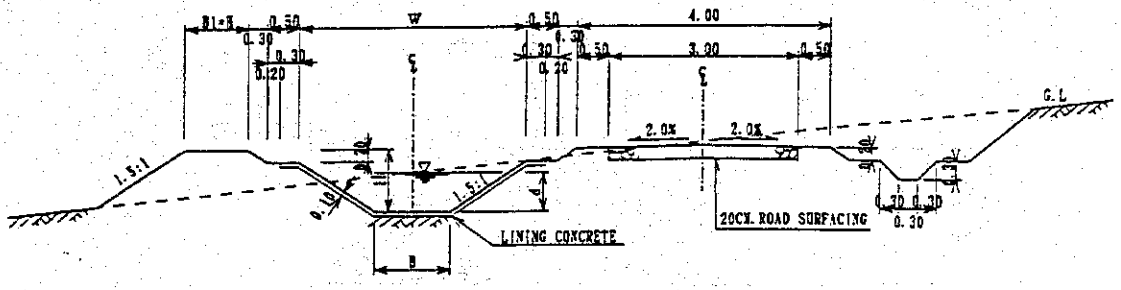
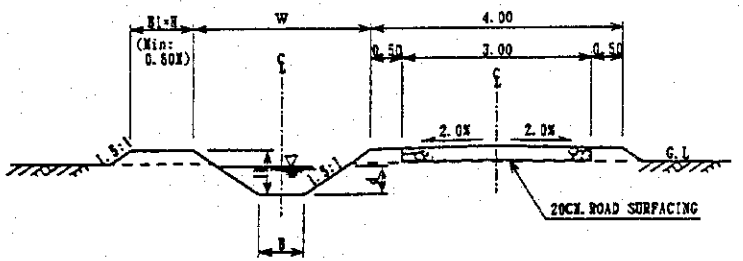


Figure 5.2.2 Typical Cross Section of Irrigation Canal



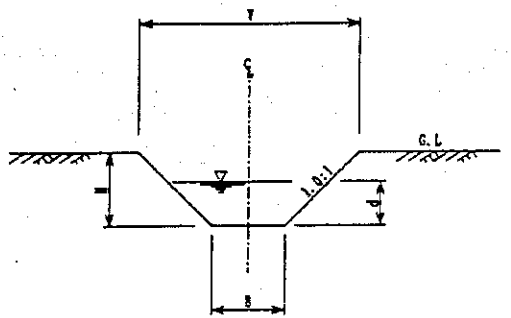
MAIN CANAL (LINED)

TYPE-I



LATERAL CANAL

TYPE-II



LATERAL CANAL

TYPE-III

DIMENSION TABLE

Main Canal

TYPE	SECTION	Q (m3/s)	n	I	B (m)	d (m)	H (m)	V (m/s)
I	M-1	0.843	0.018	1/2000	1.20	0.61	1.00	0.65
	M-2	0.758	0.018	1/2000	1.20	0.58	0.90	0.63
	M-3	0.737	0.018	1/2000	1.20	0.57	0.90	0.63
	M-4	0.647	0.018	1/2000	1.20	0.53	0.90	0.61
	M-5	0.574	0.018	1/1000	1.00	0.45	0.80	0.76
	M-6	0.312	0.018	1/1000	0.80	0.36	0.70	0.66

Lateral-A

TYPE	SECTION	Q (m3/s)	n	I	B (m)	d (m)	H (m)	V (m/s)
III	A-1	0.085	0.030	1/600	0.50	0.28	0.50	0.41
	A-2	0.066	0.030	1/600	0.40	0.27	0.50	0.39
	A-3	0.021	0.030	1/600	0.30	0.16	0.40	0.29

Lateral-B

TYPE	SECTION	Q (m3/s)	n	I	B (m)	d (m)	H (m)	V (m/s)
III	B-1	0.073	0.030	1/1200	0.30	0.36	0.60	0.31
	B-2	0.069	0.030	1/1200	0.30	0.35	0.60	0.30
	B-3	0.066	0.030	1/1200	0.30	0.34	0.50	0.30
	B-4	0.025	0.030	1/1200	0.30	0.21	0.50	0.23
	B-5	0.024	0.030	1/1200	0.30	0.21	0.50	0.23
	B-6	0.016	0.030	1/1200	0.30	0.17	0.40	0.21

Lateral-C

TYPE	SECTION	Q (m3/s)	n	I	B (m)	d (m)	H (m)	V (m/s)
II	C-1	0.202	0.025	1/1000	0.70	0.36	0.70	0.46
	C-2	0.124	0.025	1/1000	0.60	0.30	0.60	0.41
	C-3	0.117	0.025	1/1000	0.60	0.29	0.60	0.38
III	C-4	0.048	0.030	1/1000	0.50	0.22	0.50	0.29

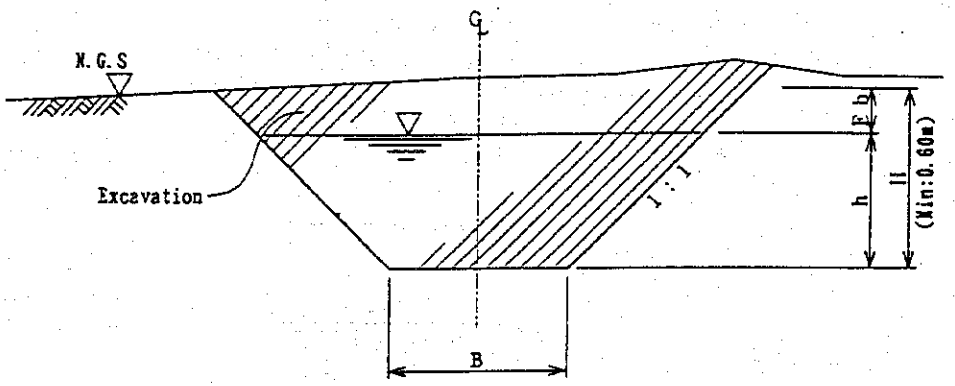
Lateral-D

TYPE	SECTION	Q (m3/s)	n	I	B (m)	d (m)	H (m)	V (m/s)
III	D-1	0.071	0.030	1/1000	0.50	0.28	0.50	0.31
	D-2	0.060	0.030	1/1000	0.50	0.26	0.50	0.30

Lateral-E

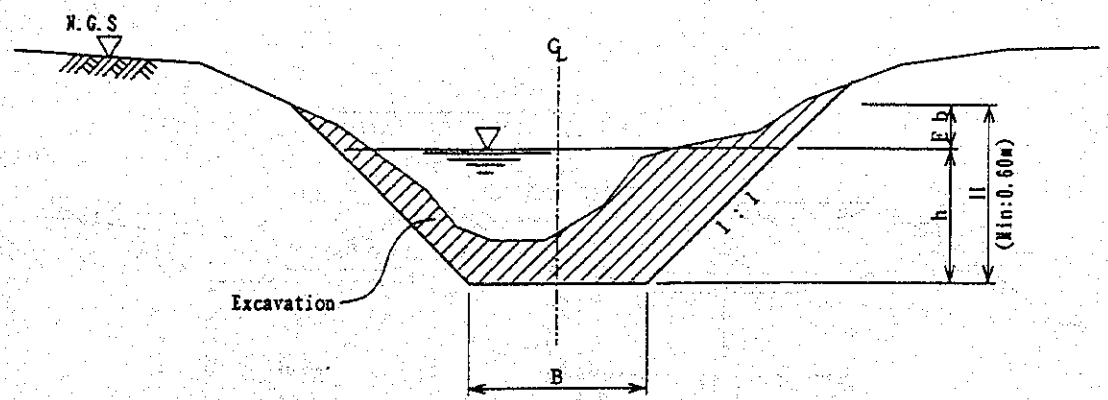
TYPE	SECTION	Q (m3/s)	n	I	B (m)	d (m)	H (m)	V (m/s)
II	E-1	0.218	0.025	1/1500	0.80	0.33	0.70	0.40
	E-2	0.181	0.025	1/1500	0.70	0.37	0.70	0.39
	E-3	0.125	0.025	1/1500	0.60	0.33	0.70	0.35
III	E-4	0.049	0.030	1/1000	0.50	0.23	0.50	0.29

Figure 5.2.3 Typical Cross Section of Drainage Canal



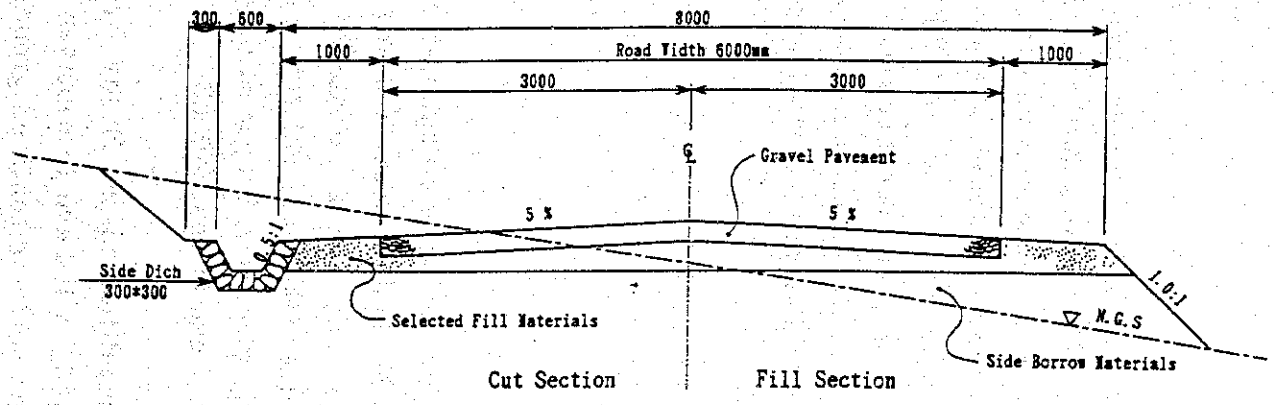
Typical Section of New Canal

NAME	L (km)	Q (m3/s)	V (m/s)	B (m)	h (m)	H (m)	Fb (m)
A-1	0.36	0.165	0.48	0.50	0.39	0.60	0.21
A-2	0.58	0.275	0.58	0.60	0.45	0.60	0.15
A-3	0.16	0.635	0.70	1.00	0.57	0.80	0.23
B-1	0.30	0.155	0.98	0.30	0.28	0.60	0.32
B-2	0.38	0.335	0.79	0.60	0.42	0.60	0.18

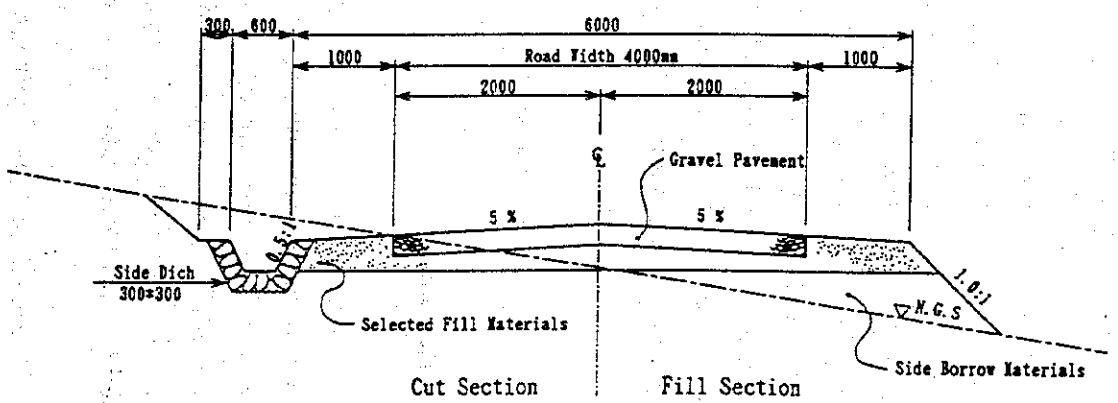


Typical Section of Excavated Creek

Figure 5.2.4 Typical Cross Section of Farm-to-Market Road



MAIN ROAD (M.R)



LATERAL ROAD (L.R)

OUTLIN OF ROAD SYSTEM

NAME	Length (km)	Total Width (m)	Effective Width (m)
Main Load			
M.R-1	3.50	8.00	6.00
-2	1.28	8.00	6.00
-3	3.50	8.00	6.00
-4	3.50	8.00	6.00
Total	11.78		
Lateral Load			
L.R-1	1.74	6.00	4.00
-2	1.79	6.00	4.00
-3	1.67	6.00	4.00
-4	2.00	6.00	4.00
-5	1.00	6.00	4.00
-6	1.28	6.00	4.00
-7	0.70	6.00	4.00
-8	3.50	6.00	4.00
-9	1.90	6.00	4.00
-10	1.70	6.00	4.00
-11	1.40	6.00	4.00
-12	1.15	6.00	4.00
-13	0.94	6.00	4.00
-14	1.60	6.00	4.00
-15	1.80	6.00	4.00
-16	0.56	6.00	4.00
-17	1.20	6.00	4.00
-18	1.90	6.00	4.00
-19	1.35	6.00	4.00
Total	29.16		

5. 3 Rural Infrastructure Facility Plan

To relieve the farmer of the weariness of farm work, it is also essential that his living conditions will be suitable and favorable to be able for him and his family to enjoy and relax. Rural infrastructures will thus play important roles in making the environment favorable to the farmer. Various facilities, such as, village water supply, village roads, health clinics, etc., are some of the essential facilities which can help improve the living conditions of the farmer.

5. 3. 1 Village Development Plan

Since there are no more space available in the home lot area at the Tagumpay home lot, the DAR has to allocate home lot area for the new farmer beneficiaries at the outlying area. Two (2) new villages are proposed to be developed in the outlying area, one at the northwest and the other, at the north-eastern part. The outlying area which is estimated to be about 410 hectares (net area) will be distributed to about 140 new farmer beneficiaries. A total home lot area of about 16.0 ha (9.0 ha for home lot area, 3.1 ha for public space and 3.9 ha for roads and others) are proposed for the two (2) new villages. (refer to Appendix I.1 and General Development Plan)

5. 3. 2 Village Water Supply Plan

a) Water Source

In the Study Area, the possible main sources of village water supply considered were groundwater from the shallow and the deep wells and surface water. Surface water for drinking would usually require a treatment facility which is difficult to maintain and operate due to the use of chlorine or chlorite which can be poisonous when not properly dispensed. Proper skills are also needed to maintain and operate the system. (refer to Appendix I.2)

Based on the hydrogeological condition of the Study Area, the groundwater yield for village water supply will have to consider two (2) possibilities, the unconfined groundwater and the confined groundwater. However, the unconfined groundwater, which is yielded from the shallow well,

is subject to rapid fluctuations according to the seasons of the year and local demand for water. Hence, the aquifer for development target will be restricted to confined groundwater, confined to the utilization of deep well.

The coarse sand layer as potential aquifer exists underneath, at the depth of 15 m from ground surface. The specific resistance by electric logging test is about 80 - 240 Ω-m. The hydraulic constant was determined by pumping test, the result of which are as follows: (refer to Appendix E 3)

Transmissivity	: 4.8 - 6.9 sq.m/day ($3.4 - 4.8 \times 10^{-3}$ sq.m/day)
Coefficient of permeability	: 0.44 - 0.69 m/day ($5.1 - 8.0 \times 10^{-4}$ cm/sec)

Based on the above hydraulic constant, the potential discharge (well capacity) of confined groundwater by single deep well, computed by Theim's steady state equations, is estimated roughly to be about 60 to 100 cu.m/day. Furthermore, for a well diameter of 100 mm and with influence area of 300 to 500 m, the estimated well capacity would approximately be 75 cu.m/day.

The groundwater with a safe yield of 75 cu.m/day is therefore proposed to be utilized as a more suitable source for village water supply in the Study Area due to the presence of a stable and cleaner water throughout the year without the need for a treatment facility. However, the system will require a submerged pumping facility which will need electricity to lift up water. The estimated cost including electricity and other necessary costs to operate and maintain the proposed water system would be about 45 pesos per month per household. (refer to Appendix I.2, E.3 and J. 2)

b) Village Water Supply System

The village water supply system consists of the deep well, a delivery tank, pipeline, and communal faucets. The scale of the facility was determined based on the designed water demand of the projected area population.

1) Water Demand

The projected population of 4,200 after 20 years at the Tagumpay area will consume water per capita of 87.5 lit/day/person, which consists of 60 lit/day for drinking and others, 10 lit/day for animals and other

farm use, 5% percent of conveyance loss at the pipelines, and 20% of operation loss. The total water demand, therefore, will be 368 cu.m/day. For the two (2) new villages with an estimated population of 2,000, the water demand designed was estimated at 175 cu.m/day. (refer to Appendix I.2)

2) Water Supply Blocks

Due to the limitations of available water, at only 75 cu.m/day per deep well, the service area will be divided into five (5) blocks at the Tagumpay area and three (3) blocks in the other two (2) new villages.

c) Facility Plan

A deep well with a submerged pump (with a diameter of 32 mm and a lifting capacity of 0.067 cu.m/min and a 2.2 kw motor with 70 meters of total head) for each block is proposed at the Tagumpay area. The diameter of the deep well with casing will be 100 mm. For other villages, a deep well with a submerged pump with diameter of 32 mm and a capacity of 0.051 cu.m/min and a 1.5 kw motor with 70 m of total head will be designed. (refer to Appendix I.2)

The water will be distributed by gravity system after it is lifted up to the delivery tank. The delivery tank which will be reinforced by concrete will have a height of about ten (10) to eleven (11) meters above ground surface based on the hydraulic calculation of the pipeline considering the existence of a minimum of 0.5 kg/sq.cm of water pressure at the faucet. The capacity of the tank proposed for each block is 7.4 cu.m considering the two (2) hours volume between the peak water demand and the average day demand. (refer to Appendix I.2)

A vinyl chloride pipe with diameters ranging from 25 to 100 mm is proposed to deliver water to the faucets. The proposed total length of the pipeline is 3,750 m for the Tagumpay area and about 1,400 meters for other villages. (refer to Appendix I.2)

About 59 communal faucets will be necessary to delivery water to the farmer's house at the Tagumpay home lot area. One (1) communal faucet will provide water for six (6) houses. Other facilities such as air valve, stop valve,

blow-off, and thrust block will also be proposed to be provided to properly maintain and operate the pipeline and for use in emergency cases. For the new villages, the same kinds of facilities are proposed. (refer to Appendix I.2)

5.3.3 Village Roads and Drains Plan

a) Village Roads

Village roads will be proposed in the home lot areas. The roads will be classified into two (2), as main village roads and village roads. The maximum longitudinal slope of 12% will be applied for the roads. Road sections with more than eight (8) percent longitudinal slope are proposed to be paved with concrete. (refer to Appendix I.3)

1) Main village road

The proposed main village road with a total length of 967 m will have two routes and will be located along the public space area at the Tagumpay home lot area. A road way width of six (6) meters with gravel pavement of 20 cm thick will be proposed. However, an 84 m of concrete pavement is proposed. In the other two (2) new villages, no main village roads will be proposed due to less traffic.

2) Village Road

About 18 village roads with a total length of 4,339 meters, four (4) meters wide and with gravel pavement of 20 cm thick will be proposed at the Tagumpay area. Other 13 village roads with a total length of about 2,700 meters will also be proposed in the other two (2) new villages. At the Tagumpay area, the roads with longitudinal steep slope of about 445 metres will be paved with concrete while at the two (2) other villages, only about 90 meters of these steep slope roads will be paved with concrete.

b) Village Drain

To keep the conditions of the home lot area favorable without the presence of stagnant water, the village drains are proposed. A relative amount of water will have to be drained from the village areas and farm fields, because due to topographic conditions, there is a tendency for the water to flow into the village from the farm areas. These water when not drained will stay and will create stagnant water in the areas.

The drainage module in the design of the village drains of 6.4 lit/sec/ha is applied based on the probable design daily rainfall of five (5) years return period of 138.6 mm/day and runoff coefficient of 80%, which will drain water within a period of two (2) days.

For the Tagumpay area, the designed total length of the six (6) proposed village drains is 1,405 meters with unlined canal. The minimum depth and bed width are 60 and 30 cm, respectively. The maximum canal bed slope of 1/130 is applied by considering the limited velocity of 1.0 m/sec, to avoid canal bed scouring. As to appurtenant structures, about 17 road crossings and 14 drops will be proposed. For the road crossings, pipe culvert structure will be used with the minimum diameter of pipe as 600 mm. (refer to Appendix I.3.)

5. 3. 4 Rural Electrification Plan

The transmission line located along the national road will be utilized. The primary lines to be connected to the line will be provided to the beneficiaries. At the Tagumpay area, about 70 wooden poles are proposed to be installed and to be provided with four (4) transformers to drop the voltage down from 7,620 volts to 220 to 240 volts. About 1.8 km of primary lines and 3.8 km of tertiary lines as distribution lines will be needed for the Tagumpay home lot area. The same system and procedure will also be proposed in the other new villages. For the two (2) village areas, about four (4) km of the primary line would be necessary. (refer to Appendix I.4)

5.3.5 Other Social Facilities Plan

For the beneficiaries to enjoy life to the fullest, there is also a need to provide basic social facilities and services such as schools, health clinics, market, multi-purpose pavement and recreational facilities. These facilities are proposed to be provided in the Study Area, specifically at the Tagumpay home lot area. The mentioned facilities which are initially proposed to be provided at the Tagumpay area will also be used by the beneficiaries in the other two (2) new villages. (refer to Figure 5. 3. 1 and Appendix I.5)

A public market, with an area of 4,500 sq.m, where the beneficiaries can sell their produce and others and buy their daily needs, is proposed to be constructed at the public space of the Tagumpay home lot area. Four (4) building modules (9 m wide and 40 m long each) are proposed.

The elementary school building would be expanded to four (4) classrooms (8 m wide and 7 m long each) with reinforced concrete structure within the 1.7 ha school space allocated at the Tagumpay home lot area. However, the necessary number of school teachers/staff should be provided by the local government prior to the commencement of construction.

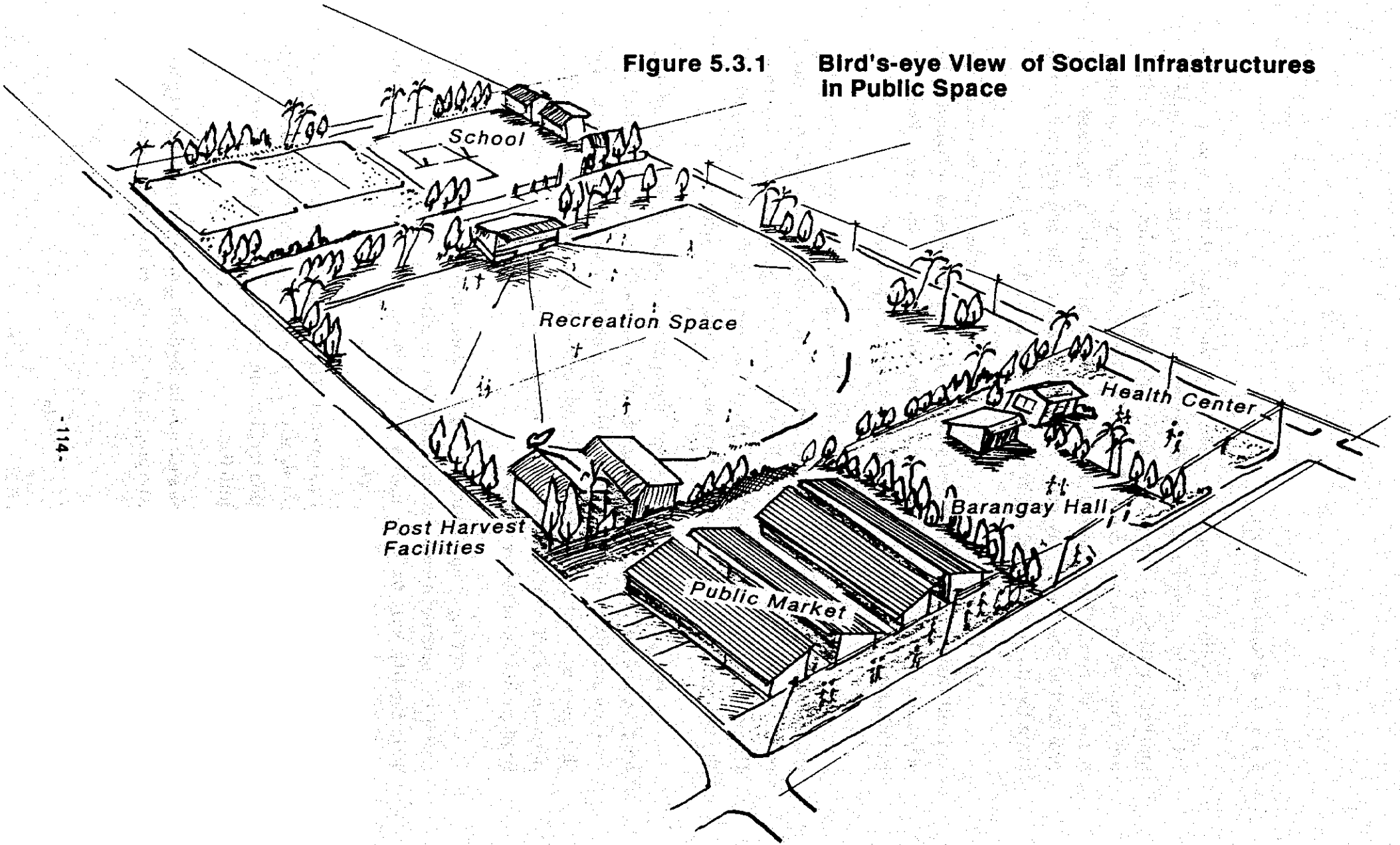
A health center with reinforced concrete structure (8 m wide and 6 m long) will be proposed to take care of the farmer's health conditions. Within the government space, an area of about 3,000 sq.m shall proposed to be allocated for this purpose. Likewise, the local government should provide the necessary personnel/staff needed, such as, doctors, nurses and midwives prior to implementation of construction.

A barangay hall, 8 m wide and 6 m long should be constructed for the use of the beneficiaries for social and other functions in each of the villages. This facility will be very useful in promoting comaraderie, unity and understanding in the community.

The multi-purposes pavement with concrete pavement of 20 cm thickness is proposed to be constructed in the main village roads for drying agricultural products, recreation facility and others. The road to be paved will have a length of 200 m and width 6 m.

Recreational facilities such as a basketball court and a wide open space with necessary utilities would be proposed at the edge of the public space.

Figure 5.3.1 Bird's-eye View of Social Infrastructures in Public Space



5.4 Agricultural Facilities Development Plan

5.4.1 Post-Harvest Facility Plan

In the future, the harvest from the Study Area will increase. Specifically, paddy which has the largest area of all proposed crops is expected to expand immediately.

At present, there is only one solar dryer in the Study Area, which is merely 38 sq.m. The insufficient drying paddy induces lower quality and selling price. As a result of the studies for drying method and quantity of facilities, solar dryer is suitable for the Area, economically. The number of other facilities, required in the Area, such as rice thresher, rice mill unit, etc. are determined based on the expected production. (refer to Figures 5.4.1 and 5.4.2)

Proposed Post-Harvest Facilities

Description	Unit	Total	First Stage Development (1)	Remark
1. Warehouse	house	3	1	350 sq.m
2. Motor Pool	house	1	1	350 sq.m
3. Solar Dryer	yard	3	1	600 sq.m
4. Rice Thresher	unit	6	2	1 ton/hr
5. Rice Mill Unit	unit	2	1	0.5 ton/hr
6. Mechanical Dryer	unit	1	1	2.4 ton capacity
7. Transportation Vehicle	unit	10	3	4 ton diesel
8. Portable Conveyer	unit	3	1	8.5 m length
9. Hand Tractor	unit	10	3	diesel engine tiller
10. Trailer	unit	10	3	0.5 ton loading
11. Others	L. S.	1	1	moisture meter calculator etc.

(1) The figures are included in the total.

5.4.2 Livestock Development Plan

Palawan province has abundant livestock free from foot and mouth diseases and vast grazing lands etc. In the MTPDP, the province is characterized as Key Livestock Development Area (KLDA), however, existing number of livestock cannot meet local demand of both the province and Puerto Princesa city.

Considerable number of farmers interviewed in the Study Area desire to have carabao, the most important animals for farmers, for farm works. Livestock raising using agricultural by-producets and grasses as feeds can help supplement farm income. In particular, carabao is indispensable animal for farmers for cultivation and transportation works. Cow milk can be a protein source for farm families. Pigs are raised in the Study Area, in the backyard of farm households and demand for pork is high. Thus, farmers already have the basic techniques for breeding animals.

According to the soil survey conducted in the Study Area, contents of humus in the soil was less than one(1)%, thus the need for more organic fertilizer such as compost in the soil. Animal manure will produce good compost for the soil.

PIADP who has their own stock farm, and city agriculturist can provide support services by supplying young animals, training for farmers and control of animal diseases.

Under the condition, livestock development plan in the Study Area was projected, however, diverse farming with animals in moderate scale will be proposed taking into consideration the present conditions, though not in commercial scale.

Pig raising is proposed to breed sow to produce piglets for selling and fattening purposes. The sow will produce piglets twice a year and about 400 farm households are proposed to raise pigs. About 700 farmers will keep carabaos and cows which will produce also milk to supply animal protein to the farm families and provide supplemental income. Old carabaos more than five(5) years will have to be sold to the local market. Cattle will also be raised by about 200 farmers and sold to the local markets after fattening (refer to Appendix L).

5.4.3 Inland Fishery Development Plan

After construction of the water resource facility, water surface of 29 ha will be developed (8 ha at first stage development). This storage water will be utilized for fish culture of tilapia, mud fish, etc. The cooperative shall be

encouraged to purchase inputs such as fishing nets and fingerling. ATI has a fisherman's training center, hence, the farmers can get technical support and guidance from the center.

5. 4. 4 Possibility of Agro-Industry Development

Based on the agricultural development plan, the following utilization and processing are possible.

Tomato	:	canning (whole tomato, tomato juice, tomato puree, tomato paste, tomato catchup), dehydrating
Corn	:	canning (whole corn, cream style corn)
Mungo bean	:	bean paste, bean noodle, bean sprouts
Cashew (shell)	:	oil extraction, dehydrating
Cashew (apple)	:	livestock feed, juice, candy, wine, syrup, jam, preserve
Mango	:	mango juice, mango puree, mango preserve, dried mango

Figure 5. 4. 1 Post-Harvest Flow Chart of Paddy

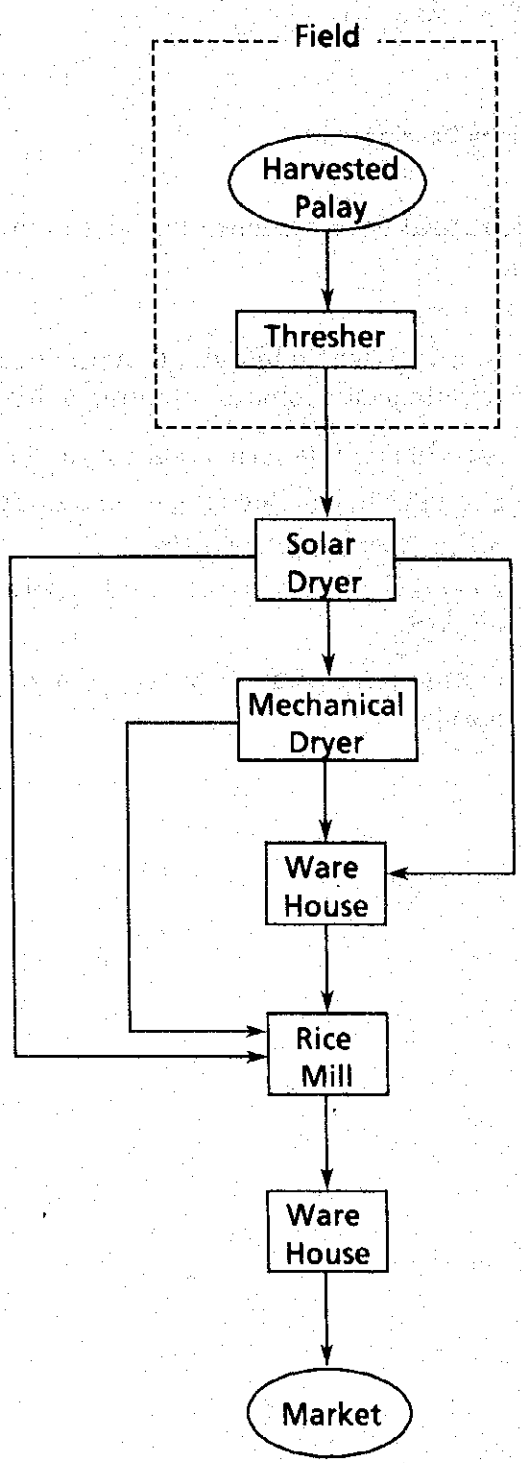
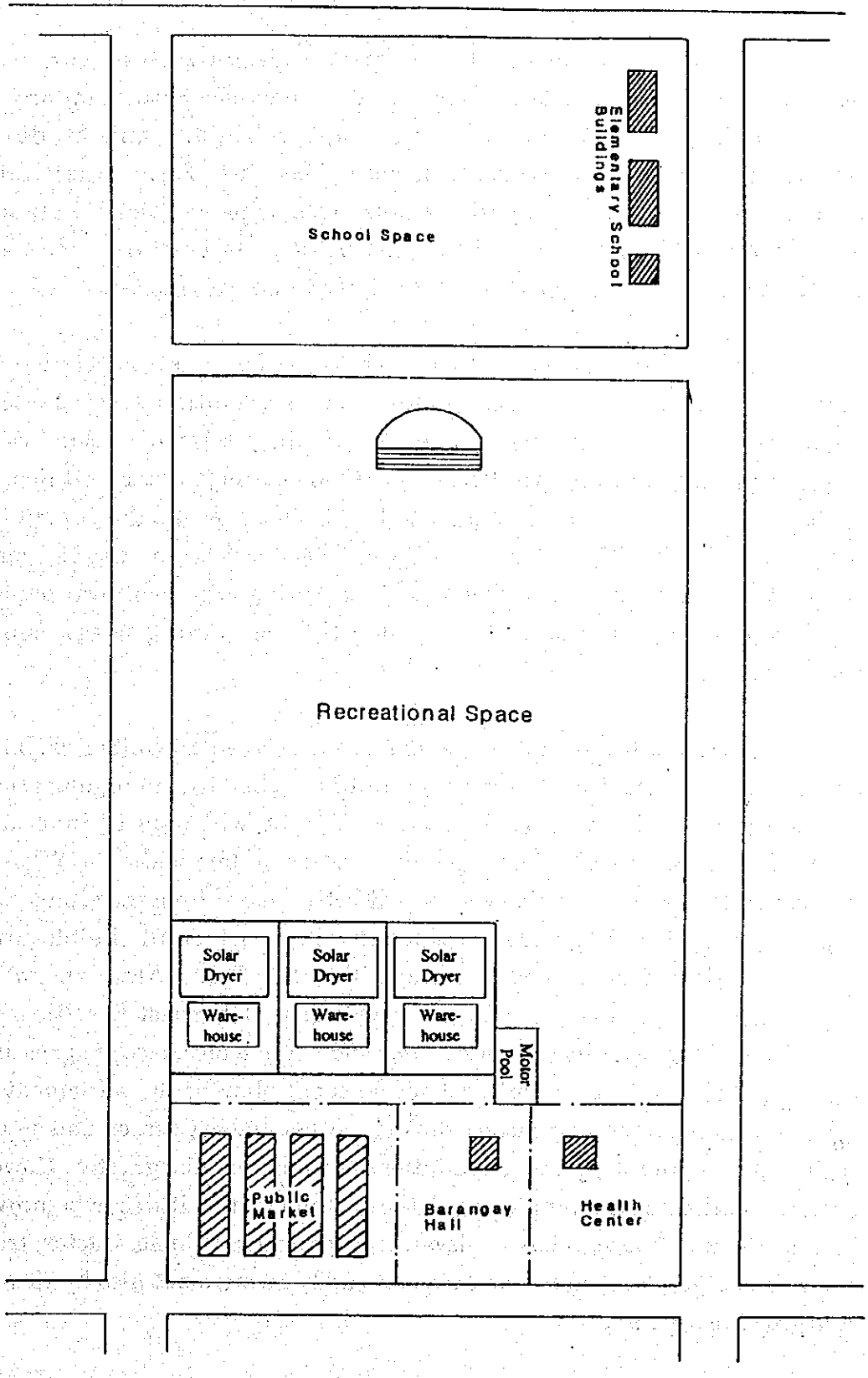


Figure 5. 4. 2 Typical Layout of Rural Infrastructures in Tagumpay Area



5. 5. Farmer's Organization Plan

5. 5. 1 Objective

The basic objective of the farmers organization plan is the development of the farmer beneficiaries at the Tagumpay Settlement area and its outlying areas into viable, organized, self reliant and productive community, sharing resources for their mutual benefits. Farmers associations shall be organized so that they will be able to participate in the operation and maintenance (O&M) of the facilities and utilities to be introduced in the Settlement area and to support specific activity to increase income.

Specific farmer's associations such as the irrigators association (IA), multi-purpose cooperatives and water users association (WUA) will be organized and/or strengthened. The IA is mainly related to the O&M of irrigation facilities, while the WUA to the O&M of village water facilities. The multi-purpose cooperative is related to the farmer's needs, the functions of which shall be the O&M of the post harvest facilities to be proposed for the Study Area and such other functions as marketing of agricultural products, purchasing of inputs to obtain more collective bargaining power, lending activities, etc.

Since the beneficiaries are simple farmers with limited skills and experiences in agricultural production, initially, the farmers organization in the Study Area will be activity specific. The IA will only include actual cultivators of land within the proposed irrigation system while the WUA will include all farmers/households who will directly benefit from the village water supply system. The multi-purpose cooperative shall include all eligible farmers (whether irrigated or rainfed farmers) within the Study Area who will be encouraged to join the association to avail of post harvest facilities to be provided and the benefits of volume sales and volume purchase of agricultural inputs and others. The agricultural development plan for the settlement area calls for different cropping pattern during the wet and dry season and on areas with different land slope due to limitations of water and topography. However, even with different cropping pattern, the post harvest facilities to be provided such as the warehouse, the solar dryer, transportation vehicle, tractor, trailer, etc, will not only be used by the irrigated paddy farmers but also by the other crop growing farmers.

Organizing these farmers into one umbrella organization and/or cooperative might complicate the organizational system during this period. Eventually in the near future, when the IA and the multi-purpose cooperative, which have been strengthened and/or organized, have become fully operational and have gained the necessary disposition, skills, leadership potentials and funds, they can interface or merge into one single organization/association.

5. 5. 2 General Plans and Activities

The NIA will be tapped in the development of the IAs as it has already established a system for developing the IAs. The NGO to be contracted by the DAR shall be responsible for the development and strengthening of the multi-purpose cooperative while the LWUA or the LGU may be tapped by the DAR to initially organize and train the WUA.

The assistance to be provided to the farmers are basic organization and training, the general activities of which are as follows: ① establishing and/or strengthening of the specific organizations; ② training of leaders and members on organization management and basic skills; ③ assisting in the preparation and establishment of the organizations structural units, and ④ establishing the linkages of the organizations/associations within the Study Area and other concerned government agencies/entities.

The initial orientation and organizational activity will be undertaken by the DAR. Since the farmer beneficiaries will be the end users of the facilities to be introduced in the settlement area, they shall be made aware that the function of operation and maintenance of facilities will be their responsibility. During all these period of organization and preparation, the DAR will coordinate and incorporate complementary activities and will function as intermediary and/or coordinator of the various organizations/agencies involved with the farmers organization to avoid confusion and/or duplication.

5. 5. 3 Irrigators Association

To ensure the long life and sustainability of irrigation projects, it is important that the provision of maintenance and operation systems be in place prior to implementation. Since the farmers are the end users of the irrigation facilities, they shall be made aware that the maintenance and operation of the facilities are their responsibility. It is therefore necessary to establish an irrigators association (IA) even before the completion of the facilities. The IA when organized are expected to operate and maintain the system, to supervise the equitable distribution of water and to collect the required irrigation fees/charges. (refer to Figure 5.5.1)

The DAR will tap the services of the NIA in the organization of the farmers and in the provision of the various trainings needed to develop their capabilities to manage and maintain the irrigation system. Specifically, the two (2) main focus of the IA organization and training are the planning, implementation and evaluation of operation and maintenance activities and activities to strengthen the IA. (refer to Appendix J.2)

When the IA have become fully operational and have gained the necessary disposition, skills, leadership potentials and funds, they can venture into other farmer related activities, such as volume acquisition of farm inputs, marketing of farm produce, acquisition and management of post harvest facilities, lending activities, etc., and/or merge and interfaced with the cooperative to be developed and organized by DAR-NGO in the Study Area.

The IA to be organized shall consist of the officers of the association (president, vice president, treasurer, etc.) to be elected and/or chosen from the existing members of the association. The head of the association is the President and under him are the other officers. The full time hired workers like the water tender, ditch tender and the gatekeepers are under the supervision of the Operations Manager. The water tenders (3 persons), gatekeepers (6 persons) and the ditch tenders (6 persons) will be hired on a full time basis by the association. The cost to the farmer of the irrigation system is about 500 pesos per hectare per cropping season. (refer to Appendix J)

5. 5. 4 Water Users Association

The water users association which will be organized prior to and/or during construction stage, will be in-charge of the operation and maintenance of the village water supply system and the collection of water charges. The success of the WUA will be measured in terms of functioning facilities, utilization of facilities and its impact on the health and economic status of women and their families. To ensure the success and continuity of the project, necessary training and skills would be provided to the members/leaders. The DAR may tap the LWUA and/or the NGO to provide orientation and skills training to the WUA. (refer to Figure 5.5.2 and Appendix J.2)

There are least five (5) officers proposed for the WUA who shall be selected from among the members of the association, namely, the president, vice-president, secretary, treasurer and bookkeeper. Two (2) systems operators are proposed to operate the system for about three (3) hours each in the morning and in the afternoon and to see to it that the systems are properly maintained. A meter reader who will also act as the water fee collector shall be hired by the association. The cost per household of the water system is about 45 pesos per month. (refer to Appendix J)

5. 5. 5 Multi-Purpose Cooperative

The existing farmers organization in the Study Area, the auto savings and the cooperative groups will be strengthened and assisted to make sure that the farmers are efficiently organized prior to implementation. The existing organizations shall be encouraged to eventually organized into one federation of farmers organization, a multi-purpose cooperative, to particularly take care of the post harvest facilities to be provided under the project and to undertake other activities which shall include but not limited to marketing of agricultural products, purchase of inputs, provision of credit and others. (refer to Figure 5.5.3)

The DAR's strategy in the development and organization of farmer beneficiaries is the contracting of NGO partners. The responsibility of developing the farmer beneficiaries into viable partner agencies for the implementation of the facilities and systems will therefore depend on the NGO

to be contracted by DAR. The DAR together with the NGO will implement the cooperative development component of the project. After proper orientation and organization, various education and training will be conducted for the farmer leaders and members. The learning will enable the farmer beneficiaries to perform their task efficiently as new owner-cultivators.

The preparation of farmers to be fully organized and prepared to accept responsibilities to operate, manage and maintain a system will take about three (3) years. (refer to Appendix J.2)

The officers of the multi-purpose cooperative are the president, vice-president, the treasurer, secretary and the operations manager. Under the operations manager are the management staff composed of four (4) persons on the full time basis, who will assist in the management of the day to day operations of the cooperative. Specific activities as need arises, such as education and training, production and marketing, etc. at the initial stage shall be headed by a committee chairman as coordinator, selected from among the members of the cooperative.

For the operation of the post harvest facilities and equipment, persons like mill operators, drivers, etc. will be hired by the cooperative on a full time basis. However, work period will only be during the planting and/or harvesting period and when the agricultural activity is in full operation. The cost per farmer of the post harvest system and for the operation and maintenance of the multi-purpose cooperative is about 400 pesos per cropping season per hectare. (refer to Appendix J)

5. 5. 6 Federation of Farmers Organization

The eventuality of forming one single farmers organization in the project area in the near future, cannot therefore be ignored. As mentioned beforehand, when the IA, WUA and the muti-purpose cooperative have become operational and have gained the necessary disposition, skills, leadership potentials and funds, they can interface or merge into one single farmers organization. A federation of farmers organization is envisioned in the project area because of the fact that the majority of the farmer beneficiaries will have

become members, not only of one (1) farmers organization but maybe two (2), if not all of the organizations to be established in the Study Area.

The following strategies shall be applied in the formation of the farmer's organizations into one federation of farmers organization: (1) the idea of forming into one single cooperative will have to be introduced and instilled in the training of the farmers; (2) the quarterly participative evaluation of the farmer organizations (after construction of project facilities) will become the focal point / venue in the decision to form one single organization. The decision will have to come from the farmers themselves and should never be imposed by DAR or the NGO contracted by DAR to assist the farmers; (3) representatives of the different farmers organization in the Study Area will have to undergo "immersion" activities (or training by actual experience) from successful cooperatives outside the Study Area to learn by actual experience, the principles and basic knowledge of organizing and managing a federated cooperative and; (4) assistance to the organizations in the formation, reorganization and strengthening of the farmers federation.

The general activities to be undertaken in the organization of the federation are: (1) reorganization and reorientation; (2) strengthening of capabilities of cooperative leaders and members through continuous training; (3) developing and strengthening business activities of its members by training of farmer leaders on rice/palay trading business, input (fertilizers and chemicals) business, marketing of produce (rice, vegetables, fruits, etc), processing of produce, etc.; and (4) strengthening relationship and establishing of linkages with other cooperatives/farmer groups, government and non-government agencies outside the project area to assist in the production and marketing of produce.

5. 5. 7 Extension and Research & Training Program

To support the agricultural development plans and programs of the Study Area, extension and research & training activities are necessary. The Palawan Experimental Station located near Puerto Princesa city and the Philrice can be tapped to conduct and carry out technical studies and experiments on the crops/livestock recommended for the Study Area.

The PNAC, located in Aborlan, adjacent to the Study Area, can be a good training ground for farmers. Its experimental fields and 21 Bayanihan Centers scattered in Palawan aims to extend improved agricultural education and livelihood opportunities to young farmers. The local government or other concerned agencies maybe tapped to provide assistance to the young farmers of the Study Area in the form of scholarships and/or funds to deserving students who would want to study in the nearby school.

The NGO partner or the extension workers can provide the opportunity to bring the farmers to the nearby Luzviminda-Mangingisda Agricultural Center (about 22 km away from the Study Area) where a nursery farm, carabao pool, vegetable and cash crops are planted and a model farm home lot is put up for demonstration purposes. Also, model farms can be developed with the assistance of the extension worker or the local government for farmers to see, gain and acquire actual and practical knowledge and skills on farming technology.

Since only one extension worker covers both barangays Kamuning and Inagawan, where the Study Area is located, other extension workers, which shall focus on other crops such as vegetables, fruits and animal husbandry, are recommended to be provided with the implementation of the Project.

5. 5. 8 Women in Development

The activity of women in the Study Area are many and varied. Aside from the regular household activity (cooking, caring for children, washing, etc.) and fetching of water for domestic consumption, women are also involved in farm production activities (planting, weeding, harvesting, drying, etc) due to lack of family labor and/or income sources.

The task of fetching water plus all other activities makes the work of women doubly taxing. The task of hauling water of women becomes harder during the dry season when the nearby wells located within the home lot area dries up or have less water. They are forced to fetch water from other sources, specifically the springs, which are far from their homes, spending more hours and thus affecting their energy and health.

Also, during the dry season, women do all their washing and bathing activities in the spring, affecting the quality of water which becomes unfit for drinking. Due to the contaminated water, women and children become more prone to water borne diseases like diarrhea, skin diseases and the like.

Women's role and participation in the development process should not therefore be ignored because of the multifaceted role they play in the activity and development of the household economy. Any development that will take place will always affect them as prime users and/or beneficiaries.

Women's organization must be developed and organized to assist in the operation and maintenance of the facilities in the Study Area. Specifically, women's involvement in the village water supply is very important to enable them to play meaningful roles in the management of the system. The village water supply would mean for the women improved working conditions due to lesser hours spent for fetching water and therefore improved income due to more free time for more economic and productive endeavors. Also, the women will be encouraged to join the other organizations to be put up, like the multi-purpose cooperative. Women's involvement in the organizations/associations will enhance their leadership qualities, improve their leadership qualities and skills through training as members, or officers or caretakers.

The activities recommended to involve women are, ① invitation of women to meetings/activities related to the project; ② development of special training modules for women; ③ assigning of specific tasks/committee to women; and ④ encouraging women to put up simple income generating activities. (refer to Appendix J.2)

Figure 5. 5. 1 Typical Organization Chart of Irrigators Association

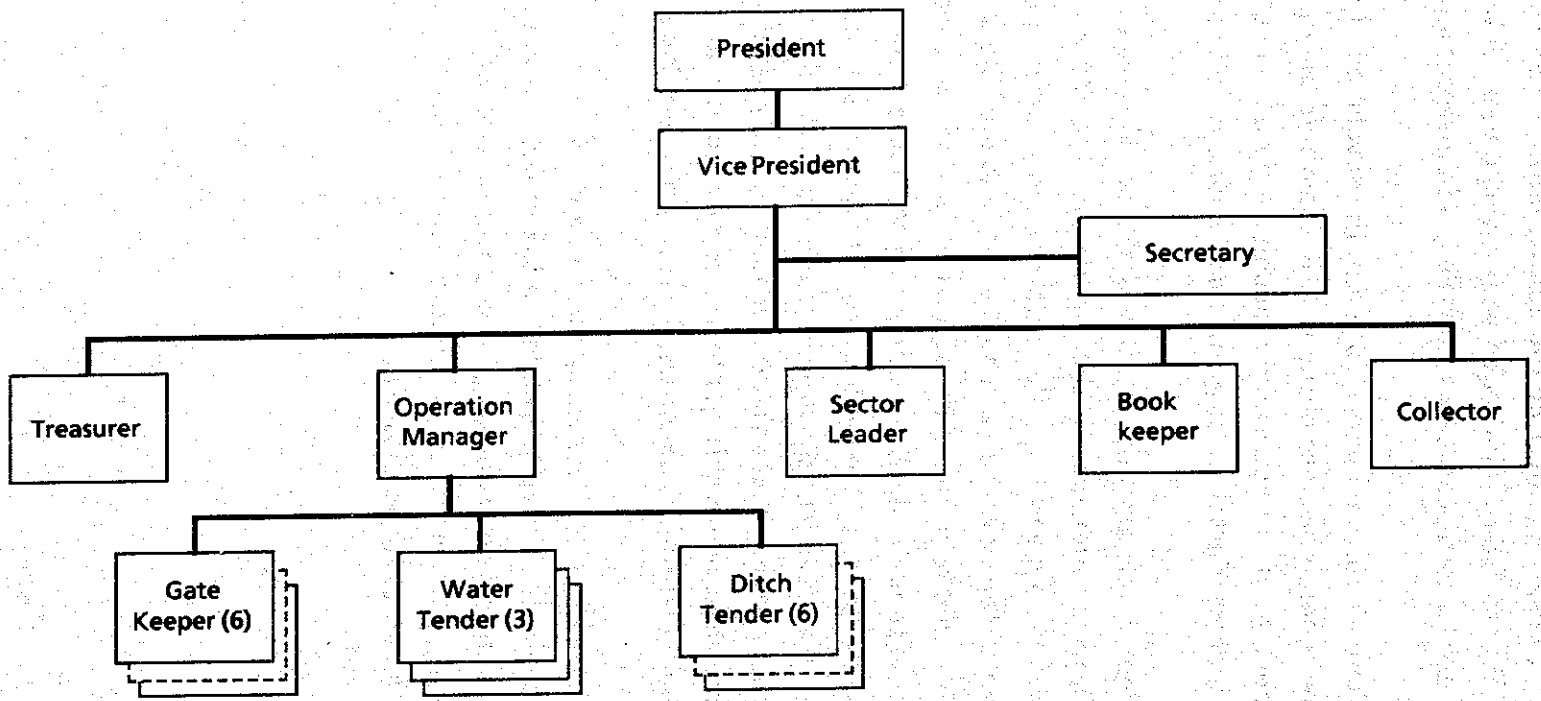


Figure 5. 5. 2 Typical Organization Chart of Water Users Association

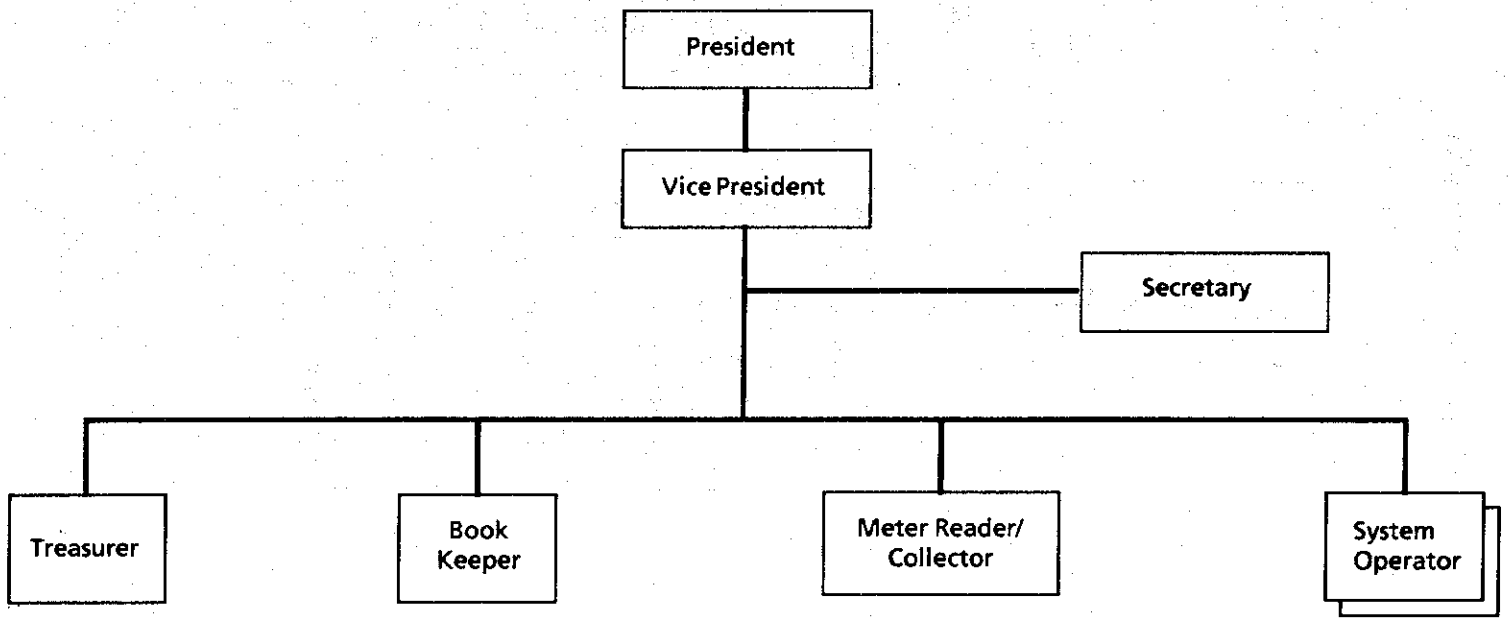


Figure 5. 5. 3 Typical Organization Chart of Multi Purpose Cooperative