

4.6. Cost Estimate

4.6.1. Construction Plan

(1) Major Works

The construction of the major works consisting of a dam and canal system is carried out by the Contractor under the supervision of Consultant who assists RID. The following conditions and methods for the construction will be considered:

(a) Preparatory works

The buildings including office, residence, warehouse, laboratory, etc. for the supervisory body of RID and Consultant will be constructed by the Contractor at the beginning stage of construction and maintained during the construction period by the Contractor.

(b) Temporary works

Contractor's camp and office, access road, river diversion works, stripping at the borrow area, transmission line for electricity, water supply system, etc. will be constructed or provided by the Contractor at their own expense.

(c) Available construction materials

- Earth material for dam embankment is taken from the nominated borrow area and the excavation site of the dam and spillway.
- Sand material for the filter drain of the dam embankment and concrete are transported from the upstream of the Mae Nam Mun.

- Concrete aggregate and riprap material for the dam are produced at the quarry or excavation site of spillway.
- Excavated material of the canal is available for its fill.
- Cement, reinforcement, steel material, etc. are transported from the manufacturing factory located in the vicinity of the Project site.
- Valve, gate, and steel pipe to be installed at the intake facilities of the dam and diversion dam are purchased from the foreign or local manufacturers.

(d) Construction method

- All excavated materials at the dam foundation will be spoiled to the spoil bank except the excavation material to be used as the embankment material.
- The curtain grout hole will be drilled by the rotary method of a boring machine, but the blanket grout hole by a crawler drilling machine.
- Embankment of the dam is carried out with the following criteria:

<u>Zone</u>	<u>Thickness of Spreading</u>	<u>Number of Passes</u>	<u>Compaction Equipment</u>
Earth zone	20 cm	6	Tamping roller 15 ton
Filter zone	40 cm	4	Vibrating roller 0.6 ton and 8 ton

- Concrete aggregate for the dam and canal in the Lam Plai Mat and Nong Lum Puk Sub-Projects will be produced by the crushing plant at the quarry site near the Nong Lum Puk damsite. However, concrete aggregate for the Huai Phlu Sub-Project will be purchased from the existing quarry site at Nang Rong.

- Expected workable days per month will be 20 days for the earthworks and 25 days for other works.

One month per annum is excluded from the workable days for the earthworks due to the periodical overhaul of construction equipment.

- Earthworks for the canal from August to September will be suspended because of the rainy season.
- Concrete works at the damsite are made by transporting the concrete from the batching plant. However, concrete works at each section of the canal are carried out by providing a number of mixers with a small capacity.
- Laterite pavement is adopted for maintenance of the road along the canal.

(2) Construction Plan for the Lam Plai Mat Sub-Project

(a) Dam

- The following major works with a large quantity are carried out in the Lam Plai Mat dam:

Dam excavation	311,000 cu.m
Grouting	14,000 m
Dam embankment	1,656,000 cu.m
Spillway excavation	202,000 cu.m
Spillway concrete	17,000 cu.m
Intake excavation	13,000 cu.m
Intake concrete	3,000 cu.m

- The river diversion works are planned along the alignment passing through station 7 + 50 at the right bank and constructed open channel.

Two coffer dams upstream and downstream are also constructed by the excavated material of the river diversion channel.

This river diversion is used for the first stage construction of the cutoff trench in the central section of the dam between stations 4 and 7.

After completion of the cutoff trench works in the central section, the river diversion is changed to the intake conduit to be installed in the right bank.

Since the central section of the dam requires deep excavation with a maximum depth of about 18 m in the riverbed, the construction of the dam at the first stage will be commenced in this section.

The excavation, grouting and backfill embankment up to the elevation of 240 m at the cutoff trench in the central section will start in November 1987 and be completed by July 1988 before the beginning the flood season from August to September.

Sufficient drainage operation will be required during the cutoff trench works to drain water leakage through the trench foundation.

- Since the dam has a long crest length of about 1,100 m, the excavation for the left and right banks could be commenced at any time.

The excavation works at both banks would be done when the grouting works at the central section are under construction.

The excavation near station 7 + 50 being placed at the river diversion, will remain at the first stage and will be carried out after changing the river diversion to the intake conduit.

- The grouting works will be intensively done at the cutoff trench of the central section to complete the works within a short period in the dry month and then proceeded toward the left and right banks.
- The embankment of the dam after completion of the backfill embankment at the central section will be made from the central section to the left bank at the first stage.

The embankment on the right bank will be commenced after changing the river diversion.

Since the embankment of the central section and left bank proceeded at the first stage, its embankment will be suspended when the right bank embankment is commenced due to adjustment of the embankment lift. After adjusting the embankment lift, the works for the left, central and right will continue keeping the same embankment lift.

- The spillway works could be commenced at any time, however, the works will be made parallel with the dam embankment at the second stage taking into consideration the excavated rock in the spillway to be used for the riprap material of dam.

- The inlet and conduit pipe works for the intake facilities will be carried out at the first construction stage in order to use them for the river diversion purpose at the second stage construction.
- The dam construction will start in the middle of 1987 and be completed in the middle of 1990 with a three-year construction period as shown in Figure 4-6-1.

The storage of water will start in the flood season from August to September 1990 and the irrigation water will be supplied to the service area in the beginning of 1991.

- The schedule of construction equipment and their output for the major works are shown in ANNEX G, Table G-1-1.

(b) Distribution System

- The distribution system in the service area of the Lam Plai Mat Sub-Project consists of the following major items:

Pa Kham Diversion Weir

Excavation	32,000 cu.m
Fill & backfill	10,000 cu.m
Concrete	10,300 cu.m
Sheet pile	1,300 sheets
R.C. pile	240 sticks
R.C. pipe	270 m
Radial gate	3 sets
Sluice gate	5 sets

Canal system

<u>Sub-system</u>		<u>Length (km)</u>	<u>Excavation (cu.m)</u>	<u>Fill (cu.m)</u>	<u>Lining Concrete (cu.m)</u>
Sra Ta Kien	Main	25.8	91,000	64,000	4,700
	Lateral	9.6	22,000	57,000	-
Soeng Sang	Main	12.3	35,000	103,000	2,100
	Lateral	17.4	45,000	142,000	-
Pa Kham	Main	30.4	148,000	106,000	7,700
	Lateral	20.9	43,000	66,000	-
Thai Charoen	Main	26.4	215,000	221,000	12,800
	Lateral	72.3	137,000	371,000	600
<u>Total</u>			<u>736,000</u>	<u>1,130,000</u>	<u>27,900</u>

-- Since the Pa Kham diversion weir site is inundated from August to October, the construction works will be done only in the dry season. The foundation works for the excavation, sheet pile, R.C. pile and base concrete will be carried out in the period of dry months from November 1988 to July 1989. After the flood season in 1989, the construction works for the concrete of weir body, the fill and gate installation are commenced and completed by April 1990.

There will be no particular attention paid to carrying out the construction works due to the diversion weir with a low height of 2.6 m and a small quantity to be executed.

-- The main canal is mostly located at a hilly area and does not cause much land acquisition problem. The lateral canal is usually constructed in the existing paddy field, in seven months from November to May, which is not in the cultivation season.

The main and lateral canals will be constructed by dividing them into several sections in accordance with the quantities to be carried out in each section.

The construction plan is made taking into consideration the quantity for each canal and the output by construction equipment to be adopted.

The approximate output per month and required working period for each canal are described in ANNEX G. Table G-1-1.

- The construction schedule for the diversion weir and canal system is shown in Figure 4-6-1.

(3) Construction Plan for Nong Lum Puk Sub-Project

(a) Dam

- The quantity to be carried out is as follows:

Dam excavation	28,000 cu.m
Dam embankment	190,000 cu.m
Spillway excavation	145,000 cu.m
Spillway concrete	440 cu.m
Spillway riprap	14,000 cu.m
Intake excavation	3,000 cu.m
Intake concrete	190 cu.m

- Since the Nong Lum Puk dam has a crest length of 1,156 m and a shallow excavation depth at the cutoff trench without grouting works, the construction of excavation and construction of the embankment of the dam will be carried out easily.

Figure 4-6-1 (1) Construction Schedule for Lam Plai Mat Sub-Project

Description of Works	Quantity	1987			1988			1989			1990			Remarks						
		8	10	12	2	4	6	8	10	12	2	4	6		8	10	12			
A. Lam Plai Mat Dam																				
1. Temporary Works																				
- Camp, Office & Workshop	L.S.																			
- Access Road	7 km																			
- River Diversion	550 m (66,000 cu.m)																			
- Stripping at Borrow Area	300,000 cu.m																			
2. Foundation at Central Section																				
- Stripping	48,000 cu.m																			
- Trench Excavation (Earth)	124,000 cu.m																			
- ditto - (Rock)	3,000 cu.m																			
- Curtain Grouting	3,000 m																			
- Backfill Embankment	130,000 cu.m																			
3. Foundation at Left Bank																				
- Stripping	33,000 cu.m																			
- Trench Excavation (Earth)	22,000 cu.m																			
- ditto - (Rock)	5,000 cu.m																			
- Curtain Grouting	4,000 m																			
- Blanket Grouting	1,000 m																			
4. Foundation at Right Bank																				
- Stripping	46,000 cu.m																			
- Trench Excavation (Earth)	18,000 cu.m																			
- ditto - (Rock)	12,000 cu.m																			
- Curtain Grouting	4,100 m																			
- Blanket Grouting	1,000 m																			
5. Dam Embankment																				
- Improvements & Random Zone	1,420,000 cu.m																			
- Horizontal & Vertical Drain	34,700 cu.m																			
- Riprap	67,000 cu.m																			

Figure 4-6-1 (2) Construction Schedule for Lam Plai Mat Sub-Project

Description of Works	Quantity	1987			1988			1989			1990			Remarks						
		8	10	12	2	4	6	8	10	12	2	4	6		8	10	12			
6. Spillway																				
- Earth Excavation	50,000 cu.m																			
- Rock Excavation	152,000 cu.m																			
- Concrete Works	17,300 cu.m																			
7. Intake Facility																				
- Excavation Works	Earth 3,700 cu.m, Rock 9,100 cu.m																			
- Concrete Works	5,000 cu.m																			
- Gate Installation	L.S.																			
B. Pa Kham Diversion Weir																				
- Earth Excavation	32,000 cu.m																			
- Embankment	10,000 cu.m																			
- Piling Works	L.S.																			
- Concrete Works	10,300 cu.m																			
- Gate Installation	L.S.																			
C. Canal System																				
1. Sra Ta Kien Sub-System																				
- Main Canal, Earth Works	Ex. 91,000 cu.m, Fill 64,000 cu.m																			
- Main Canal, Concrete Works	4,700 cu.m																			
- Lateral Canal, Earth Works	Ex. 22,000 cu.m, Fill 57,000 cu.m																			
- Drainage Canal, Earth Works	Ex. 35,000 cu.m																			
2. Soeng Sang Sub-System																				
- Main Canal, Earth Works	Ex. 35,000 cu.m, Fill 103,000 cu.m																			
- Main Canal, Concrete Works	2,100 cu.m																			
- Lateral Canal, Earth Works	Ex. 45,000 cu.m, Fill 142,000 cu.m																			
- Drainage Canal, Earth Works	Ex. 24,000 cu.m																			

Figure 4-6-1 (3) Construction Schedule for Lam Plai Mat Sub-Project

Description of Works	Quantity	1987				1988				1989				1990				Remarks								
		8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2		4	6	8	10	12			
3. Pa Kham Sub-System																										
- Main Canal, Earth Works	Ex. 148,000 cu.m, Fill 106,000 cu.m																									
- Main Canal, Concrete Works	7,700 cu.m																									
- Lateral Canal, Earth Works	Ex. 43,000 cu.m, Fill 66,000 cu.m																									
- Drainage Canal, Earth Works	Ex. 33,000 cu.m																									
4. Thai Charoen Sub-System																										
- Main Canal, Earth Works	Ex. 215,000 cu.m, Fill 221,000 cu.m																									
- Main Canal, Concrete Works	12,800 cu.m																									
- Lateral Canal, Earth Works	Ex. 137,000 cu.m, Fill 371,000 cu.m																									
- Drainage Canal, Earth Works	Ex. 123,000 cu.m																									

- Since the spillway excavation is quite large, its works would be made parallel with the dam embankment and excavated materials could be used for the dam embankment.
- The riprap works for protection of the chute and stilling basin in the spillway are carried out with the material transported from the quarry site, which is newly developed near the Nong Lum Puk damsite for the concrete aggregate of the Lam Plai Mat Sub-Project.
- The construction of the dam will be commenced in the middle of 1987 and completed in one year.

The detailed construction schedule is shown in Figure 4-6-2.

(b) Canal system

The canal construction is only for 10.2 km for the main 10.2 km and 2.5 km for the lateral and mainly consists of earthworks. The works are also easily done in one year.

(4) Construction plan for the Huai Phlu Sub-Project

(a) Dam

- The quantity to be carried out is as follows:

Dam excavation	64,000 cu.m
Grouting works	5,500 m
Dam embankment	274,000 cu.m
Spillway & Intake	
Excavation	33,000 cu.m
Concrete	2,330 cu.m

- The Huai Phlu dam construction works shall be carried out after completion of the construction of the Nong Lum Puk dam and with the same construction equipment to be used for the Nong Lum Puk.

Namely, the construction works for the Huai Phlu dam will start in November 1988 after the flood season is over.

- The excavation, grouting, embankment works could be mostly carried out in about one and half year.
- The construction schedule based on the equipment output is shown in Figure 4-6-2.

(b) Canal system

The canal system consists of only 19.8 km for the main and 8.8 km for the lateral earth canal.

(5) Construction Plan for the On-Farm Work and Muban Communal Facilities.

(a) On-farm work

The on-farm work consists of simple earthworks for the farm ditches and roads in fields of 20 to 30 ha, and could be easily constructed with the manpower from the farmers' association.

However, the technical assistance for the layout, design and construction will be vended by RID. Some small turnouts of concrete structure will also be constructed under the RID's technical guidance.

(b) Muban communal facilities

The farm pond, fishery pond, well for domestic water supply, etc. will be constructed as the muban communal facilities together with the on-farm work by the farmers' association.

ARD will provide the farmer with construction equipment and materials, and RID will give technical guidance for the construction.

Figure 4-6-2 Construction Schedule for Nong Lum Puk and Huai Phlu Sub-Project

Description of Works	Quantity	1987			1988			1989			1990			Remarks						
		8	10	12	2	4	6	8	10	12	2	4	6		8	10	12			
A. Nong Lum Puk Sub-Project																				
1. Access Road & Borrow Area	3 km, 12,000 cu.m																			
2. Dam																				
- Excavation	28,000 cu.m																			
- Embankment	190,000 cu.m																			
- Spillway Excavation	145,000 cu.m																			
- Spillway Concrete Works	440 cu.m																			
- Spillway Riprap	14,000 cu.m																			
- Intake Excavation	3,000 cu.m																			
- Intake Concrete Works	190 cu.m																			
- Intake Gate Installation	L.S.																			
3. Canal System																				
- Main Canal, Earth Works	Ex. 27,000 cu.m, Fill 31,000 cu.m																			
- Lateral Canal, Earth Works	Ex. 6,000 cu.m, Fill 10,000 cu.m																			
B. Huai Phlu Sub-Project																				
1. Access Road & Borrow Area	5 km, 20,000 cu.m																			
2. Dam																				
- Excavation	70,000 cu.m																			
- Embankment	274,000 cu.m																			
- Grouting	5,500 m																			
- Spillway Excavation	28,000 cu.m																			
- Spillway Concrete Works	2,000 cu.m																			
- Intake Excavation	5,000 cu.m																			
- Intake Concrete Works	300 cu.m																			
- Intake Gate Installation	L.S.																			
3. Canal System																				
- Main Canal, Earth Works	Ex. 51,000 cu.m, Fill 62,000 cu.m																			
- Lateral Canal, Earth Works	Ex. 20,000 cu.m, Fill 20,000 cu.m																			
- Drainage Canal, Earth Works	Ex. 2,000 cu.m																			

(c) Construction period

Construction will be made in parallel with the major work from December to April, which is not the cultivation season for the paddy and therefore sufficient labor force will be available.

4.6.2. Basic Rate

The basic rate for labor, material and construction equipment is estimated on the basis of the prevailing rate in the Lower Northeast and the rest of Thailand, as follows:

(1) Wage Rate per Day

Foreman I	160 (฿)
Foreman II	120
Operator for heavy equipment	110
Assistant operator	80
Driver	80
Steel worker	80
Carpenter	90
Mechanic	120
Electrician	110
Driller	120
Common labor	60

(2) Material Rate

<u>Description</u>	<u>Unit</u>	<u>Rate (฿)</u>
Portland cement	ton	1,900
Reinforcing bar	ton	10,000
Wire for binding	kg	17
Gasoline	liter	11.45
Light oil	liter	7.25
Lubricant	liter	35
Gravel for Huai Phlu	cu.m	200
Sand from Mun river	cu.m	350
Laterite	cu.m	60
Timber (soft)	cu.m	6,400
Timber (hard)	cu.m	8,500
Dynamite	kg	160
Detonator	pc.	25
Electric charge	kWh	2.2

(3) Construction Equipment Rate

<u>Description</u>	<u>Capital Cost (P'000)</u>	<u>Hourly Rate (P)</u>
Bulldozer, 11 ton	1,100	481
Bulldozer, 21 ton	2,240	944
Bulldozer, 32 ton	3,500	1,362
Tractor Shovel, 1.2 m ³	1,000	417
Tractor Shovel, 1.8 m ³	1,400	599
Tractor Shovel, 2.2 m ³	1,960	762
Backhoe Shovel, 0.4 m ³	1,050	388
Backhoe Shovel, 0.8 m ³	1,900	659
Dump Truck, 8 ton	550	240
Dump Truck, 11 ton	800	319
Dump Truck, 18 ton	1,860	682
Tamping Roller, 15 ton	650	174
Vibrating Roller, 8 ton	950	483
Tired Roller, 20 ton	750	288

The construction equipment rate per hour is estimated, based on the capital cost, the ratio for depreciation, repair and maintenance for equipment operation, fuel consumption and operator.

The detailed estimate of construction equipment rate is shown in ANNEX G, Table G-2-7.

(4) Foreign and Local Currency Portions for Basic Rate

The foreign and local currency portions for the basic rate are estimated, based on the prevailing percentage in the international fund agency, as follows:

<u>Description</u>	<u>Percentage</u>	
	<u>F/C</u>	<u>L/C</u>
Cement	60	40
Reinforcement	70	30
Fuel	80	20
Timber	20	80
Explosive	80	20
Electric Charge	-	100
Depreciation for Equipment	100	-
Repair for Equipment	80	20
Maintenance for Equipment	-	100
Labor	-	100

4.6.3. Unit Rate

(1) Unit Rate for Major Works

The unit rate for the major works by RID is estimated, based on the output of construction equipment, the basic rate for labor, the material and equipment, and the construction plan.

An overhead of 20 percent for the unit rate has been considered for the works to be carried out on a Contract basis, based on the following formula:

	<u>Description</u>	<u>Rate (%)</u>
(1)	Profit	6.5
(2)	Administration	3.5
(3)	Tax	3.4
(4)	Cost reserved	4.1
(5)	Insurance	1.5

$$\text{Rate of Overhead: } \frac{\{1 + (1)\} \{(1) + (2)\}}{\{1 - (3)\} \{1 - (4)\} \{1 - (5)\}} = 1.20$$

The estimated unit rate for the major works is shown in Table 4-6-1.

(2) Unit Rate for the On-Farm Work

The unit rate for the on-farm work was estimated, based on the material rate to be used for the works and quantity calculated by the preliminary design for the sample area. The common labor cost was excluded because the work will be carried out by the farmers' association.

The unit rate is shown in Table 4-6-1 and its detail is estimated in ANNEX Table G-2-8.

Table 4-6-1 Unit Rate

(Unit: ¥)

Description of Works	Unit	Lam		Plai		Mat		Nong Lum		Puk		Huai Phlu		
		F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	Total
A. Dam														
- Stripping	cu.m	36	8	44	24	6	30	24	6	24	30	24	6	30
- Trench Excavation(Earth)	cu.m	45	10	55	27	6	33	27	6	27	33	27	6	33
- ditto - (Soft Rock)	cu.m	104	37	141	-	-	-	64	30	64	94	64	30	94
- Imprevious Zone	cu.m	62	14	76	50	11	61	50	11	50	61	50	11	61
- Random Zone	cu.m	59	13	72	-	-	-	-	-	-	-	-	-	-
- Vertical Drain	cu.m	48	541	589	28	536	564	28	536	28	564	28	536	564
- Horizontal Drain	cu.m	124	305	429	86	296	382	86	296	28	451	28	423	451
- Riprap	cu.m	64	16	80	52	16	68	52	16	52	68	52	16	68
- Reinforced Concrete	cu.m	1,432	1,670	3,102	1,406	1,664	3,070	1,323	1,845	1,323	3,168	1,323	1,845	3,168
- Drilling for Blanket Grout	m	168	37	205	-	-	-	168	37	168	205	168	37	205
- Drilling for Curtain Grout	m	616	208	824	-	-	-	616	208	616	824	616	208	824
- Cement for Grouting	ton	2,970	3,204	6,174	-	-	-	2,970	3,204	2,970	6,174	2,970	3,204	6,174
B. Canal System														
- Stripping	cu.m	7	2	9	7	2	9	7	2	7	9	7	2	9
- Excavation	cu.m	11	15	26	11	15	26	11	15	11	26	11	15	26
- Fill	cu.m	20	17	37	20	17	37	20	17	20	37	20	17	37
- Sodding	sq.m	0	12	12	0	12	12	0	12	0	12	0	12	12
- Laterite Pavement	cu.m	11	110	121	11	110	121	11	110	11	121	11	110	121
- Linning Concrete	cu.m	818	1,274	2,091	709	1,240	1,949	614	1,448	614	2,062	614	1,448	2,062
C. On-Farm Work														
- Ordinary Service Unit	ha	475	875	1,350	475	875	1,350	475	875	475	1,350	475	875	1,350
- Muban Cooperative Service Unit	ha	570	1,050	1,620	570	1,050	1,620	570	1,050	570	1,620	570	1,050	1,620
D. Muban Communal Facilities														
- Pond, I - A	place	254,000	199,000	453,000	-	-	-	254,000	199,000	453,000	453,000	254,000	199,000	453,000
- Pond, I - B	place	276,000	212,000	488,000	-	-	-	276,000	212,000	488,000	488,000	276,000	212,000	488,000
- Pond, I - C	place	150,000	168,000	318,000	-	-	-	-	-	-	-	-	-	-
- Pond, II - A	place	360,000	242,000	602,000	-	-	-	360,000	242,000	602,000	602,000	360,000	242,000	602,000
- Pond, II - B	place	376,000	255,000	631,000	-	-	-	-	-	-	-	-	-	-
- Pond, III - A	place	485,000	280,000	765,000	485,000	280,000	765,000	485,000	280,000	765,000	765,000	485,000	280,000	765,000
- Pond, III - C	place	208,000	203,000	411,000	208,000	203,000	411,000	208,000	203,000	411,000	411,000	208,000	203,000	411,000
- Well for Drinking Water	place	0	3,000	3,000	0	3,000	3,000	0	3,000	0	3,000	0	3,000	3,000

Table 4-6-2 Construction Cost

(P '000)

Description	Lam Plai Mat			Nong Lum Puk			Huai Phlu			Total		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
1. Preparatory Work	5,560	10,670	14,230	120	350	470	280	830	1,110	3,960	11,850	15,810
2. Dam												
- Temporary Work	12,680	15,950	28,630	760	1,420	2,180	1,370	2,490	3,860	14,810	19,860	34,670
- Foundation Treatment	25,848	8,140	31,988	690	170	860	5,072	2,111	7,183	29,610	10,421	40,031
- Dam Embankment	90,885	38,550	129,435	6,836	5,107	11,943	12,054	7,523	19,577	109,775	50,980	160,755
- Spillway	43,397	55,260	98,657	5,597	1,833	7,430	3,991	4,292	8,283	52,985	41,385	94,370
- Intake Facility	10,880	6,600	17,480	1,580	510	1,890	2,700	1,010	5,710	14,960	8,120	23,080
Sub-Total	181,690	104,500	286,190	15,263	9,040	24,303	25,187	17,226	42,413	222,140	150,766	352,906
3. Canal System												
- Diversion Weir	19,799	18,100	37,899	-	-	-	-	-	-	19,799	18,100	37,899
- Main Canal	49,197	79,599	128,796	1,999	5,904	5,905	4,002	7,503	11,505	55,198	91,006	146,204
- Lateral Canal	24,598	40,700	65,298	700	1,202	1,902	1,700	3,501	5,201	26,998	45,403	72,401
- Drainage Channel	2,600	3,500	6,100	-	-	-	20	40	60	2,620	3,540	6,160
Sub-Total	96,194	141,899	238,093	2,699	5,106	7,805	5,722	11,044	16,766	104,615	158,049	262,664
Total	281,444	257,069	538,513	18,082	14,496	32,578	31,189	29,100	60,289	330,715	300,665	631,380

4.6.4. Project Cost

The project cost consists of the construction cost of the major works, on-farm work and the Muban communal facilities, and other costs for O/M equipment, right-of-way, survey/investigation works, administration and consulting services.

(1) Construction Cost

The construction cost of the major works to be carried out by RID is estimated, based on the quantities calculated by preliminary design and the unit rate as described in Table 4-6-1. The detailed construction cost estimate is shown in ANNEX Tables G-2-1 to G-2-4 and summarized in Table 4-6-2.

The construction cost of the Muban communal facilities work is estimated, based on the type of work, as shown in ANNEX table G-2-9.

(2) Other Cost

(a) On-Farm Equipment

The cost of on-farm equipment for three sub-projects of about 10,000 ha is estimated at \$14,260,000 as shown in ANNEX H-1-3 and allocated among three sub-projects based on the proportion of respective service area.

(b) Right-of-Way

There is no land acquisition and compensation in the reservoir area of the Lam Plai Mat and Huai Phlu Sub-Project. The right-of-way will be required for the paddy cultivation area in the Nong Lum Puk reservoir area and along the canal alignment of the service area in the three sub-projects.

The cost was estimated with a unit of $\text{฿}2,000/\text{rai}$, as follows:

Project	Reservoir Area		Service Area		Total	
	Area (rai)	Amount ($\text{฿}'000$)	Area (rai)	Amount ($\text{฿}'000$)	Area (rai)	Amount ($\text{฿}'000$)
Lam Plai Mat	-	-	940	1,880	940	1,880
Nong Lum Puk	125	250	25	50	150	300
Huai Phlu	-	-	80	160	80	160
<u>Total</u>	<u>125</u>	<u>250</u>	<u>1,045</u>	<u>2,090</u>	<u>1,170</u>	<u>2,340</u>

(c) Survey and Investigation Works

The survey and investigation works consist of preparation of map, geological investigation and construction material survey for the detail design of the major works and on-farm works.

The cost was estimated at $\text{฿}15,290,000$ as shown in ANNEX Table G-2-5.

(d) Administration Cost

The administration cost is estimated at about $\text{฿}35,000,000$ corresponding to about 5 percent of the total construction cost. The cost consists of salary, transportation means and miscellaneous costs, except the cost of building facilities and their maintenance of the RID Project office, which was estimated in the construction cost of the preparatory work of the major works. The cost is allocated among the three sub-projects by the ratio of the respective service area.

(e) Cost of Consulting Services

The cost of consulting services for the detail design and construction supervision of the major works is estimated at $\text{฿}77,300,000$ as shown in ANNEX Table G-2-6. The cost has also been allocated among the three sub-projects by the ratio of the service area.

(f) Project Cost

The project cost based on the above estimation is summarized in Table 4-6-3.

Table 4-6-3 Project Cost

(\$ '000)

Description	Lam Plai Mat Sub-Project			Mong Lum Puk Sub-Project			Hual Phlu Sub-Project			Total		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
A. Major Work												
1. Preparatory Work	2,851	9,533	11,384	94	282	376	222	666	388	5,167	9,481	12,648
2. Dam	145,544	83,602	228,946	12,211	7,255	19,446	20,148	13,788	33,936	177,703	104,625	282,328
3. Canal System	76,959	113,521	190,480	2,160	4,080	6,240	4,581	8,827	13,408	83,700	126,428	210,128
4. Advanced Payment	28,145	25,707	53,852	1,809	1,450	3,259	3,119	2,910	6,029	53,073	30,067	63,140
5. Retention Money	28,145	25,706	53,851	1,808	1,449	3,257	3,119	2,909	6,028	53,072	30,064	63,136
Total	281,444	257,069	538,513	18,082	14,496	32,578	31,189	29,100	60,289	530,715	300,665	651,380
B. On-farm and Muban	14,470	16,330	30,800	856	854	1,710	2,333	2,227	4,560	17,659	19,411	37,070
C. O/M Equipment	12,830	-	12,830	430	-	430	1,000	-	1,000	14,260	-	14,260
D. Right-of way	-	1,880	1,880	-	300	300	-	160	160	-	2,340	2,340
E. Survey & Investigation	1,210	12,390	13,600	160	440	600	190	960	1,090	1,560	13,730	15,290
F. Detailed Design	24,761	8,914	33,675	819	294	1,113	1,921	692	2,613	27,501	9,900	37,401
G. Supervision	30,613	5,312	35,925	1,011	176	1,187	2,375	412	2,787	35,999	5,900	39,899
H. Administration	13,500	18,000	31,500	450	600	1,050	1,050	1,400	2,450	15,000	20,000	35,000
Base Cost	378,828	319,395	698,723	21,808	17,160	38,968	40,058	34,891	74,949	440,694	371,946	812,640
I. Physical Contingencies	37,883	31,990	69,873	2,181	1,716	3,897	4,006	3,489	7,495	44,070	37,195	81,265
Sub - Total	416,711	351,885	768,596	23,989	18,876	42,865	44,064	38,380	92,444	484,764	409,141	893,905
J. Price Contingencies	191,263	204,540	395,803	9,471	9,246	18,717	21,588	14,092	45,680	222,522	237,878	460,200
Grand - Total	607,974	556,425	1,164,399	33,460	28,122	61,582	65,652	62,472	128,124	707,086	647,019	1,354,105

Note: Price escalation rates applied for estimating Price Contingencies are as follows:

	1985 (%)	1984 (%)	1985 (%)	1986 (%)	1987 (%)	1988 (%)
Domestic	12	10	9	8	8	8
Foreign	7.5	7.5	7.5	6.0	6.0	6.0

CHAPTER V PROJECT ORGANIZATION AND IMPLEMENTATION

CHAPTER V. PROJECT ORGANIZATION AND IMPLEMENTATION

5.1. Overall Project Management and Coordination

(1) Water resources planning at the national level has been, since 1978, the responsibility of the Accelerated Water Resources Development Committee with the Prime Minister as its chairman, and the Minister of Agriculture and Cooperatives, the Minister of Industry and the Deputy Minister of Interior as its vice-chairmen. The Water Resources Planning Sub-Committee of NESDB, which is represented by the Electricity Generating Authority of Thailand, (EGAT) currently functions as a technical advisory arm to the Committee.

In the context of implementing the proposed medium scale water development project in the backward Lower Northeast region, the Committee will have to provide the necessary direction and strong commitment at the nation level and will guide and coordinate the actions of the government agencies concerned both in Bangkok and in changwat, in order to ensure the performance and success of the subject Project.

On the other hand, the Rural Development Committees have been set up at the national, changwat and amphoe levels in accordance with the regulation of the Prime Minister's Office on Rural Development Administration 1981. This National Committee is responsible for planning and implementing the government rural development policy for the improvement of local life in line with the need of people, with the Prime Minister as its chairman, and the five Ministers of the Interior, Agriculture and Cooperatives, Education, Public Health and Office of the Prime Minister, as its vice-chairman.

(2) In order to achieve successful implementation of the subject Project in an orderly manner, a proposal has been conceived for the establishment of a tentatively called Lower Northeast Medium Scale Water Development Committee (LNMSWDC) covering the special geographical region under the Accelerated Water Development Committee and the National Rural Development Committee. This LNMSWDC would assume both planning and decision-making functions at the national level following such three-pronged approach as (1) assistance, (2) instruction and (3) monitoring in launching coordinated measures initially and in implementing them continuously.

(3) Aside from construction and subsequent O & M of the storage dams, main and lateral irrigation canals down to the outlets into the service units and drainage channels, which would be under the sole responsibility of RID, the key issue for successful implementation of the subject Project should focus upon the proposed water-based integrated muban development through construction of the communal facilities as well as the on-farm development in the ordinary irrigation service units by water users' groups, which is a serious and challenging task that cannot be carried out without a concerted effort of the central government agencies being coupled with increased participation of the local administration at changwat, amphoe, tambon and village levels under the Ministry of Interior.

(4) It can be also considered that administrative reforms for the purpose of proper implementation of the proposed Medium Scale Irrigation Project in the Lower Northeast on the basis of water-based integrated rural development would be both unnecessary and unrealistic. Administrative procedures have been established during long years of practice, and cannot be changed radically. With this concept in mind, a successful strategy would be to organize properly the goodwill and resources of existing agencies to achieve the desired goals through their active cooperation; therefore, while clarification of strength and weakness of each

agency is made, it may not be imperative to set up a new organizational unit such as the Lower Northeast Medium Scale Water Development Authority, or stop existing agencies from performing useful roles.

It appears at present that most agencies proceed to implement their projects in a semi-independent manner, and this independence might be necessary if rapid progress is required. However, if the subject Project is to succeed, various agencies will need to coordinate their expertise in the projects. Weakness of the field agencies in any particular area may be strengthened by assistance from other agencies.

Lower Northeast Medium Scale Water Development Committee

- | | | |
|---------------|---|----------------------------------------------------------------------------------------------------------------------------------|
| Chairman | - | Minister of Interior (MOI) |
| Vice-Chairman | - | Minister of Agriculture and
Cooperatives (MOAC) |
| Secretary (2) | - | Director-General of Department of
Local Administration (DOLA), MOI |
| | - | Director-General of Royal Irrigation
Dept. (RID), MOAC |
| Member (11) | - | Permanent Secretary of MOI |
| | - | Permanent Secretary of MOAC |
| | - | Secretary-General of the Office of
National Economic and Social
Development Board (NESDB), Office
of the Prime Minister |
| | - | Director-General of Bureau of the
Budget, Office of the Prime
Minister |
| | - | Director-General of Community Deve-
lopment Dept. (CDD), MOI |

- Secretary-General of the Office of Accelerated Rural Development (ARD), MOI
- Director-General of Dept. of Cooperatives Promotion (DOCP), MOAC
- Director-General of Dept. of Agricultural Extension (DOAE), MOAC
- Director-General of Dept. of Fisheries (DOF), MOAC
- Director-General of Livestock Development (DOLD), MOAC
- General Manager of Bank for Agriculture and Agricultural Cooperatives (BAAC)

(5) The necessary coordination among the government agencies on the basis of a multi-agency approach should not be suggested on a voluntary basis. Given that each agency has established a structural pattern of well-entrenched competition rather than of functional consultation and cooperation, one should not expect that confrontation could easily be overcome and reversed into collaboration. It is, therefore, expected that the above-conceived special committee for the Project at the national level outlines directions as to which agency should be responsible for what field, phase, stage, step or spatial unit of planning, implementation and O & M. In particular, these indispensable directions should stipulate purpose, objective, approach, technique, method, input, link, control and information, in order to facilitate or strengthen functional effectiveness. Consolidating and reviewing the budgets for the subject Project of various agencies could assist the Committee in guiding policy. Finally, decisions on strategy are necessarily dynamic in nature; therefore by learning from past experience, strategy may be improved over time.

5.2. Project Implementing Agencies

It would be assumed that the nine government agencies under the proposed Committee should be responsible for the following functions:

- Royal Irrigation Department (RID), MOAC:
 - ° Construction of dams, irrigation canal network up to outlets into the service units and drainage channel.
 - ° O & M of the above work in the Lam Plai Mat Sub-Project.
 - ° Assistance in organizing Water Users' Groups in each irrigation service unit and Water Users' Association in each sub-project, in cooperation with CDD, DOAE, and DOCP.
 - ° Technical assistance in planning, design, construction and O & M of the irrigation service units.
 - ° Technical assistance to the Water Users' Association in each of the Nong Lum Puk and Huai Phlu Sub-Projects in O & M of the RID-constructed major work inclusive of water delivery and use scheduling.
- Department of Agricultural Extension (DOAE), MOAC:
 - ° Agricultural extension services to farmers in agricultural production technique, etc.

- Department of Fishery (DOF), MOAC:
 - ° Assistance in fish breeding technique, i.e., breeding of fry, fertilizer application, harvesting, and O & M of the muban communal pond and the RID-constructed reservoirs.

- Department of Livestock Development (DOLD), MOAC:
 - ° Extension services for livestock development through water use from the muban communal pond.

- Department of Cooperatives Promotion (DOCP), MOAC:
 - ° Promotion of adequate types of cooperative organizations for economic activities in fisheries, livestock production, supply of credit, purchase of production inputs and marketing of agricultural produce as well as non-agricultural commodities and manufactured goods, making use of the opportunity of dealing with farmers of the "Water Users' Association".

- Department of Local Administration (DOIA), MOI:
 - ° Overall coordination of development for the Project as a secretariat under the Committee.

 - ° Coordination of the various agencies at the local level, with particular responsibility for full mobilization of the local administration and local self-administration system.

 - ° Special coordination of the water-based integrated muban development.

Note: While the changwat governors and amphoe officers are supposed to take orders from all the ministries of the central government, they also supervise their administrative

organizations and local administrative bodies which in turn directly answer only the Ministry of Interior. This may be the reason why other ministries always prefer to set up their own extension offices in the regions and changwat, thus adding to confusion of the various development activities.

- Community Development Department (CDD), MOI:

- ° Assistance to the farmers and other villagers organizing themselves for self-help, self-reliance and active participation in planning and construction of the various terminal facilities and subsequent O & M, as a liaison between the Project beneficiaries and the government agencies.

Note: The CDD's normal responsibility is to assist muban people in identifying and planning the rural development schemes, help supervise construction, organize muban people for operation and maintenance and generally act as a liaison between government agencies and the Project beneficiaries.

- Office of Accelerated Rural Development (ARD), MOI:

- ° Technical assistance to Tambon or Muban Development Committee with respect to planning, construction and O & M of village communal facilities.

- Bank for Agriculture and Agricultural Cooperative (BAAC):

- ° Provision of institutional credits in the form of production loans for agricultural purposes and of investment loans for on-farm development and agricultural assets.

5.3. Implementation of Major Work

5.3.1. Implementation Mode of Major Work

The major work consisting of dam and canal systems in the three sub-projects has been carried out under the control of RID.

Since the major work includes dam and canal systems of a large medium scale requiring a high construction cost, the major work will be implemented with a loan from an international financing agency with the following procedures.

The detail design and construction supervision of the major work will be carried out by a consultant employed by RID under the engineering service loan. The construction of the major work will be executed on a Contract or Force Account basis under the construction loan.

However, it is recommendable that the major work would be carried out on a Contract basis for the following reasons:

- Since the major work includes dam and canal systems on a large scale, construction on a Contract basis will be smooth and on time as compared with a Force Account basis.
- When construction work will be carried out on a Force Account basis, the procurement of construction equipment should be made prior to the commencement of the construction and will require a period of about one and half years, taking into consideration the preparation of tender documents, execution of tendering and contracting, manufacturing of equipment and transportation of equipment to the site.

In case construction is done on a Contract basis, construction could be commenced after tendering of the major work for the Contractor and save a period of about one year.

- Some heavy construction equipment to be used for the construction of the Lam Plai Mat dam would not depreciate during the construction period of three years, taking into consideration the operating hours of equipment for the works, and also, would not be used for operation and maintenance after completion of the works. The utilization method of construction equipment also brings about an advantage for construction on the Contract basis.

5.3.2. RID Organization

The RID Design Division will directly be in charge of the detail design and tendering of construction for the major work at its headquarter office.

The Project Office, however, will be established at the Project site during the construction stage of the major work. The Project Office will also function as technical assistant to the on-farm work carried out by the farmer's association. The Project Office will be organized as shown in Figure 5-1-1.

The organization will consist of three divisions - the administrative division, the supervisory body for the major work, and the technical assistant for on-farm development and will be managed by a project manager and three division chiefs under RID Regional Office VI.

The administrative division will consist of four sections of administration, accounting, land acquisition and coordination with other agencies concerned.

The supervisory division will be divided into three sections: the section for dam construction for the three dams and diversion weir, the section for upstream canal construction covering the area from Lam Plai Mat dam to the diversion weir in the Lam Plai Mat service area and two small service areas of Nong Lum Puk and Huai Phlu, and the section for downstream canal construction downstream of the diversion weir.

The technical assistant division will be divided into two sections for the upstream and downstream service area.

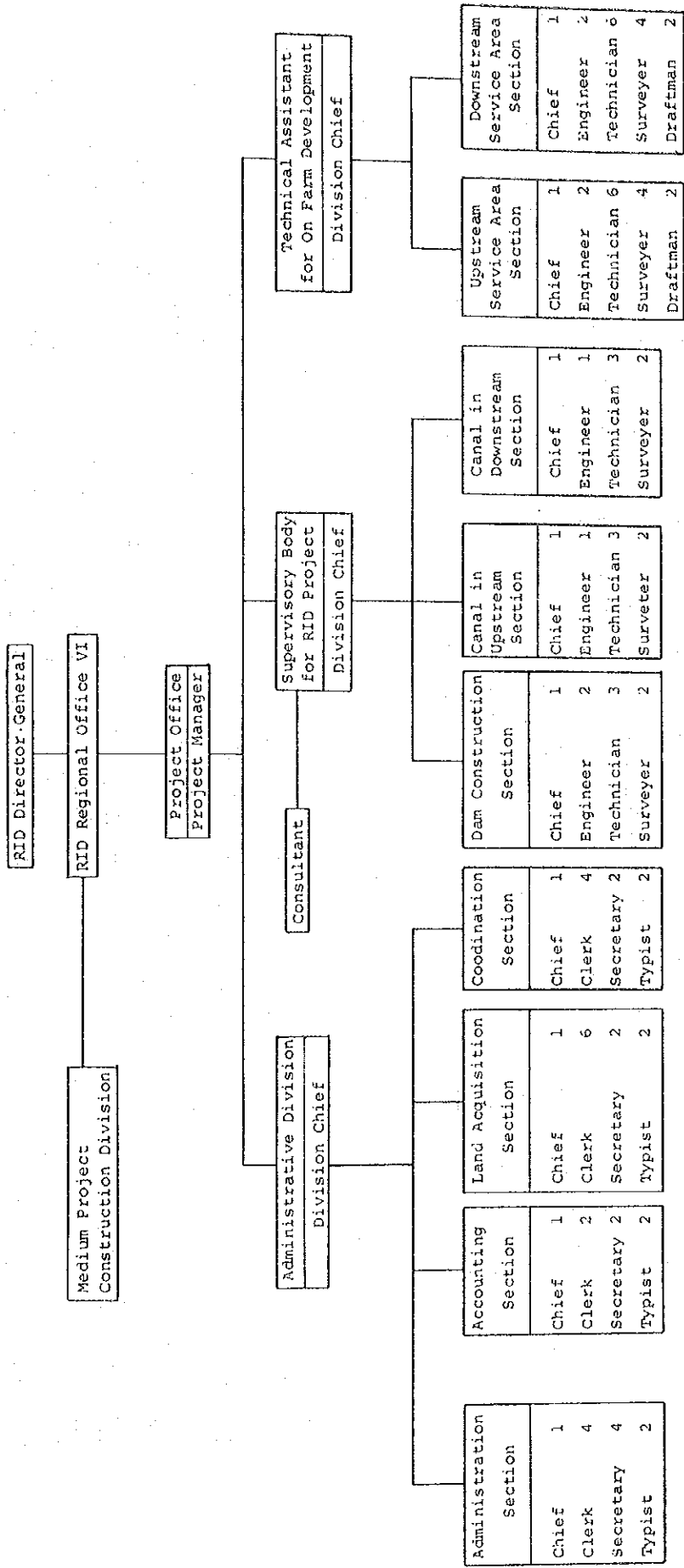
5.3.3. RID Project Office

The RID Project Office will be constructed at the Lam Plai Mat damsite and most of the staff mentioned in Figure 5-1-1 will stay in this Office to supervise the major work and assist in the on-farm work.

Building facilities for the project office including office, residence, dormitory, site laboratory, etc. along with a water and power system will be required for the staff of RID and the Consultant.

The construction cost of the building facilities is shown in Table G-2-4.

Figure. 5-1-1. Project Organization Chart of RID for Implementation



- Note 1. Dam construction section controls the three dams of Lam Plai Mat, Nong Lum Puk and Huai Phlu.
 2. Upstream section controls the diversion dam and canals in the upstream of Lam Plai Mat, Nong Lum Puk and Huai Phlu.
 3. Downstream section controls the canals in the downstream of Lam Plai Mat.

5.4. Implementation of On-Farm Work and Muban Communal Facilities

(1) It has been proposed previously that both on-farm work and muban communal facilities under the RID Medium Scale Irrigation Projects would have an increasing possibility of construction by farmers themselves, with greater emphasis upon the local farmers' participation in initiating the Project, in contributing labor for construction and in cost sharing, so that the local people feel the system and relevant facilities belong to them.

The rural sociological study indicates that it would be unrealistic to expect farmers to participate in water development activities as individuals or groups, unless they believe their participation will benefit them. Local participation could bring useful information and local interests into decision processes, and would enhance the legitimacy of both local institutions and central government, providing a ready outlet for the expression of any complaint. The above-mentioned procedures would certainly generate and strengthen the local cooperative and self-help activities for the development of project itself and the construction of subject terminal facilities.

(2) It is suggested that as soon as the central government intends to implement the Project, the proposed program should be introduced to the mubans concerned through the local administration system with various promotion campaigns organized under DOLA, MOI who is responsible for the proper coordination of all activities to be made by the line agencies concerned. It is imperative to have the various project beneficiaries' organizations set up at the very beginning of the Project implementation, viz., the water users' group for on-farm work within each irrigation service unit. In case of the muban communal facilities, the muban development committees concerned should play a crucial role in coordinating all relative activities within their own mubans to implement the Project successfully.

(3) It can be considered that distribution of the water supply within the proposed irrigation service units is not technically so difficult; however, it requires a precise survey of the irrigable land, a high standard of mapping and design and the knowledge of construction to eliminate any faulty design of some facilities in the on-farm work. It is proposed that full technical assistance for this would be rendered to each water users' group by RID. For the muban cooperative facilities such as the muban pond and water supply facilities, ARD would be responsible for this kind of technical assistance to the full extent.

(4) It is proposed that the executing agencies for construction of the on-farm work and muban communal facilities would be the water users' groups and the muban development committees, respectively. A relevant lesson inherent in development experience in Thailand indicates that since the evidence strongly supports that free development assistance generates little sense of gratitude or responsibility for maintenance or production follow-through, it is not considered necessary for development assistance to be a donation to be effective and helpful even in the poor Lower Northeast region.

(5) It is expected, with the above concept, the Project beneficiaries should contribute, free of charge, all the unskilled labor for construction and all the land for the Project, while such water structures made of concrete would be constructed on a local contractor basis or on force account basis under RID or ARD. Financial resources for construction of the structures which cannot be technically made by farmers themselves would be mainly of two kinds: (1) government subsidies which need not be recovered, and (2) loans which need to be recovered over time.

It is envisaged that provision for loans would be extremely useful because when the loan is repaid, the beneficiaries will own such structures and maintain them properly. Recovery may take many forms: paying water charge and land tax. Funds which are recovered can be used again, while funds which cannot be recovered are a direct transfer to the muban people concerned.

(6) It has been learned that there is a possibility of the BAAC's financing for the on-farm work construction, where the borrower is not the respective water users' group, but individual farmers participating in the on-farm operations. With the exception of the muban cooperative service unit where the number and name of the farmers to participate in the dry season field cropping would be changed year by year, BAAC would be qualified to channel its financial resources into the construction of the ordinary service units, if viable, within its framework of the special integrated area agricultural development projects. To achieve a greater impact, the joint venture project lending approach which is a complex one, is being employed, presupposing that the agencies responsible for project execution have the administrative and technical capacity to plan, design and implement the project whose maximum benefits accrue to the farmer participants.

The BAAC's loan conditions for the above are as follows:

- Borrower's contribution --- up to 20% of the total cost.
- Government subsidies ----- may be needed.
- BAAC's long term investment loan --- 14 percent interest rate p.a. with a 15 to 20 year repayment period including the grace period of five years. If the fund on loan to BAAC from international financing agencies or the Thai government is available, the above rate could be reduced.

(7) It is salient that BAAC would not be qualified to finance the loan for the construction of the muban communal facilities including the muban cooperative service units because it would be rather difficult to specify the beneficiaries within the mubans concerned. In this case, a proper measure will be necessary to be taken to limit the amount of government subsidy to supplement a suitable form of loan.

The poverty of the Project area would be alleviated to a considerable extent, but the alleviation is necessarily limited both (1) by financial constraints and (2) by the critical need to make the muban self-reliant in the future, capable of taking care of their own needs without further assistance. It is important to design the construction and financing plan so that it does not undermine long-term growth prospects, introducing gradually a sense of responsibility and ownership, which will ultimately uplift the poorest Lower Northeastern region.

5.5. Consulting Services

A consultant will be required for the detailed design and construction supervision of the major work only.

(1) Detailed Design

The detailed design works will be made under the engineering service loan by an international financing agency and would be commenced after completion of procedure for the engineering service loan and the tendering for the recruitment of consultant.

RID will prepare the plane map at a scale of 1:10,000 for the Lam Plai Mat service area covering about 15,000 ha prior to commencement of the detailed design works, because the present map in the Feasibility Study is not accurate.

The detailed design works by a consultant include the survey and investigation works for the structure, definitive plan for the Project, the detailed design of each project structure and preparation of tender documents.

The detailed design works will be completed in 14 months beginning in dry month of November 1984 and until December 1986.

The detailed design work schedule and manning schedule are shown in ANNEX H, Figures H-1-1 and H-1-2.

(2) Construction Supervision

The construction supervision will be made by the same consultant who carries out the detailed design works.

The tendering works including prequalification, site explanation and tender evaluation for the tenderers will be carried out in six months after the detailed design works. Then the supervision works for construction to be carried out by the contractor will be made during the construction period of three years.

A consultant would also be required for the maintenance period of six months after completion of construction to inspect the repairing of defective works by the contractor, and to guide the water storage in the reservoir and water management of the service area.

The manning schedule for the construction supervision is shown in ANNEX H, Figure H-1-3.

5.6. Operation and Maintenance

5.6.1. Major Work in the Lam Plai Mat Sub-Project

The operation and maintenance of the major work in the Lam Plai Mat Sub-Project will be carried out directly by RID due to the large medium scale of the dam and canal systems.

The operation and maintenance of the project facilities after completion of their works will be made by the new organization provided at the site under RID Regional Office VI. The new organization will control and manage the functional operation in the reservoir, diversion weir and canal systems with the following particular attention to water management.

- Since the Lam Plai Mat reservoir will bring about water shortage in a service area of 9,100 ha in the dry year with a fluctuation of 2 or 3 times in 10 years, the irrigation rotation system will be introduced for the service area in dry year. The allocation of the service area in the irrigation rotation will be determined by judging the remaining effective reservoir storage in the end of February. In general the irrigation rotation will be introduced in case the remaining effective reservoir storage reaches 30 percent of the effective capacity, otherwise the water shortage will take place during the irrigation season of the paddy.
- The run-of-the-river flow between the dam and diversion weir shall be taken by the weir and supplied to the downstream service area with the first priority in the wet season and the runoff in the Lam Plai Mat reservoir shall be stored as much as possible for the dry season.

- The water control at turnouts of the canal systems to the service area will be made accurately, otherwise the downstream service area could not obtain the designed water amount due to the long distance of the canal systems.

The proposed organization for operation and maintenance is shown in Figure 5-1-2.

The operation and maintenance office of RID will be placed at the Lam Plai Mat damsite and the office facilities provided during the construction period of the major work will be utilized. The operation and maintenance equipment will be newly provided, because the construction works will be done on a contract basis and no equipment except transportation vehicles will remain at the site.

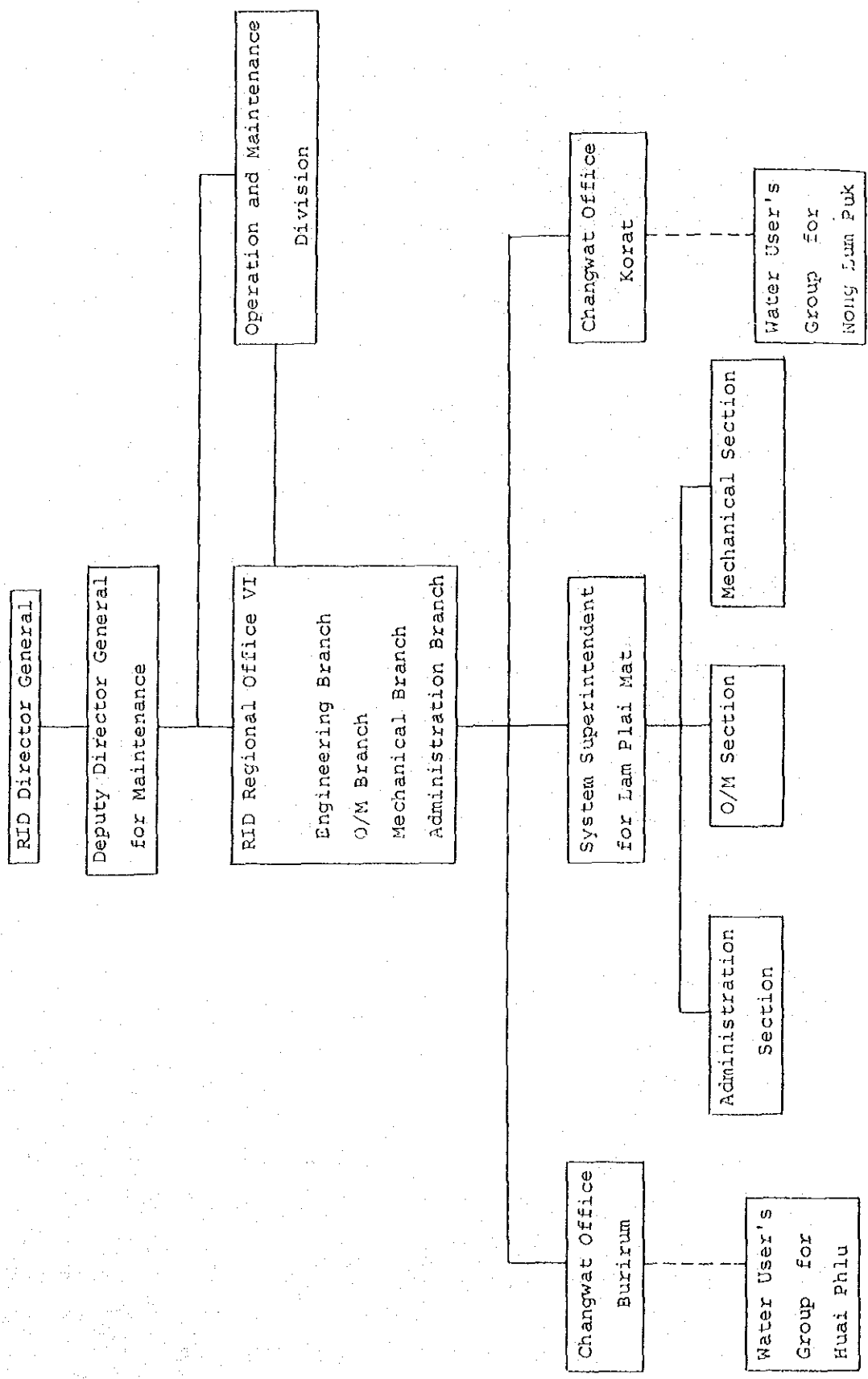
The operation and maintenance cost is estimated in ANNEX H, Table H-1-1, and summarized as follows:

Equipment Purchasing Cost	฿ 14,260,000
Annual Operation and Maintenance Cost...	฿ 8,623,000

5.6.2. Major Work in the Nong Lum Puk and Huai Phlu Sub-Project

As for the operation and maintenance of the major work to be provided by RID, it would be uneconomical for the government to supply a full-time operator to regulate water use and carry out proper maintenance of the facilities, but it will require considerable effort to organize and train personnel among the farmers at the sub-project level. The government should set up training programs by utilizing existing institutions such as universities, technical schools and RID training centers. With emphasis on training in the field, the RID existing projects and demonstration sites should be used for the on-the-job training purpose in accordance with acquisition of sound engineering practices.

Figure. 5-1-2 Proposed O/M Organization of RID



More practically, it is suggested that each of the water users' association will select, immediately after organization, three to four leading young men who are qualified by tambon in cooperation with RID and others and will be sent to the above existing institutions for training for at least two years. When RID completes the construction of the major work, all responsibility for the subsequent operation and work will be entrusted to the water users' association and the young men will be nominated as full-time operators to carry out the operation and maintenance as water master, zone men and gate tenders, within each of the water users' associations. It is expected that RID would be requested to continue technical assistance for O & M in the field for the subsequent two to three years, and then RID's responsibility will be shifted to only monitoring of all the activities to be made by the water users' associations.

All the maintenance work of the major work will be the responsibility of the water users' association with an exception of important repair works which could not be carried out by the association itself in technical and cost terms. Such repair works and the supply of materials will be inevitably done by the RID Region VI Office with the O & M equipment to be procured under the Project.

The Project farmers will also be expected to pay for irrigation water actually delivered at the end of each crop season. The water charges should at least cover the costs of operation and maintenance of the major work, i.e., salary of local operators, yearly cleaning and minor repairs.

5.6.3. On-Farm Work and Muban Communal Facilities

The operation and maintenance of the on-farm work would ultimately be the responsibility of the water users' groups covering each of the command area in the ordinary service units and muban

cooperative service units, where the leader and common irrigator should be elected. RID will provide the technical assistance to them for proper development of effective and self-sustaining activities including rotational water schedules and maintenance before each irrigation season, for at least two years. After that, RID would supervise the actual performance of each water users' group with frequent advice on the problems encountered.

As for the operation and maintenance of the muban communal facilities, operators will be appointed by the Village Development Committee with the technical assistance of ARD for pond and water supply facilities, DOF for pond fisheries and RID and DOAE for muban cooperative service units. It is considered necessary that members concerned do pay a membership fee for proper operation and maintenance of those communal facilities, with a policy that stipulations of payment for water should include specifications of the kind of water being used first, and of its purpose secondly. As is similar with the major works constructed by RID, major repair works will be executed by ARD.

5.7. Project Implementation Schedule

The project implementation schedule is prepared on the basis of the major work, which will be financed by an international agency.

The construction of the major works will be commenced about three years after completion of the Feasibility Study taking into consideration the loan procedures, the preparation for implementation, the detail design and tendering for construction.

The construction of major work will be completed in three years for the Lam Plai Mat Sub-Project and about one and a half years for Nong Lum Puk and Huai Phlu.

The on-farm work and muban communal facility work will be commenced in parallel with the major work to supply the water immediately after completion of the major work.

The implementation schedule for the Project is shown in Figure 5-1-3.

Figure 5-1-3 Implementation Schedule for The Project

Description	1983	1984	1985	1986	1987	1988	1989	1990	1991
A. Construction Schedule									
1. Feasibility Study									
2. Loan Procedures									
- Engineering Service Loan									
- Construction Loan									
3. Construction for Major Works									
- Preparation									
- Consultant Recruitment									
- Detailed Design									
- Project Administration									
- Right-of-Way									
- Tender for Construction									
- Construction									
- Lam Plai Mat Sub-Project									
- Nong Lum Puk Sub-Project									
- Hual Phlu Sub-Project									
- Maintenance by Contractor									
4. Construction by Farmer's Association									
- Detailed Design									
- On-farm Work									
- Lam Plai Mat Sub-Project									
- Nong Lum Puk Sub-Project									
- Hual Phlu Sub-Project									
- Muban Communal Facilities									
- Lam Plai Mat Sub-Project									
- Nong Lum Phuk Sub-Project									
- Hual Phlu Sub-Project									
B. Action Program by Executing Agencies Concerned									
1. Royal Irrigation Department (RID), MOAC									
- Detailed Design and Construction of Dams, Irrigation Canal and Drainage Canal									
- O & M of the Lam Plai Mat Sub-Project									
- Assistance in Organizing Water User's Groups									
- Technical Assistance in Construction and O & M of the Irrigation Service Units									
- Technical Assistance to the Water Users Association in O & M of the RID-constructed Major Works (Nong Lum Puk and Hual Phlu Sub-Project)									
2. Department of Agricultural Extension (DOAE), MOAC									
- Extension Services to Farmers in Agricultural Production Technique and etc.									
3. Department of Fisheries (DOF), MOAC									
- Supplying Fish Fry to the Muban Pond and RID-constructed Reservoir									
- Extension Services to the Villagers in Fish Production Technique and etc.									
4. Department of Livestock Development (DOLD), MOAC									
- Extension Services for Livestock Development through Water Use from the Muban Pond									
5. Department of Cooperatives Promotion (DOCP), MOAC									
- Promotion of Cooperation Activities in Fisheries, Livestock production, Supply of Credit, Purchase of Production Inputs and Marketing of Agricultural Products									
6. Department of Local Administration (DOLA), MOI									
- Overall Coordination of Development for the Project									
- Coordination of the Various Agencies at the Local Level									
- Special Coordination of Water-based Integrated Muban Development									
7. Community Development Department (CDD), MOI									
- Assistance to the Villagers Organizing Themselves for Self-help, Self-reliance and Active Participation in Planning and Construction of the Various Terminal Facilities and Subsequent O & M.									
8. Office of Accelerated Rural Development (ARD), MOI									
- Technical Assistance to Tambon or Muban Development Committee with respect to Planning, Construction and O & M of Village Communal Facilities									
9. Bank for Agriculture and Agricultural Cooperative									
- Provision of Institutional Credits in the Form (BAAC) of Production Loans for Agricultural Purposes and of Investment Loans for On-farm Development and Agricultural Assets.									

CHAPTER VI PROJECT EVALUATION

CHAPTER VI. PROJECT EVALUATION

6.1. Introduction

The Medium Scale Irrigation Package Project in Lower Northeast Thailand is envisaged to serve the low income village people through provision of definitely needed social services that primarily focus on the development of water resources. Emphasis is placed on the development of irrigation systems and muban pond for multiple uses among the largest number of beneficiaries possible. This is one of the important rural development programs incorporated in the "Poverty Alleviation and Development Plan of Remote and Border Rural Areas". From the national socio-economic viewpoint, the Project therefore aims to contribute to improving the unequal distribution of social benefits rather than to attaining national efficiency in capital investment.

In addition to the financial and economic analysis commonly undertaken in the Project evaluation, this study, noting the importance of the socio-economic impact of the Project on villages in the Lower Northeast, attempts to analyze the poverty alleviation effect. The analysis of poverty alleviation effect centers on income growth and distribution with the project among the beneficiary farmers and does not propose to evaluate the project through "social prices". This is primarily because the evaluation method through social prices is still unestablished and therefore poses some difficulty in actual application. Analysis of income distribution is regarded as conducive to the establishment of social prices. The project costs and benefit are estimated in 1983 constant prices.

6.2. Financial Analysis

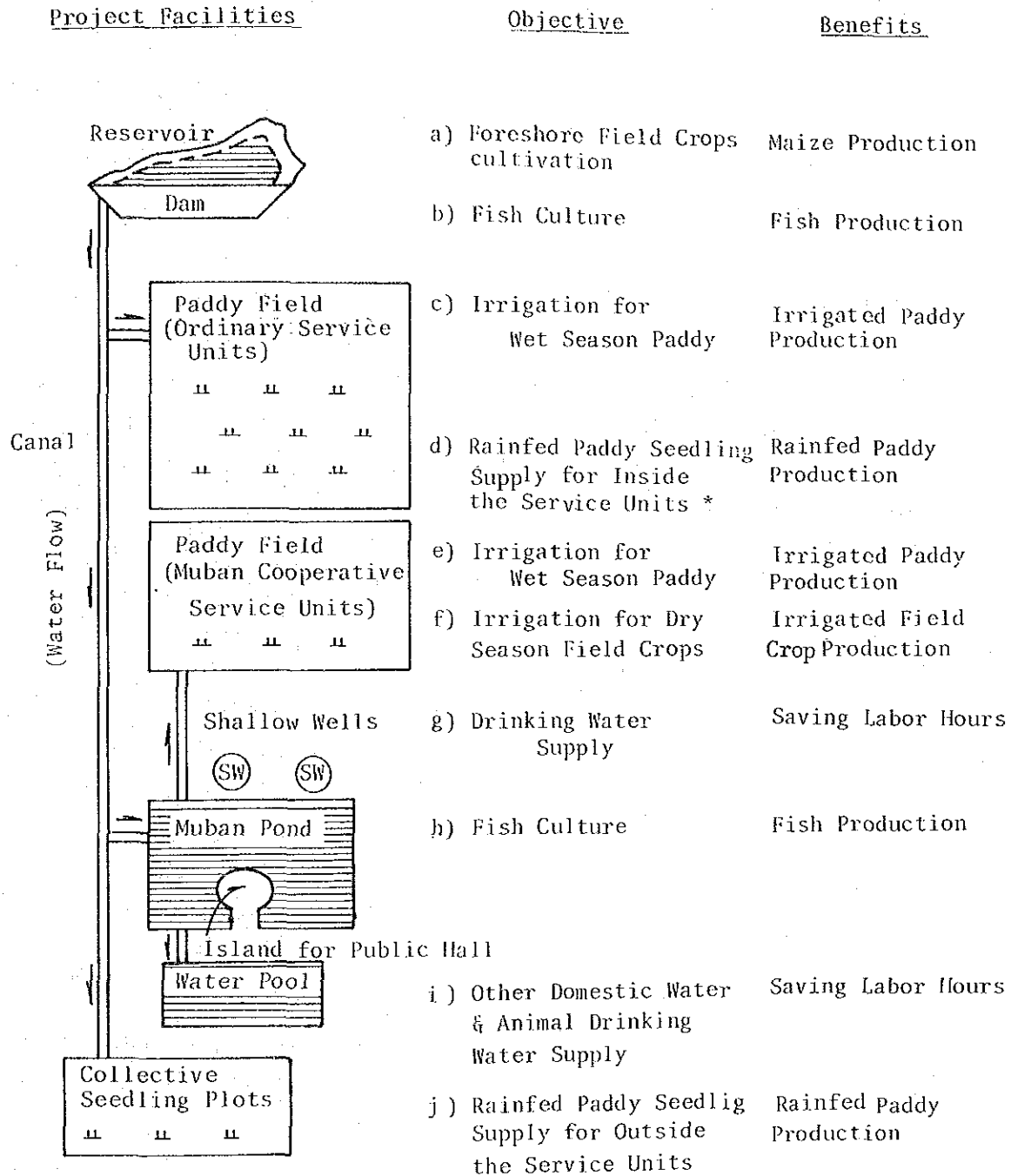
6.2.1. Financial Benefits

The project cost includes those of construction works, operation and maintenance for the irrigation and muban pond. From the viewpoint of national socio-economy, various kinds of benefits would be generated from the Project (see Figure 6-2-1). From the financial point of view, however, all these benefits are not necessarily quantified in monetary terms, i.e., benefits from rural water supply and fish culture in the Muban Pond do not always entail the flow of money into the market since these benefits can be considered to be replacing those benefits of a similar nature at present and without the Project.

Financial benefits are derived from the paddy and field crop production of the ordinary and muban cooperative service units, fish production in the reservoir and maize production in the foreshore, but the latter two benefits are not considered for the present analysis. Crop benefits of the ordinary and muban cooperative service units are as follows;

Sub-Project (Net Area)		<u>Financial Benefit</u>			
		GPV	Production Cost	NPV	Benefit (฿/ha)
1. Lam Plai Mat (9,100 ha)	WO	26,133	19,916	6,217	
	W	112,961	57,797	55,164	48,947 (5,379)
2. Nong Lum Puk (300 ha)	WO	1,097	818	279	
	W	3,945	2,038	1,907	1,628 (5,427)
3. Huai Phlu (700 ha)	WO	1,785	1,208	577	
	W	7,343	3,823	3,520	2,943 (4,204)
4. Overall (10,100 ha)	WO	29,015	21,942	7,073	
	W	124,249	63,658	60,591	53,518 (5,299)

Figure 6-2-1 Function of the Medium Scale Irrigation Project



Note : * ... Based upon the water operation study for the last 30 years, it is impossible to irrigate a certain percent of paddy field inside the ordinary and muban cooperative service units in some years.

6.2.2. Poverty Alleviation Effect: Income Growth and Distribution

(1) Estimation Method of Income Growth and Distribution

Among the various benefits that accrue to the beneficiary farmers after implementation of the Project, income effect on the farm economy has been analyzed. Those that have a direct influence on farm income are the following, i.e. increase in yield and 100 percent harvesting rate of wet season paddy in the service area, stabilized wet season paddy production outside the service area with irrigated seedling plots through increase in planted area, harvesting area as well as yield, and field crop production in the dry season paddy field. In addition to the above, the Project implementation will also help increase the farm income by enhancing freshwater fish production in the muban pond and the reservoir. But these fish benefits, as part of the farm income, are excluded for the following reason. Fish production in the muban pond helps in particular to replace those fish to be caught at a high cost (with long labor hours) without the Project rather than to increase its per capita consumption. It is quite difficult to estimate the income to be generated among a large number of unspecified villagers outside the Project Area, although the fish from the reservoir will be sold in the market.

Special effort has been made to clarify the income level and its distribution of the farm households in the Project Area based upon the farm household sample survey conducted during the months of September and October 1983. This income distribution has been grouped into four classes, viz. (1) Poor, (2) Marginal, (3) Better-off, and (4) Wealthy, in accordance with the criteria employed in NESDB.

Income Distribution in the Northeast

<u>Item</u>	<u>Poor</u>	<u>Marginal</u>	<u>Better-off</u>	<u>Wealthy</u>	<u>Average</u>
<u>Annual Income Range (฿ per Capita)</u>					
- 1975/76 Price Level	1,981	1,981-2,640	2,640-3,960	3,960	
- 1982/83 Price level	3,500	2,500-4,670	4,670-7,000	7,000	
1) No. of Households(%), 1975/76 ^{2/}	43.3	27.1	22.3	7.3	100.0
2) Ave. Household Income (฿),					
- 1975/76	9,876	14,304	21,216	43,932	16,152
- 1982/83	17,450	25,270	37,480	77,620	28,537
3) Ave. Family Size, 1975/76	6.76	6.01	5.38	4.69	6.11
4) Ave. per Capita Income (฿),					
- 1975/76	1,470	2,380	3,940	9,370	2,640
- 1982/83	2,580	4,200	6,970	16,550	4,630

Note: 1/ The poverty line based upon the expenditures for the recommended minimum requirements of food and non-food items.

2/ There would not be a change at present, NESDB.

Source: NESDB, Thailand.

(2) Income Growth and Distribution

In order to comply with the definition of annual income that has been used for the classification of four groups as given by NESDB, some factors have been revised with available figures, taking into account their own consumption of foods they produce, costs paid and others. Then, the income distribution from the sample farms in the Project Area has been grouped in line with NESDB definition as in Table 6-2-1.

Table 6-2-1 Change of Income Distribution of Sample Farms

Items	Income class ฿ / capita	Better-			Overall
		Poor <3,500 ฿	Marginal 3,500- 4,670	off 4,670- 7,000	
1. Lam Plai Mat Sub-Project (89 samples)					
1-1 Present					
		%			
a) No. of Households	56(62.9)	13(14.6)	13(14.6)	7(7.9)	89(100)
b) Average Family Size	6.2	6.4	6.1	4.0	6.0
c) Average Annual Income (฿ / capita)	2,140	4,050	5,870	13,200	3,580
1-2 With Project					
		%			
a) No. of Households	18(20.2)	26(29.2)	24(27.0)	21(23.6)	89(100)
b) Average Family Size	6.5	6.3	6.0	5.2	6.0
c) Average Annual Income (฿ / capita)	2,360	4,080	5,790	10,360	5,470
2. Nong Lum Puk Sub-Project (62 samples)					
2-1 Present					
		%			
a) No. of Households	19(30.6)	9(14.5)	10(16.1)	24(38.8)	62(100)
b) Average Family Size	6.4	6.3	5.8	5.8	6.1
c) Average Annual Income (฿ / capita)	2,250	4,290	5,400	16,520	8,320
2-2 With Project					
		%			
a) No. of Households	17(27.4)	6(9.6)	12(19.4)	27(43.5)	62(100)
b) Average Family Size	6.6	5.8	6.1	5.7	6.1
c) Average Annual Income (฿ / capita)	2,670	4,520	5,360	16,880	9,170
3. Huai Phlu Sub-Project (50 samples)					
3-1 Present					
		%			
a) No. of Households	28(56.0)	5(10.0)	10(20.0)	7(14.0)	50(100)
b) Average Family Size	6.2	6.4	6.8	6.1	6.3
c) Average Annual Income (฿ / capita)	2,060	4,170	5,740	12,210	4,450
3-2 With Project					
		%			
a) No. of Households	20(40.0)	6(12.0)	12(24.0)	12(24.0)	50(100)
b) Average Family Size	6.5	5.8	6.5	6.3	6.3
c) Average Annual Income (฿ / capita)	2,290	4,010	5,540	11,060	5,410

The following are observed between the income level of the rural Northeast and the sample farms of with and without the Project.

- i) At present; the average annual income per capita of the sample farms in the Lam Plai Mat, Nong Lum Puk and Huai Phlu Sub-Project is 77 (฿ 3,580), 180 (฿ 8,320) and 96 percent (฿ 4,450) of the rural Northeast average. Income level in the Nong Lum Puk Sub-Project at present would be extremely high comparing with the average income of the rural Northeast. This is from cassava production due to favorable transportation to Korat and also due to the off-farm income. As a whole, inequality of sample farm's income distribution in the Project Area showed up more prominently above all in the Lam Plai Mat and Huai Phlu Sub-Project.

- ii) With the Project; income level of the sample farm of the Lam Plai Mat and Huai Phlu Sub-Project would be over 118 (฿ 5,470) and 117 percent (฿ 5,410) of the rural Northeast average. The income distribution effect on the beneficiary by the Project implementation is confirmed in every Sub-Project particularly in the Lam Plai Mat Sub-Project area due to the income distribution effect to the beneficiary by 1.5 times of the average of the present income level. With the Project, income distribution of the farm households will be improved in the Lam Plai Mat Sub-Project area whereas it will remain the same in the other two Sub-projects. This is because the Project is intended to benefit primarily the paddy farmers and the farmers in the said two Sub-project areas engage mostly in upland crop production.

(3) Poverty Index

Discussion of the income would be made from two aspects, viz., its average level of farm households concerned and its distribution. There seems to be no appropriate analytical method that deals with both collectively.

$$\text{Poverty Index} = \frac{\text{Ave. Household Income in Rural Northeast}}{\text{Ave. Household Income in Sub-Project Area}} \times \text{Distribution of Households in Poverty Group in Sub-Project}$$

Poverty Index of the Sample Farms in the Project Area

	<u>Lam Plai Mat</u>	<u>Nong Lum Puk</u>	<u>Huai Phlu</u>	<u>Rural Northeast</u>
(1) At Present				
Ave. Annual Per Capita Income (฿)	3,580	8,320	4,450	4,630
Ave. Household Size	6.0	6.1	6.3	6.1
Ave. Annual Household Income (฿)	21,490	50,760	28,060	28,260
Distribution of Households in Poverty Group (%)	63	31	56	44
<u>Poverty Index</u>	<u>0.83</u>	<u>0.17</u>	<u>0.56</u>	<u>0.44</u>
(2) With Project				
Ave. Annual Per Capita Income (฿)	5,470	9,170	5,410	
Ave. Household Size	6.0	6.1	6.3	
Ave. Annual Household Income (฿)	32,830	55,940	34,110	
Distribution of Households in Poverty Group (%)	20	27	40	
<u>Poverty Index</u>	<u>0.17</u>	<u>0.14</u>	<u>0.33</u>	

Subsequently, the Project evaluation of the three Sub-Projects from the regional and private economic aspects is carried out by the newly introduced Poverty Alleviation Rate:

$$\text{Poverty Alleviation Rate} = \frac{\text{Poverty Index with the Project}}{\text{Poverty Index without the Project}}$$

The following findings are obtained:

- Poverty Index: the higher the income level, the lower the poverty index.
- Poverty Alleviation Rate: the higher the rate, the more significant the poverty alleviation effect.
- The poverty alleviation effect would be remarkable in the Lam Plai Mat Sub-Project. In the Nong Lum Puk Sub-Project, the Poverty Index with the Project is almost identical to that of the without-case; therefore, little effect is observed in the Poverty Alleviation Rate.
- It can be considered that the Project which has the higher Poverty Index without the Project conditions is qualified as the likely potential Project with the higher priority for earlier implementation.
- Attention should be paid to the fact that the Poverty Alleviation Rate does not contain any factor of the Project cost.

6.2.3. Farm Budget Analysis

The farm budget analysis has been made for the "rice main" owner farm (2.3 ha) and the "rice + upland crop" owner farm (3.3 ha), because the financial benefit from the Project is mainly expected for the paddy farm. The farm size by type as mentioned above is based on the farm economic survey in the Project Area.

As present, the farm income of these farms is $\text{P} 10,850$ for the "rice main" farm and $\text{P} 14,430$ for the "rice + upland crops" farm. The survey has revealed that the family living cost in the sample farms at present is lower than the poverty line of $\text{P} 3,500$ per capita.

Table 6-2-2 Farm Budgets for the Average Farm Size*

	Paddy Farm		Paddy - Upland Crop Farm	
	Without Project	With Project	Without Project	With Project
(1) Number of Sample Farms	16 (41%)		23 (59%)	
(2) Number of Family Members (Person/Farm)	6		6	
(3) Operated Land (ha)				
a. Paddy Field	2.30	2.19	2.10	2.00
b. Upland Field	-	-	1.20	1.20
<u>Total</u>	<u>2.30</u>	<u>2.19</u>	<u>3.30</u>	<u>3.20</u>
(4) Planted Area (ha)				
a. Paddy, Wet Season	1.73	2.19	1.58	2.00
b. Cassava	-	-	0.70	0.70
c. Maize	-	-	0.50	0.50
d. Field Crops, Dry Season Cropping in the Muban Cooperative Service Unit	-	0.31	-	0.31
<u>Total</u>	<u>-</u>	<u>2.52</u>	<u>-</u>	<u>3.51</u>
(5) Gross Income from Crop Production (฿)	5,140	26,270	12,200	32,210
(6) Crop Production Cost (฿)	3,920	12,550	7,390	15,480
(7) Net Income from Crops (฿)				
a. Paddy Wet Season	1,220 (11.3%)	7,820 (33.5%)	1,120 (7.8%)	7,150 (27.1%)
b. Upland Crops	-	-	3,690 (25.6%)	3,690 (14.0%)
c. Field Crops, Dry Season Cropping in the Muban Cooperative Service Unit	-	5,890 (25.2%)	-	5,890 (22.3%)
<u>Total</u>	<u>1,220 (11.3%)</u>	<u>13,720 (58.7%)</u>	<u>4,810 (33.3%)</u>	<u>16,730 (63.4%)</u>
(8) Income from Livestock (฿)	2,890 (26.6)	2,890 (12.4)	2,890 (20.0)	2,890 (11.0)
(9) Total of Agricultural Income (฿)	4,110 (37.9)	16,610 (71.1)	7,700 (53.3)	19,620 (74.4)
(10) Off-farm Income (฿)	6,740 (62.1)	6,740 (28.9)	6,740 (46.7)	6,740 (25.6)
(11) Farm Income (฿)				
a. Total	10,850 (100.0)	23,350 (100.0)	14,440 (100.0)	26,360 (100.0)
[Income per Capita]	[1,810]	[3,890]	[2,410]	[4,390]
b. Excluding Off-farm Income	4,110	16,610	7,700	19,620
[Income per Capita]	[690]	[2,770]	[1,280]	[3,270]
c. Excluding Field Crops Income	10,850	17,460	14,440	20,410
[Income per Capita]	[1,810]	[2,910]	[2,410]	[3,410]

Note: * ... Result of the Farm survey in the Lam Plai Mat, Nong Lam Puk and Huai Phu Sub-Projects, the farms in the upper stream in the Lam Plai Mat Sub-Project were considered average.

However, the implementation of the Project will make it possible for these farmers to raise their living standard above the poverty line with the increase in paddy planting rate and its yield inside and outside the service units and the increase in dry season field crops cultivation in the muban cooperative service units along with the small off-farm income.

In general, the Project will give more benefits to the large size farmers with the cultivation of dry season field crops in the muban cooperative service unit, while the small size farmers without the cultivation of dry season field crops will not always receive the Project benefits, and therefore, work in off-farm employment. Under this circumstance, it should be considered essential to give them the cultivating opportunity if the small size farms have enough labor to manage the 2 rai of dry season field crops in the muban cooperative service unit. And, intensive guidance and extension services should be given to those farmers on the farming techniques throughout the Project.

6.2.4. Farm Income and Cost Recovery

Though the Project aims at social development, the benefits will improve the level of village life and expand the family budgets as well, it is necessary to charge a part of the Project costs to the beneficiaries.

The costs to be born by the beneficiaries are the construction costs of the on-farm works and the operation and maintenance costs of the irrigation system at the on-farm level. This is estimated, as shown below, at $\text{฿ } 711$ (loan repayment of $\text{฿ } 448$ and O & M cost of $\text{฿ } 263$) per hectare per year which accounts for only 14 percent of the incremental net crop production value of $\text{฿ } 5,299$ at the ordinary and muban cooperative service units.

<u>Sub-Project</u>	<u>Construction Cost of On-Farm Works</u>		<u>Annual</u>		<u>Annual</u>
	<u>Total</u> ^{1/} (,000 ฿)	<u>Annual Loan Repayment</u> ^{2/} (฿/ha)	<u>O & M Cost</u> ^{3/} (,000 ฿)	<u>Cost</u> ^{3/} (฿/ha)	<u>Total Cost</u> (฿/ha)
1. Lam Plai Mat	2,970	448	2,349	258	706
2. Nong Lum Puk	-do-	-do-	131	437	885
3. Huai Phlu	-do-	-do-	178	254	702
4. Overall	-do-	-do-	2,656	263	711

Note; 1/... ฿ 2,970/ha (ordinary service unit = ฿1,350/ha, muban cooperative service unit = ฿ 1,620/ha)

2/... 14 percent of interest and 20 years of repayment period

3/... Salaries and wages for zoneman, gate tender, and casual employees

6.3. Economic Analysis

6.3.1. Economic Benefits

From the National socio-economic point of view, in addition to the financial benefits, various kinds of directly and indirectly associated benefits would be created from the Project; moreover, in following up the benefit stream, various categories of the benefits would be possibly realized from the proper operation and positive utilization of the muban cooperative pond by all the villagers. These benefits could be considered additional value to be generated through implementation of the Project major works.

Benefits from the Project would be divided into three categories by their characteristics; namely, crop production, water use and fish production. These three kinds of benefits in monetary terms would be increased through the Project implementation.

(1) Crop Production Benefits

Crop production benefits will be five items, and share around 80 to 90 percent of the total economic benefit as follows:

- (a) Irrigation for wet season paddy in the ordinary service units and muban cooperative service units

This benefit is the increase in yield and the 100 percent harvesting rate of wet season paddy in the irrigated paddy field, and shares around 70 percent of the total crop production benefit in any Sub-Project.

- (b) Irrigation for dry season field crops in the muban cooperative service units

The benefit will be the increase in field crop production in the dry season paddy field.

- (c) Irrigation for the muban cooperative seedling plots for the wet season rainfed paddy outside the service unit

This benefit will be generated by supplying the non-irrigated paddy field of the beneficiary farmers with good seedlings which will be grown for use in the rainfed paddy field.

In the Project Area where the rainfed agriculture is predominant, the paddy planting always awaits the rainfall, which implies that the farmers often fail to obtain the good seedling when transplanting takes place.

The rainfed paddy production would be greatly stabilized if good seedling is ready to be transplanted whenever necessary. The benefit of good seedling has been assumed to be a 10 percent increase in planted area as well as a five percent increase of the present yield of paddy.

- (d) Irrigation for the muban cooperative seedling plots for wet season rainfed paddy inside the service units

This benefit is the same sort of the above (c) benefit in the rainfed paddy cultivation within the irrigation service units when the Project reservoir water is not available in dry years.

- (e) Foreshore field crops in the RID-constructed reservoirs at a low water level

This benefit will be the increase in maize production by the beneficiary farmers in the reservoir area above the low water level. In accordance with the reservoir operating rule based upon the limited water storage level, there would be a possibility to introduce maize cultivation in May to August for many years. This would be applied to such small-medium scale reservoirs as those in

the Nong Lum Puk and Huai Phlu Sub-Projects where the water users' association is in charge of the operation and maintenance of the dam and reservoir, and the Project farmers concerned live in its vicinity.

Maize cultivation of 42 ha and 80 ha on the average as estimated by a 30-year water operations period in the Sub-Projects of Nong Lum Puk and Huai Phlu, respectively, has been proposed for inclusion in view of the less harmful effect on the reservoir sediment and others.

(2) Water Use Benefits

- (a) Water supply for drinking and domestic use for muban people through the muban pond and successive communal facilities.

The primary benefit to be realized from the construction of muban pond will be the provision of domestic water in the dry season to the whole households. The benefit of water supply at the muban pond would be estimated on the basis of the saving of labor hours spent on fetching water for the villagers between without Project and with Project. Period of domestic water use benefit is considered for a total of 167 days, from December to the middle of May.

Items	Labor Requirement per Day (hrs/family)			Annual Labor Requirement (hrs/family)	Annual Benefit (฿/family)
	1. Drinking Water	2. Other Water	Total		
1. Without Project	0.507	0.642	1.149	191.9	159 ^{1/}
2. With Project	0.233	0.536	0.769	128.4	

Note: ^{1/} (191.9 hr - 128.4 hr) x ฿ 20 @ 8 hours = ฿ 159
Source: Farm Economic Survey.

Benefit by Sub-Project

<u>Sub-Project</u>	<u>Beneficiary Families in Future (households)</u>	<u>Benefit (000฿)</u>
1. Lam Plai Mat	9,246	1,470
2. Nong Lum Puk	934	149
3. Huai Phlu	1,000	150

- (b) Water supply for drinking for the muban buffaloes and cattle through the muban ponds and successive communal facilities

In addition to the benefit from domestic water supply to the village households, the Project is also expected to save labor hours spent on getting drinking water for livestock. Period of livestock water use benefit is considered 167 days, the same as the period of human domestic water use. Quality of livestock water is considered equal to other domestic water for human beings. Annual Benefit per animal is estimated at ฿ 9 for buffalo and ฿ 10.2 for cattle.

<u>Sub-Project</u>	<u>Number of Animals in Future</u>		<u>Benefit (000฿)</u>		
	<u>Buffalo</u>	<u>Cattle</u>	<u>Buffalo</u>	<u>Cattle</u>	<u>Total</u>
1. Lam Plai Mat	13,500	2,161	122	21	143
2. Nong Lum Puk	400	132	4	1	5
3. Huai Phlu	900	23	8	0	8

- (3) Fish Production Benefits

- (a) Fishery in the muban ponds

The muban pond is expected to annually produce 2,500 kg of freshwater fish per hectare. In the Project Area, freshwater fish are often caught during the river flooding and are consumed either raw, dried or salted and, at present, its annual consumption per capita is about 10 kg.

The construction of the muban pond in the Project will make it possible for the villagers to produce freshwater fish throughout the year. The muban pond will be located in the midst of each village since it primarily serves to supply water for vegetable production in the dry season as well as for domestic use. However, the construction of a large scale muban pond is quite difficult due to the problem of land acquisition in the village and it is not possible to produce all the freshwater fish necessary for the villager's consumption.

Though fish consumption in the village is expected to increase slightly, the muban pond can be regarded as a source of fish production replacing the river where fish are caught at present. The benefit from the freshwater fish, therefore, is the difference in the cost of fish production in the muban pond and farm-gate price of freshwater fish based upon the market price as presented below:

Sub-Projects	Area of Muban Pond (ha)	Production ^{1/} (tons)	Gross Production Value ^{2/} (000฿)	Production Cost ^{3/} (000฿)	NPV Benefit (000฿)
1. Lam Plai Mat	45.7	114	2,850	656	2,194
2. Nong Lam Puk	4.8	12	300	69	231
3. Huai Phlu	6.4	16	400	92	308

- Note: ^{1/} Production yield is considered 2,500 kg/ha.
^{2/} Economic farm-gate price of freshwater fish is assumed at 25 ฿/kg.
^{3/} Economic cost of fish production in the muban pond is estimated at 5.75 ฿/kg.

(b) Fishery in the RID-Constructed Reservoirs

Freshwater fish produced in the three Sub-Project reservoirs will be sold in the market. Fish yield at full development has been decided based on the discussion with the staff of the Department of Fishery as well as the existing fish culture in the dam reservoir.

Sub-Project	Area of Reservoir (ha)	Fish Yield (kg/ha)	Production (tons)	GPV (000฿)	Production Cost (000฿)	NPV Benefit (000฿)
1. Lam Plai Mat	1,040 ^{1/}	100	104	2,600	513	2,087
2. Nong Lum Puk	120	200	24	600	118	482
3. Huai Phlu	144	200	29	725	143	582

Note: 1/ Area of full water level.

(4) Quantifiable Benefits

Quantifiable benefits by the Sub-Project can be summarized as follows.

(Unit: 000฿)

Sub-Project	Crop Benefit	Water Use Benefit	Fishery Benefit	Sub-Total	Minus Benefit	Total
1. Lam Plai Mat (%)	94,696 (94)	1,613 (2)	4,281 (4)	100,590 (100)	3,287	97,303
2. Nong Lum Puk (%)	3,256 (79)	154 (4)	713 (17)	4,123 (100)	348	3,775
3. Huai Phlu (%)	6,405 (86)	167 (2)	890 (12)	7,462 (100)	506	6,956
4. Overall (%)	104,357 (93)	1,934 (2)	5,884 (5)	112,175 (100)	4,141	108,034

In addition to three kinds of benefit, the minus benefit of cassava production in the reservoir was estimated. It has been identified that there are presently cassava productions of 936 ha, 99 ha, and 144 ha in the proposed reservoir area for the Sub-Project of Lam Plai Mat, Nong Lum Puk and Huai Phlu, respectively. In the Lam Plai Mat case, cultivation of this cassava is permitted until the 1983/84 year in connection with the Development for Defense of the Boundary between the Khon Buri-Soeng Sang Project since October 1982. In general, cassava cultivation in the proposed reservoirs is practiced on encroached public land; therefore, no compensation should officially be required.

6.3.2. Other Economic Benefits

Besides the direct benefits in monetary terms mentioned above, the Project will realize both the indirect and associated benefits and exert various influences on the backward muban societies. From the socio-economic standpoint, the following benefits will be considered:

(1) Benefit at the Project Area Level

- The Project realization will improve the farmers' living standard through an increase in the farm income. The increase in the farm income from the increase of agricultural income means the increase in consumption and saving. The magnifying of the farm family economy will improve the villagers living standard in terms of quantity and quality.
- With the Project, for making good use of irrigation water inside the ordinary service units, it will be necessary to establish the water user's associations and the agricultural cooperatives by all the beneficiary farmers. These cooperative systems will certainly improve communication among farmers influencing the technical up-grading of crop cultivation and farm management of the farmers around the Project Area as well as in the Project Area.
- Through cropping, fishing, and rural water use in the muban cooperative service unit, the Project will enable the beneficiaries to keep close communication with each other as well, resulting in giving fair knowledge of irrigation, crop cultivation, fish culture, health and savings as well as the promotion of village cooperative activities as a whole.

- With the Project, the muban pond will be more conveniently utilized for drinking, bathing, and washing especially in the dry season. This will improve the public health in the Project mubans.
- With the Project, even in the dry season, the villagers with the muban pond can get very fresh and cheap fish as protein sources. Some of the muban ponds to be constructed are located in the "Rural Poverty Area", and the nutrition improvement of the rural people should be significant.
- The Project aims to realize the maximum return to the Project to be shared by the largest possible number of the village residents. As a result, the benefits accrue not only to the farmers inside the irrigable area but the farmers outside the irrigable area and the all villagers related in the Project Area.
 - ° Irrigation for the muban cooperative seedling plots for wet season rainfed paddy outside the service unit.
 - ° Water supply for drinking and domestic use for the muban people and animals through the muban pond and successive communal facilities.
 - ° Fishery in the muban pond.

Namely, the Project implementation is significant in the sense of its large impact on the stabilization of national economy.

- Many farmers will have the opportunity of employment in the construction and operation and maintenance of the proposed Project. It has been assumed that there are totally 521,000 unskilled labors (444,000 in Lam Plai Mat, 23,000 in Nong Lum Puk and 54,000 in Huai Phlu Sub-Project) available during the construction period.

(2) Benefit at the National Level

- At present, the total production of paddy in the Project Area is 10,900 tons, which meets 63 percent of demand including consumption, seeds and loss in the Project Area. When the Project is carried out, about 27,800 tons of additional paddy production will be realized in the Project Area which will help to improve self-sufficiency and to increase the export (11,000 tons). The gross value expressed in the 1983 international price of incremental production of paddy excluding domestic consumption in the Project Area is estimated at about ฿ 116 million in the present value. After adjusting for foreign exchange costs of traded recurrent inputs, mainly fertilizer of ฿ 12 million, the Projects direct foreign exchange effect would total approximately about ฿ 104 million (US\$ 4.5 million).
- The Project will improve the rural people's living standard through the proposed intensive water use for agriculture, fishery and domestic needs. Namely, the Project is of the effective socio-economic development type, not only for promoting rural public welfare but also alleviating the disparity in living standard between the regions.

6.3.3. Project Cost

The Project cost estimated in the economic analysis includes capital cost, and operation and maintenance cost. The capital cost covers that of major works (such as preparatory work, the dam and canal system) and on-farm work, muban communal facilities, O & M equipment, right-of-way, survey & investigation, administration and consulting services, but excludes price contingencies during the construction period. The operation and maintenance cost after the Project construction covers the annual cost of salary and wages of dam and canal system operators, fuel and repair of equipment, material supplies, and other general expenditures.

The capital cost consists of foreign and local cost components, and the latter component is re-evaluated into the economic cost to warrant comparison with the economic benefit of the Project. For the estimation of the Project cost, tax on equipment for the major works to be purchased directly from foreign countries is deducted both from the foreign and local cost components and their domestic prices are determined by using the conversion factor. The domestic cost of construction materials to be purchased in Thailand and the cost of common labor are also evaluated with the conversion factors. Similar evaluation has also been made with respect to the O & M cost. The conversion factors employed are those determined by the World Bank.

The capital and O & M costs of each Sub-Project are estimated in the following page. Compensation for land acquisition in the reservoir area for the Nong Lum Puk Sub-Project is excluded in the year of dam construction, but would be considered every year as the net production value of the paddy field in the estimation of the Internal Rate of Return (IRR). In case Nong Lum Puk and Huai Phlu Sub-Projects are to be implemented independently, the construction period is reduced by one and two years, respectively.

Project life is assumed to be 50 years considering that the Project places emphasis on a social return to the investment.

Financial and Economic Project Cost

(Unit: Million Baht)

Year	Lam Plai Mat		Nong Lum Puk		Huai Phlu		Overall	
	Finan- cial	Eco- nomic	Finan- cial	Eco- nomic	Finan- cial	Eco- nomic	Finan- cial	Eco- nomic
(1) Capital Cost of Project								
1. 1985	17.48	15.88	1.43	1.37	2.68	2.51	18.08	16.46
2. 1986	43.19	41.38	8.25	6.43	12.76	9.91	49.57	47.41
3. 1987	106.64	47.68	29.06	22.06	36.08	26.88	114.60	51.99
4. 1988	162.20	146.72	4.12	3.15	24.16	19.24	206.77	181.55
5. 1989	282.63	252.17	-	0.03	6.74	4.92	329.76	291.24
6. 1990	92.02	82.55	-	0.03 ^{2/}	-	-	103.92	93.57
7. 1991	64.43	9.90	-	0.03	-	-	71.20	10.59
8 - 50. 1992-2034	-	-	-	0.03	-	-	-	0.03
1994								
2000								
2006								
2012	^{1/} 12.85	10.79	0.48	0.38	0.99	0.83	14.32	12.00
2018	(x 7)							
2024								
2030								
<u>Total</u>	<u>838.54</u>	<u>671.8</u>	<u>46.22</u>	<u>36.81</u>	<u>89.36</u>	<u>69.27</u>	<u>994.14</u>	<u>777.89</u>
(2) O & M Cost of Project								
1985-1987	0	0	0	0	0	0	0	0
1988	0	0	0.40	0.37	0	0	1.74	1.60
1989	0	0	0.40	0.37	0.72	0.66	5.63	5.18
1990	5.22	4.81	0.40	0.37	0.72	0.66	9.11	8.39
1991-2034	8.71	8.02	0.40	0.37	0.72	0.66	9.83	9.05

Note: ^{1/} Replacement cost of O & M equipment for the respective year.

^{2/} Economic value of 20 ha of paddy field in the Nong Lum Puk dam reservoir to be compensated was estimated by the net annual production value of paddy production for the Project life.

6.3.4. Economic Rate of Return

The stream of nine categories of the Project economic benefits, as previously stated, has been estimated on the assumption that the development period of the projected full benefits would be 7 years for paddy and field crops in the Lam Plai Mat Sub-Project and 5 years in the Nong Lum Puk and Huai Phlu Sub-Projects, while a total period is 10 years based upon fisheries development in the Project reservoirs for all the Sub-Projects.

Economic analysis of the Project has been made by employing the IRR method. The IRR is a rate that makes the net present worth of the incremental net benefit stream equal zero and has been calculated at 11.2 percent for the Lam Plai Mat Sub-Project, 8.7 percent for the Nong Lum Puk Sub-Project and 8.0 for the Huai Phlu Sub-Project. And the IRR, for the package plan, is estimated at 10.7 percent.

6.3.5. Sensitivity Analysis

Analyses have been made to test the sensitivity of rate to other parameters than those considered probable in the initial calculation. The parameters employed are reduction in benefits, delay in benefits, increase in Project costs, and combinations of these parameters.

(1) Reduction in Benefit

If there were no effective water use, effort in crop cultivation technique by the farmers, good cooperation in the muban cooperative service unit between the villagers, or effective leading of the villagers by government, every IRR of the three Sub-Project would fall. If all the benefits were reduced by 10 percent, IRRs of Lam Plai Mat, Nong Lum Puk and Huai Phlu, package of three Sub-Projects and package of Lam Plai Mat and Huai Phlu Sub-Project would fall to 10.1, 7.6, 7.0, 9.6 and 9.8 percent, respectively.

Construction Schedule and Benefit Development

	1985	1986	1987	1988	1989	1990	1991
<u>Single Project</u>							
(1) <u>Lam Plai Mat</u> (9,100 ha) -----				IRR (1) = 11.2%, IRR (2) = 11.6%			
Pre-construction	From July 1984						
Construction: Major Work							
: Terminal Work				20%	40%	40%	
Benefit Development (10 yrs.)						60%	
							40%
(2) <u>Nong Lum Puk</u> (300 ha) -----				IRR (1) = 8.7%, IRR(2) = 9.8%			
Pre-construction	From July 1984						
Construction: Major Work							
: Terminal Work							
Benefit Development (10 yrs.)							
(5) <u>Huai Phlu</u> (700 ha) -----				IRR (1) = 8.0%, IRR (2) = 8.9%			
Pre-construction	From July 1984						
Construction: Major Work							
: Terminal Work							
Benefit Development (10 yrs.)							
<u>Package Project</u>							
(Case 1 = Package of three Sub-Project) -----				IRR (1) = 10.7%, IRR (2) = 11.2%			
(1) Pre-construction	From July 1984						
(2) Construction: Major Work							
Lam Plai Mat							
Nong Lum Puk							
Huai Phlu							
(3) Construction: Terminal							
Lam Plai Mat				20%	40%	40%	
Nong Lum Puk							
Huai Phlu							
(4) Benefit Development							
Lam Plai Mat (10 yrs.)							
Nong Lum Puk (10 yrs.)						60%	
Huai Phlu (10 yrs.)							40%
<u>Package Project</u>							
(Case 2 = Package of Lam Plai Mat and Huai Phlu Sub-Project) -----				IRR(1) = 10.9%, IRR(2) = 11.4%			

(2) Delay in Benefit

Delay in benefit buildup may result from slow on-farm development and construction of the muban pond by the farmer. If on-farm development and construction of the muban pond is delayed by two years, the IRR would fall to 10.4 for Lam Plai Mat, 8.1 for Nong Lum Puk, 7.6 for Huai Phlu, 9.9 for the package of the three Projects and 10.1 for the Lam Plai Mat and Huai Phlu Sub-Project.

Sensitivity Test (EIRR)

Alternative	Single Project			Package Project	
	Lam Plai Mat	Nong Lum Puk	Huai Phlu	(P-1)+(P-5) (C-3)	(P-1)+(C-3)
(1) proto-type IRR (1)	11.2	8.7	8.0	10.7	10.9
IRR (2)	11.6	9.8	8.9	11.2	11.4
(2) a 10% increase in construction cost	10.3	7.9	7.3	9.8	10.0
(3) a 10% reduction in benefits	10.1	7.6	7.0	9.6	9.8
(4) a two-year delay in benefits	10.4	8.1	7.6	9.9	10.1
(5) a combination of (2) and (3)	9.3	6.8	6.4	8.8	9.0
(6) a combination of (2) and (4)	9.6	7.4	6.9	9.2	9.4
(7) a combination of (3) and (4)	9.4	7.0	6.6	8.9	9.1
(8) a combination of (2), (3) and (4)	8.6	6.4	6.0	8.2	8.4

Note: IRR (1): Original; Includes negative benefit of the reservoir cassava productions.

IRR (2): Excludes negative benefit.

Negative benefit is calculated by the net production value of cassava in the dam reservoir. The planted area of cassava without Project is estimate as follows:

Lam Plai Mat Dam Reservoir 936 ha
 Nong Lum Puk 99 ha
 Huai Phlu 144 ha