Table 7.1 INVENTORY OF EXISTING DIVERSION WORKS

Type of Diversion Works	Name of Diversion Works	Water Resource	Dam/Checkgate				Sluiceway					Intake Gate					Intake Barrel			Present Condition
			Type	Height (m)	Length (Width) (m)	No. of Check-gate	Bank	Gate Type	Width (m)	Height (m)	No.	Bank	Type	Width (m)	Height (m)	No.	Width (m)	Height (m)	No.	
	Porac-Gumain RIS																			
Diversion Dam	Porac Diversion Dam	Porac River	Ogee/F.S.	2.64	43.30	-	Right Left	Roller Roller	2.35 3.30	3.51 3.51	1 1	Right Left	Slide Slide	1.83 1.83	1.58 1.58	1 3	1.55 1.55	1.55 1.55	1 3	Heavy siltation Eroded banks Lost riprap
	Gumain Diversion Dam	Gumain River	Ogee	2.00	226.00	-	Right Left	Roller Roller	0.69 1.65	2.29 2.29	1 1	Right Left	Slide Slide	1.43 1.19	1.30 1.19	4 1	1.43 1.19	1.30 1.19	4 1	Sediment Lost riprap
Check-gate	Dorabulbul C.G.	Mabobayan Creek	Stoplog	2.35	3.80	6	-	-	-	-	-	Right	Stoplog	0.81	0.59	1		ø24"	1	Small cracks Eroded banks
	Pangpang C.G.	Sapang Palay Creek	2-Slide 2-Stoplog	1.90	3.80	6	-	-	-	-	-	Right Left	Stoplog Stoplog	0.60 0.90	0.60 0.90	1 1		ø16" ø24"	1 1	Normal
	Bakal C.G.	"	Stoplog	2.60	2.00	3	-	-	-	-	-	Left		Non-gate			Farm ditch			Siltation Eroded banks
	Sta C.G.	"	Stoplog	1.22	2.25	2	-	-	-	-	-			Creek at the right side						"
	Patenge C.G.	Porac River	Stoplog	3.19	2.00	6	-	-	-	-	-		Patenge	Creek at the left side						"
	Bitas C.G. (Dam 89)	"	Stoplog	3.70	1.59	11	-	-	-	-	-	Right	Stoplog	2.00	2.00	1	Canal			Siltation Small cracks
	Sartor C.G.	Sartor Creek	-	1.47	1.60	16	-	-	-	-	-	Porac Pala Canal West					1.61	1.47	1	Heavy Sediment Eroded banks
	Macabulos C.G.	"	Stoplog	2.00	2.30	6	-	-	-	-	-	Right	Stoplog	0.57	0.56	1		ø18"	1	Sediment Small Cracks
	Pesson C.G.	"	Stoplog	2.00	1.80	6	-	-	-	-	-	Right	Stoplog	0.56	0.57	1		ø18"	1	"
	Tolentino C.G.	Santa Catalina Creek	Stoplog	3.20	3.59	2	-	-	-	-	-	Right Left	Stoplog Slide	0.45 0.86	0.45 0.76	1 1	0.75	0.83 ø18"	1 1	"
	Laguna C.G.	"	Stoplog	0.55	0.50	2	-	-	-	-	-	Right Left	Slide Slide	0.45 0.30	0.45 0.33	1 1		ø18" ø12"	1 1	Eroded banks
	Dam 83	Balcarangan Creek	Stoplog	3.28	2.00	6	-	-	-	-	-	Right Left	Stoplog Stoplog	0.73 0.93	0.875 1.00	1 1	Farm ditch "			Siltation
	Dam 84	"	Stoplog	3.33	2.00	3	-	-	-	-	-	Right Left	Stoplog Stoplog	0.365 0.975	1.07 1.07	1 1	" "			Eroded banks
	Dam 84A	"	Stoplog	2.56	1.97	3	-	-	-	-	-	Right Left	Stoplog Stoplog	1.01 1.01	0.82 1.48	1 1	" "			Normal
	Dam 85	"	Stoplog	2.71	2.00	3	-	-	-	-	-	Right Left	Stoplog Stoplog	0.95 1.01	0.82 0.82	1 1	" "			Eroded banks
	Cadiz-an RIS																			
Diversion Dam	Cadiz-an Diversion Dam	Cadiz-an River	Ogee	1.80	72.00	-	Left	Roller	4.30	1.90	1	Left	Slide	2.00	3.00	2	2.00	3.00	2	Sediment Lost riprap
Check-gate	Bitin C.G.	Bodega Creek	Stoplog	2.00	1.58	2	-	-	-	-	-	Left	-	Non-gate				ø30"	1	Siltation Small Cracks Eroded banks
	Alfaro C.G.	Balcarangan Creek	Stoplog	1.22	1.65	1	-	-	-	-	-	Right	Stoplog	0.90	0.90	1	0.60	0.70	1	"
	Pingol C.G.	"	Stoplog	1.43	1.73	5	-	-	-	-	-	Left	Stoplog	0.60	0.60	1		ø18"	1	"
	Calangala C.G. (Dam 87)	"	Stoplog	1.62	1.72	3	-	-	-	-	-	Left	Stoplog	-	-	-		ø15"	1	"
	Lazo Pas C.G.	Lazo Pas Creek	Stoplog	2.00	1.35	3	-	-	-	-	-	-	-	-	-	-	-	-	-	Siltation
	Dam 90A	"	Stoplog	2.29	1.00	2	-	-	-	-	-	Left	Stoplog	0.30	0.90	1		ø30cm	1	Siltation Small cracks Eroded banks
	Dam 91	"	Stoplog	1.10	1.80	3	-	-	-	-	-	Left	Stoplog	0.60	0.60	1		ø15"	1	"
	Dam 92	"	Stoplog	1.10	1.70	1	-	-	-	-	-	Right	Stoplog	0.70	0.70	1		ø18"	1	Siltation Big cracks Eroded banks
	Other Irrigation Checkgate System																			
	Sapang C.G.	Ebus Creek	2-Slide 2-Stoplog	1.80	1.80	3	-	-	-	-	-	Left	Stoplog	0.60	0.60	1		ø18"	1	Normal
	Pera C.G.	Santa Catalina Creek	Stoplog	2.38	1.80	2	-	-	-	-	-	Right Left	Stoplog	Non-gate 0.60	0.90	1	Farm ditch 0.60	0.90	1	Siltation Small cracks Eroded banks
	Calalabing C.G.	"	Stoplog	1.71	2.43	2	-	-	-	-	-	Left	Stoplog	0.60	0.60	1	0.60	0.60	1	Eroded banks
Diversion Dam	Balancinga Dam	Cala-Tena River	Stoplog	1.50	1.75	10	-	-	-	-	-	-	-	-	-	-	-	-	-	Cannot use Big cracks Eroded banks
	Balsic Dam	Balsic River	Ogee/ F.S.	1.36	41.60	-	Right	Stoplog	1.90	1.36	1	Right	-	-	-	-		ø12"	1	Cannot use Broken Eroded banks

Table 7.2 STATISTICAL ANALYSIS OF EXTREME DRY YEAR

Year /1	Annual Rainfall (mm)	Dry Season/2 Rainfall (mm)	Annual/3 Runoff (MCM)	Dry Season/3 Runoff (MCM)
1958/59	2,183.3	20.4	312.5	34.9
1959/60	1,425.7	283.7	108.2	23.0
1960/61	3,140.7	107.8	320.9	32.5
1961/62	1,498.1	112.7	154.7	25.8
1962/63	2,794.7	144.4	265.9	32.0
1963/64	2,873.4	84.2	252.3	26.2
1964/65	1,922.4	211.2	201.1	40.8
1965/66	1,734.9	207.4	261.0	43.5
1966/67	2,711.5	150.3	416.1	44.5
1967/68	2,643.2	51.1	248.2	24.4
1968/69	1,997.7	93.5	191.9	27.2
1969/70	1,899.1	72.6	170.1	33.9
1970/71	2,411.3	163.2	277.5	54.4
1971/72	2,592.3	286.1	337.4	82.3
1972/73	5,502.2	59.6	491.2	42.6
1973/74	2,043.7	145.0	210.5	25.2
1974/75	3,688.9	369.0	280.9	43.7
1975/76	1,789.0	160.6	163.6	38.3
1976/77	2,721.2	121.8	317.2	35.8
1977/78	1,711.9	161.6	252.0	54.6
1978/79	2,687.0	16.9	212.1	25.1
1979/80	1,450.2	34.7	199.0	27.9
1980/81	1,753.4	85.6	172.6	29.2
1981/82	1,470.7	58.8	159.1	27.5
1982/83	1,503.7	34.3	311.0	43.3
Value in 5-Year Return Period	1,720	60.0	180.0	26.5

Remarks: /1: May to April based on the proposed cropping calender
/2: Dry Season: from November to April
/3: At proposed Gumain Dam Site

Table 7.3 ANNUAL DIVERSION WATER REQUIREMENT

(Unit: mm)

Year/1	Paddy			Sugar-cane	Diversified Crop
	Wet	Dry	Total		
1958/59	653	1,770	2,423	1,216	1,490
59/60	640	1,523	2,163	975	1,175
1960/61	319	1,668	1,987	1,268	1,326
61/62	535	1,787	2,322	1,214	1,420
62/63	565	1,623	2,188	1,218	1,408
63/64	253	1,658	1,911	1,049	1,425
64/65	455	1,475	1,930	778	1,257
65/66	285	1,527	1,812	1,047	1,250
66/67	473	1,494	1,967	1,133	1,368
67/68	167	1,728	1,895	1,125	1,459
68/69	358	1,785	2,143	1,100	1,393
69/70	387	1,721	2,108	931	1,377
1970/71	247	1,464	1,711	901	1,284
71/72	451	1,353	1,804	1,157	1,184
72/73	242	1,733	1,975	1,240	1,412
73/74	357	1,557	1,914	1,107	1,316
74/75	677	1,207	1,884	1,282	1,128
75/76	850	1,498	2,348	1,252	1,297
76/77	551	1,656	2,207	1,319	1,326
77/78	539	1,678	2,217	1,251	1,498
78/79	380	1,719	2,099	1,439	1,473
79/80	852	1,763	2,615	1,443	1,473
1980/81	792	1,644	2,436	1,368	1,464
81/82	650	1,664	2,314	1,679	1,420
82/83	765	1,805	2,570	1,558	1,473
Average	498	1,620	2,118	1,202	1,364
(C.W.R.)/2	890	1,018	1,908	1,230	817

Remarks: /1: May to April based on the proposed cropping calender

/2: Crop Water Requirement

Table 7.4 CROP WATER REQUIREMENT FOR PADDY

CROP PAD
SEASON WET
IRRIGATION PERIOD 5/14-10/22
LAND SOAKING 5/14- 7/ 4
LAND PREPARATION 5/21- 7/24
NORMAL IRRIGATION 6/10-10/22

EVA	(MM/DAY)	4.97	6.05	6.87	7.37	5.89	4.32	3.73	3.30	3.49	3.96	4.28	4.56					
PET	(MM/DAY)	5.20	6.21	6.44	7.80	6.95	5.40	4.84	4.28	4.75	4.62	4.88	4.71					
MONTH		5	5	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10
NO.OF DAYS		(7)	(11)	(10)	(10)	(10)	(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(10)	(10)	(10)	(2)
AREA FACTOR																		
KLS	(MM/DAY)	0.054	0.156	0.156	0.156	0.152	0.025	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KLP	(MM/DAY)	0.	0.111	0.333	0.444	0.444	0.408	0.200	0.018	0.	0.	0.	0.	0.	0.	0.	0.	0.
KFC	(MM/DAY)	0.	0.	0.	0.111	0.333	0.567	0.800	0.982	1.000	1.000	1.000	1.000	0.844	0.667	0.433	0.200	0.018
KC		0.	0.	0.	0.87	0.92	0.96	1.00	1.03	1.10	1.14	1.16	1.15	1.11	1.08	1.05	1.00	0.94
CROP WATE REQ																		
LS	(MM/DAY)	17.96	17.96	18.28	18.28	18.28	18.56	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LP	(MM/DAY)	3.57	3.57	3.57	3.57	3.57	3.57	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FC	(MM/DAY)	0.	1.99	2.15	2.20	2.29	2.35	2.64	3.06	3.95	4.47	4.99	6.33	6.52	6.52	6.50	6.12	5.47
CWR	(MM)	8.49	49.70	57.80	73.64	88.57	71.24	68.68	76.84	67.08	68.79	76.61	74.63	61.38	47.36	29.66	13.24	0.23

CROP PAD
SEASON DRY
IRRIGATION PERIOD 10/14- 3/24
LAND SOAKING 10/14-12/ 4
LAND PREPARATION 10/21-12/24
NORMAL IRRIGATION 11/10- 3/24

EVA	(MM/DAY)	4.97	6.05	6.87	7.37	5.89	4.32	3.73	3.30	3.49	3.96	4.28	4.56					
PET	(MM/DAY)	5.20	6.21	6.44	7.80	6.95	5.40	4.84	4.28	4.75	4.62	4.88	4.71					
MONTH		10	10	11	11	11	12	12	12	1	1	1	2	2	2	3	3	3
NO.OF DAYS		(7)	(11)	(10)	(10)	(10)	(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(8)	(10)	(10)	(4)
AREA FACTOR																		
KLS	(MM/DAY)	0.054	0.156	0.156	0.156	0.152	0.025	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KLP	(MM/DAY)	0.	0.111	0.333	0.444	0.444	0.408	0.200	0.018	0.	0.	0.	0.	0.	0.	0.	0.	0.
KFC	(MM/DAY)	0.	0.	0.	0.111	0.333	0.567	0.800	0.982	1.000	1.000	1.000	1.000	0.844	0.667	0.433	0.200	0.018
KC		0.	0.	0.	0.87	0.92	0.96	1.00	1.03	1.10	1.14	1.16	1.15	1.11	1.08	1.05	1.00	0.94
CROP WATE REQ																		
LS	(MM/DAY)	17.96	17.96	18.28	18.28	18.28	18.56	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LP	(MM/DAY)	3.57	3.57	3.57	3.57	3.57	3.57	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FC	(MM/DAY)	0.	1.99	2.15	2.20	2.29	2.35	2.64	3.06	3.95	4.47	4.99	6.33	6.52	6.52	6.50	6.12	5.47
CWR	(MM)	6.79	39.62	53.59	68.88	82.83	73.48	69.30	75.55	77.20	79.28	88.35	91.47	75.06	46.46	27.94	16.88	0.58

Table 7.5(1) CROP WATER REQUIREMENT FOR SUGARCANE

CROP SUG
SEASON ALL
IRRIGATION PERIOD 12/ 1- 2/28
LAND PREPARATION 1/ 1- 2/28
NORMAL IRRIGATION 12/ 1- 2/28

EVA (MM/DAY)	4.97	6.05	6.87	7.37	5.89	4.32	3.73	3.30	3.49	3.96	4.28	4.50							
PET (MM/DAY)	5.20	6.21	6.44	7.80	6.95	5.40	4.84	4.28	4.75	4.62	4.88	4.71							
MONTH	12	12	12	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	
NO.OF DAYS	(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(8)	(10)	(10)	(11)	(10)	(10)	(10)	(10)	(10)	(11)	
AREA FACTOR																			
KLP (MM/DAY)	0.011	0.033	0.055	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.055	0.033	0.011	
KFC1 (MM/DAY)	0.	0.	0.	0.011	0.033	0.055	0.077	0.099	0.122	0.144	0.166	0.188	0.211	0.233	0.255	0.277	0.299	0.322	
KFC2 (MM/DAY)	0.011	0.033	0.055	0.077	0.099	0.122	0.144	0.166	0.188	0.211	0.233	0.255	0.277	0.299	0.322	0.333	0.333	0.333	
KC FOR PLANT	0.	0.	0.	0.50	0.50	0.50	0.50	0.50	0.51	0.51	0.52	0.53	0.55	0.57	0.60	0.63	0.65	0.68	
KC FOR RATOON	0.50	0.50	0.50	0.50	0.50	0.51	0.51	0.52	0.53	0.55	0.57	0.60	0.63	0.65	0.68	0.69	0.73	0.76	
CROP WATE REQ																			
LP (MM/DAY)	3.57	3.57	3.57	3.57	3.57	3.57	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
FC1 (MM/DAY)	0.	0.	0.	2.60	2.60	2.60	3.10	3.10	3.17	3.28	3.35	3.41	4.29	4.45	4.68	4.38	4.52	4.73	
FC2 (MM/DAY)	4.71	4.71	4.71	5.20	5.20	5.30	6.33	6.46	6.58	7.08	7.34	7.73	9.83	10.14	10.61	9.59	10.15	10.56	
CWR (MM)	0.70	2.10	3.86	5.39	7.11	9.90	12.61	14.89	13.87	20.78	23.76	29.95	37.38	41.78	47.19	44.98	47.85	55.64	

MONTH	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10	11	11	11	
NO.OF DAYS	(10)	(10)	(10)	(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(10)	(10)	(10)	(11)	(10)	(10)	(10)	
AREA FACTOR																			
KLP (MM/DAY)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
KFC1 (MM/DAY)	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.332	0.299	0.277	0.255	0.233	0.211	
KFC2 (MM/DAY)	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.333	0.332	0.299	0.277	0.255	0.233	0.211	
KC FOR PLANT	0.69	0.73	0.76	0.79	0.81	0.83	0.86	0.87	0.89	0.90	0.91	0.91	0.90	0.89	0.87	0.86	0.85	0.84	
KC FOR RATOON	0.79	0.81	0.83	0.86	0.87	0.89	0.90	0.91	0.91	0.90	0.89	0.87	0.86	0.85	0.84	0.83	0.82	0.81	
CROP WATE REQ																			
LP (MM/DAY)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
FC1 (MM/DAY)	3.73	3.94	4.10	3.82	3.92	4.02	3.68	3.72	3.81	4.27	4.32	4.32	4.16	4.11	4.02	4.20	4.15	4.10	
FC2 (MM/DAY)	8.53	8.75	8.96	8.32	8.42	8.62	7.70	7.79	7.79	8.55	8.46	8.26	7.95	7.85	7.76	8.10	8.00	7.91	
CWR (MM)	40.82	42.26	43.52	40.45	41.10	46.27	37.91	38.34	42.49	42.71	42.55	41.92	40.19	35.78	35.90	31.36	28.31	25.33	

Table 7.5(2) CROP WATER REQUIREMENT FOR SUGARCANE

MONTH	12	12	12	1	1	1	2	2	2
NO.OF DAYS	(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(8)
AREA FACTOR									
KLP (MM/DAY)	0.	0.	0.	0.	0.	0.	0.	0.	0.
KFC1 (MM/DAY)	0.188	0.166	0.144	0.122	0.099	0.077	0.055	0.033	0.011
KFC2 (MM/DAY)	0.188	0.166	0.144	0.122	0.099	0.077	0.055	0.033	0.011
KC FOR PLANT	0.83	0.82	0.81	0.80	0.79	0.78	0.78	0.77	0.76
KC FOR RATOON	0.80	0.79	0.78	0.78	0.77	0.76	0.75	0.	0.
CROP WATE REQ									
LP (MM/DAY)	0.	0.	0.	0.	0.	0.	0.	0.	0.
FC1 (MM/DAY)	3.91	3.86	3.82	4.16	4.11	4.06	4.84	4.78	4.72
FC2 (MM/DAY)	7.54	7.44	7.35	8.11	8.01	7.90	9.31	0.	0.
CWR (MM)	21.52	18.76	17.68	14.97	11.99	10.13	7.79	1.58	0.42

Table 7.6 CROP WATER REQUIREMENT FOR VEGITABLES

CROP VEG
SEASON ALL
IRRIGATION PERIOD 10/13- 5/ 3
LAND PREPARATION 10/27- 5/ 3
NORMAL IRRIGATION 0/ 0- 0/ 0

EVA	(MM/DAY)	4.97	6.05	6.87	7.37	5.89	4.32	3.73	3.30	3.49	3.96	4.28	4.56							
PET	(MM/DAY)	5.20	6.21	6.44	7.80	6.95	5.40	4.84	4.28	4.75	4.62	4.88	4.71							
MONTH		10	10	11	11	11	12	12	12	1	1	1	2	2	2	3	3	3	4	
NO.OF DAYS		(8)	(11)	(10)	(10)	(10)	(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(8)	(10)	(10)	(11)	(10)	
AREA FACTOR																				
KLP	(MM/DAY)	0.036	0.271	0.311	0.311	0.301	0.122	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
KFC	(MM/DAY)	0.	0.018	0.200	0.422	0.644	0.878	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.982	0.800	
KC		0.	0.43	0.44	0.45	0.47	0.50	0.56	0.63	0.76	0.86	0.96	1.02	1.05	1.05	1.01	0.93	0.85	0.80	
CROP WATE REQ																				
LP	(MM/DAY)	3.57	3.57	3.57	3.57	3.57	3.57	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
FC	(MM/DAY)	0.	1.99	2.15	2.20	2.29	2.35	2.64	3.06	3.95	4.47	4.99	6.33	6.52	6.52	6.50	6.12	5.47	6.24	
CWR	(MM)	1.03	11.04	15.40	20.37	25.52	25.03	26.38	33.68	39.52	44.72	54.91	63.34	65.20	52.16	65.04	61.18	59.13	49.92	

MONTH		4	4	5
NO.OF DAYS		(10)	(10)	(3)
AREA FACTOR				
KLP	(MM/DAY)	0.	0.	0.
KFC	(MM/DAY)	0.578	0.356	0.122
KC		0.74	0.67	0.60
CROP WATE REQ				
LP	(MM/DAY)	0.	0.	0.
FC	(MM/DAY)	5.77	5.23	4.17
CWR	(MM)	33.36	18.60	1.53

Table 7.7 IRRIGATION WATER REQUIREMENT FOR PADDY

CROP PAD
YEAR 1980 START
SEASON WET
IRRIGATION PERIOD 5/14-10/22

MONTH		5	5	6	6	6	7	7	7	8	8	8	9	9	9	10	10	10
NO.OF DAYS		(7)	(11)	(10)	(10)	(10)	(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(10)	(10)	(10)	(2)
10DAYS	(MM)	37.60	0.	18.30	32.10	169.90	111.80	141.50	230.50	11.70	34.30	62.70	56.70	99.30	0.	0.	0.	0.
RE	(MM)	37.60	0.	18.30	32.10	76.36	57.12	59.47	51.92	11.70	34.30	62.70	56.70	94.73	0.	0.	0.	0.
FWR	(MM)	0.	49.70	39.50	41.54	12.21	14.11	9.21	24.91	35.38	34.49	13.91	17.93	0.	47.56	29.66	13.24	0.23
GWR	(MM)	0.	97.46	77.45	81.44	23.95	27.68	18.06	48.85	108.59	67.63	27.28	35.15	0.	93.25	58.17	25.96	0.45
UWR	(L/S/HA)	0.	11.28	8.96	9.43	2.77	3.20	2.09	5.65	12.57	7.83	3.16	4.07	0.	10.79	6.73	3.00	0.05

TOTAL GWR = 791.36 MM

CROP PAD
YEAR 1980 START
SEASON DRY
IRRIGATION PERIOD 10/14- 3/24

MONTH		10	10	11	11	11	12	12	12	1	1	1	2	2	2	3	3	3
NO.OF DAYS		(7)	(11)	(10)	(10)	(10)	(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(8)	(10)	(10)	(4)
10DAYS	(MM)	0.	153.70	77.70	7.90	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RE	(MM)	0.	57.20	47.30	7.90	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FWR	(MM)	6.79	0.	12.29	60.98	82.83	73.48	69.30	75.55	77.20	79.28	88.35	91.41	75.06	46.46	37.94	16.88	0.58
GWR	(MM)	12.48	0.	22.60	112.10	152.26	135.08	127.59	138.89	141.91	145.74	162.41	168.04	137.97	85.40	69.74	31.03	1.07
UWR	(L/S/HA)	1.44	0.	2.62	12.97	17.62	15.63	14.74	16.07	16.42	16.87	18.80	19.45	15.97	9.88	8.07	3.59	0.12

TOTAL GWR = 1644.77 MM

Table 7.8(1) IRRIGATION WATER REQUIREMENT FOR SUGARCANE (1979 PLANTED CROP)

CROP SUG
YEAR 1979 START
SEASON ALL
IRRIGATION PERIOD 12/ 1~ 2/28

MONTH		12	12	12	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5
NO.OF DAYS		(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(9)	(10)	(10)	(11)	(10)	(10)	(10)	(10)	(10)	(11)
100AYS	(MM)	0.	0.	7.10	0.	0.	0.	0.	0.	0.	0.	0.	4.60	0.	0.	0.	7.60	37.60	0.
RE	(MM)	0.	0.	7.10	0.	0.	0.	0.	0.	0.	0.	0.	4.60	0.	0.	0.	7.60	37.60	0.
FWR	(MM)	0.70	2.10	0.	5.39	7.11	9.90	12.61	14.89	15.61	20.78	23.76	25.35	37.38	41.78	47.19	37.38	10.25	55.64
DWR	(MM)	1.40	4.21	0.	10.78	14.21	19.80	25.22	29.79	31.21	41.55	47.53	50.69	74.75	83.56	94.38	74.77	20.49	111.27
UWR	(L/S/HA)	0.16	0.49	0.	1.25	1.64	2.29	2.92	3.45	3.61	4.81	5.50	5.87	8.65	9.67	10.92	8.65	2.37	12.88

MONTH		6	6	6	7	7	7	8	8	8	9	9	9	10	10	10	11	11	11
NO.OF DAYS		(10)	(10)	(10)	(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(10)	(10)	(10)	(11)	(10)	(10)	(10)
100AYS	(MM)	18.30	32.10	169.90	111.80	141.50	230.50	11.70	34.30	62.70	56.70	599.50	0.	0.	0.	153.70	77.70	7.90	0.
RE	(MM)	18.30	32.10	169.90	93.52	41.10	26.04	11.70	34.30	62.70	56.70	54.57	0.	0.	0.	153.70	29.42	7.90	0.
FWR	(MM)	22.52	10.16	0.	0.	0.	20.23	26.21	4.04	0.	0.	0.	41.92	40.19	35.78	0.	1.94	20.41	25.33
DWR	(MM)	45.04	20.32	0.	0.	0.	40.47	52.42	8.08	0.	0.	0.	83.83	80.37	71.56	0.	3.88	40.82	50.66
UWR	(L/S/HA)	5.21	2.35	0.	0.	0.	4.68	6.07	0.93	0.	0.	0.	9.70	9.30	8.28	0.	0.45	4.73	5.86

MONTH		12	12	12	1	1	1	2	2	2
NO.OF DAYS		(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(8)
100AYS	(MM)	0.	0.	0.	0.	0.	0.	0.	0.	0.
RE	(MM)	0.	0.	0.	0.	0.	0.	0.	0.	0.
FWR	(MM)	21.52	18.76	17.68	14.97	11.99	10.13	7.79	1.58	0.42
DWR	(MM)	43.03	37.53	35.36	29.94	23.99	20.26	15.57	3.16	0.83
UWR	(L/S/HA)	4.98	4.34	4.09	3.47	2.78	2.34	1.80	0.37	0.10

TOTAL DWR = 1442.76 MM

Table 7.8(2) IRRIGATION WATER REQUIREMENT FOR SUGARCANE (1980 PLANTED CROP)

CROP SUG
YEAR 1980 START
SEASON ALL
IRRIGATION PERIOD 12/ 1- 2/28

MONTH		12	12	12	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5
NO.OF DAYS		(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(8)	(10)	(10)	(11)	(10)	(10)	(10)	(10)	(10)	(11)
10DAYS	(MM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	13.70	14.00	14.80
RE	(MM)	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	13.70	14.00	14.80
FWR	(MM)	0.70	2.10	5.86	5.39	7.11	9.90	12.61	14.89	13.87	20.78	23.76	29.95	37.38	41.78	47.19	31.28	33.85	40.84
DWR	(MM)	1.40	4.21	7.72	10.78	14.21	19.80	25.22	29.79	27.74	41.55	47.53	59.89	74.75	83.56	94.38	62.57	67.69	81.67
UWR	(L/S/HA)	0.16	0.49	0.89	1.25	1.64	2.29	2.92	3.45	3.21	4.81	5.50	6.93	8.65	9.67	10.92	7.24	7.83	9.45

MONTH		6	6	6	7	7	7	8	8	8	9	9	9	10	10	10	11	11	11
NO.OF DAYS		(10)	(10)	(10)	(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(10)	(10)	(10)	(11)	(10)	(10)	(10)
10DAYS	(MM)	132.90	373.40	42.60	99.80	139.10	2.00	85.10	195.40	31.60	14.80	23.10	70.10	98.30	38.90	22.30	9.70	3.50	35.60
RE	(MM)	132.90	153.85	9.15	70.59	45.33	2.00	82.18	38.34	26.86	14.80	23.10	70.10	50.87	38.90	22.30	9.70	3.50	35.60
FWR	(MM)	0.	0.	34.36	0.	0.	44.27	0.	0.00	15.62	27.91	19.45	0.	0.	0.	13.60	21.66	24.81	0.
DWR	(MM)	0.	0.	68.73	0.	0.	88.54	0.	0.00	31.25	55.81	38.90	0.	0.	0.	27.19	43.32	49.62	0.
UWR	(L/S/HA)	0.	0.	7.95	0.	0.	10.25	0.	0.00	3.62	6.46	4.50	0.	0.	0.	3.15	5.01	5.74	0.

MONTH		12	12	12	1	1	1	2	2	2
NO.OF DAYS		(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(8)
10DAYS	(MM)	0.	0.	0.	0.	0.	0.	0.	0.	0.
RE	(MM)	0.	0.	0.	0.	0.	0.	0.	0.	0.
FWR	(MM)	21.52	18.76	17.68	14.97	11.99	10.13	7.79	1.58	0.42
DWR	(MM)	43.03	37.53	35.36	29.94	23.99	20.26	15.57	3.16	0.83
UWR	(L/S/HA)	4.98	4.34	4.09	3.47	2.78	2.34	1.80	0.37	0.10

TOTAL DWR = 1367.53 MM

Table 7.9 IRRIGATION WATER REQUIREMENT FOR VEGITABLES

CROP VEG
YEAR 1980 START
SEASON ALL
IRRIGATION PERIOD 10/13- 5/ 3

MONTH		10	10	11	11	11	12	12	12	1	1	1	2	2	2	3	3	3	4
NO.OF DAYS		(8)	(11)	(10)	(10)	(10)	(10)	(10)	(11)	(10)	(10)	(11)	(10)	(10)	(8)	(10)	(10)	(11)	(10)
10DAYS	(MM)	0.	153.70	77.70	7.90	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RE	(MM)	0.	153.70	61.63	7.16	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FWR	(MM)	1.03	0.	0.	13.22	25.52	25.03	26.38	33.68	39.52	44.72	54.91	63.34	65.20	52.16	65.04	61.18	59.13	49.92
DWR	(MM)	2.06	0.	0.	26.44	51.04	50.07	52.75	67.35	79.04	89.44	109.82	126.68	130.41	104.33	130.09	122.36	118.26	99.84
UWR	(L/S/HA)	0.24	0.	0.	3.06	5.91	5.79	6.11	7.80	9.15	10.35	12.71	14.66	15.09	12.07	15.06	14.16	13.69	11.56

MONTH		4	4	5
NO.OF DAYS		(10)	(10)	(3)
10DAYS	(MM)	0.	0.	0.
RE	(MM)	0.	0.	0.
FWR	(MM)	33.36	18.60	1.53
DWR	(MM)	66.72	37.21	3.05
UWR	(L/S/HA)	7.72	4.31	0.35

TOTAL DWR = 1466.97 MM

Table 7.10 WATER RE-USE POINTS AND IRRIGABLE AREA

(Unit: ha)

No.	Re-use Point	River or Creek	Catchment Area		Commanded Area	Irrigable Area	Supplementary Water from
			Gross	Paddy Field			
1	Natividad	Guagua R.	2,500	450	360	240	Porac Diversion Dam
2	Sampang	San Antonio R.	760	460	100	100	"
3	Patangue	Porac (old) R.	450	190	760	90	"
4	Calalabing	Santa Calalina R.	1,100	590	130	130	"
5	Dam-84	Pokaranan C.	1,030	820	250	160	Gumain Diversion Dam
	Total				1,600	720	

Table 7.11 PROPOSED IRRIGATION SYSTEM

Item	Total	Sub-Irrigation System		
		Porac River Irrigation System (PRIS)	Gumain River Irrigation System (GRIS)	Caulaman River Irrigation System (CRIS)
1. Water Resources		Gumain River and Porac River	Gumain River	Gumain River and Caulaman River
2. Intake Facilities		Upper Gumain Diversion Dam	Gumain Diversion Dam	Upper Gumain Diversion Dam
		Porac Diversion Dam		Caulaman Diversion Dam
3. Major Canals		Porac Diversion Canal	Gumain South Main Canal	Caulaman Diversion Canal
		Porac East Main Canal		
		Porac West Main Canal		Caulaman Main Canal
4. Net Irrigation Area (ha)	16,750	7,710	3,760	5,280
5. Irrigation Area for Each Crop (ha)				
- Wet Season Paddy	11,000	6,000	2,970	2,030
- Dry Season Paddy	6,400	3,290	2,180	930
- Sugarcane	5,750	1,710	790	3,250
- Vegetables	1,800	880	310	610
6. Annual Diversion Water Requirement (MCM)	273	128	62	83

Table 7.12 GENERAL FEATURES OF UPPER GUMAIN DIVERSION DAM

1) Dam Portion		
Design flood	:	2,000 m^3/sec
Design flood water level	:	FWL 51.0 m
Type	:	Ogee type
Crest elevation	:	EL. 45.0 m
Length of crest	:	80.0 m
Height	:	4.0 m
Length of apron	:	35.0 m
Length of launching apron	:	20.0 m
2) Scouring Sluice		
- Right Bank		
Gate type	:	Roller gate
Size of gates (B x H x No.)	:	3.0m x 4.0m x 1 No.
- Left Bank		
Gate type	:	Roller gate
Size of gates (B x H x No.)	:	4.0m x 4.0m x 1 No.
3) Intake Structures		
- Right Bank (Caulaman Diversion Canal)		
Design intake discharge	:	5.23 m^3/sec
Intake water level	:	WL. 45.0 m
Gate type	:	Sluice gate
Size of gates	:	2.0m x 2.0m x 2 Nos.
Bottom elevation	:	EL. 43.5 m
- Left Bank (Porac Diversion Canal)		
Design intake discharge	:	7.16 m^3/sec
Intake water level	:	WL. 45.0 m
Gate type	:	Sluice gate
Size of gates	:	2.0m x 2.0m x 3 Nos.
Bottom elevation	:	EL. 43.5 m
4) Dike Portion		
Top of embankment	:	EL. 53.0 m
Length of dike	:	270.0 m
Width of crest	:	5.0 m
Side slope	:	1 : 2.0

Table 7.13 GENERAL FEATURES OF REHABILITATED PORAC DIVERSION DAM

1) Dam Portion		
Dam type	:	Ogee with falling gate
Crest length	:	43.3 m
Height of crest	:	2.8 m
Length of apron	:	16.0 m
Crest elevation	:	EL. 22.6 m
Gate type	:	Falling gate
Capacity of flood way	:	450 m^3/sec
2) Scouring Sluice		
- Right Bank		
Gate type	:	Roller gate
Size of gates (B x H x No.)	:	2.4m x 3.5m x 1 No.
- Left Bank		
Gate type	:	Roller gate
Size of gates (B x H x No.)	:	3.0m x 3.5m x 1 No.
3) Intake Structures		
- Right Bank (West Main Canal)		
Gate type	:	Sluice gate
Size of gates (B x H x No.)	:	1.5m x 1.5m x 1 No.
Intake water level	:	WL. 24.0 m
Design intake discharge	:	1.11 m^3/sec
- Left Bank (East Main Canal)		
Gate type	:	Sluice gate
Size of gates (B x H x No.)	:	1.5m x 1.5m x 3 Nos.
Intake water level	:	WL. 24.0 m
Design intake discharge	:	6.09 m^3/sec

Table 7.14 GENERAL FEATURES OF REHABILITATED GUMAIN DIVERSION DAM

1) Dam Portion		
Dam type	:	Ogee type
Crest length	:	224.0 m
Height of crest	:	2.0 m
Length of apron	:	14.0 m
Crest elevation	:	EL. 17.4 m
Capacity of flood way	:	1,700 m^3/sec
2) Scouring Sluice		
- Right Bank		
Gate type	:	Roller gate
Size of gates (B x H x No.)	:	4.6m x 2.2m x 1 No.
- Left Bank		
Gate type	:	Roller gate
Size of gates (B x H x No.)	:	1.8m x 2.2m
3) Intake Structures		
- Right Bank (South Main canal)		
Gate type	:	Sluice gate
Size of gates (B x H x No.)	:	1.4m x 1.3m x 4 Nos.
Intake water level	:	WL. 17.4 m
Design intake discharge	:	3.91 m^3/sec

Table 7.15 GENERAL FEATURES OF REHABILITATED CAULAMAN DIVERSION DAM

1) Dam Portion		
Dam type	:	Ogee type
Crest length	:	72.0 m
Height of crest	:	1.8 m
Crest elevation	:	EL. 21.4 m
Capacity of flood way	:	1,380 m^3/sec
2) Scouring Sluice		
Gate type	:	Roller gate
Size of gates (B x H x No.)	:	4.3m x 1.9m x 1 No.
3) Intake Structures		
Gate type	:	Sluice gate
Size of gates (B x H x No.)	:	2.0m x 1.0m x 2 Nos.
Intake water level	:	WL. 21.4 m
Design intake discharge	:	5.22 m^3/sec

Table 7.16 GENERAL FEATURES OF IRRIGATION FACILITIES

I. Irrigation Canal

(Unit: km)

Canals	PRIS	CRIS	GRIS	Total
1. Diversion Canal	6.9(0)	6.7(0)	-	13.6(0)
2. Main Canal	12.0(12.0)	12.8(12.8)	4.0(4.0)	28.8(28.8)
3. Lateral	88.4(31.3)	40.4(12.5)	40.8(22.0)	169.6(65.8)
4. Main Farm Ditch	101.9(-)	84.4(-)	60.0(-)	246.3(-)
5. Supplementary Farm Ditch	254.8(-)	210.6(-)	150.0(-)	615.4(-)

II. Related Structures

(Unit: Nos.)

Structures	PRIS	CRIS	GRIS	Total
1. Head Gate	19(8)	7(4)	9(2)	25(14)
2. Turnout	136(22)	106(37)	70(17)	312(76)
3. Check Gate	77(10)	57(0)	36(0)	170(10)
4. Culvert	87(37)	68(39)	36(25)	191(101)
5. Bridge	7(2)	12(3)	-	19(5)
6. Syphon	9(7)	2(2)	1(1)	12(10)
7. Drop	6(1)	12(0)	-	18(1)
8. Waste Way & Spill Way	6(0)	3(0)	4(0)	13(0)
9. Cross Drain	10(6)	4(0)	-	14(6)
10. Aqueduct	2(0)	-	-	2(0)

Remarks:
1) PRIS: Porac River Irrigation System (include new area commanded by Porac Diversion Canal)
2) CRIS: Caulaman River Irrigation System (include new area commanded by Caulaman Diversion Canal)
3) GRIS: Gumain River Irrigation System
4) Figures in ( ) indicate the length of existing canal or the number of existing structure

Table 7.17 PRESENT FLOW CAPACITY OF NATURAL DRAINAGE CANALS

River or Creek	Section	Station/1 (km)	Present Flow Capacity (m^3/sec)	Design Discharge (m^3/sec)
1. Guagua River	1	3.25	85.8	7.0
	2	1.50	48.9	8.9
	3	0	51.1	10.1
2. Porac River (old)	1	4.25	158.1	9.3
	2	2.40	16.4	16.8
	3	0	8.5	18.2
3. Pokaranan Creek	1	2.5	41.5	13.6
	2	0.75	58.1	15.5
	3	-1.0	27.1	24.4
4. Lauc Pao Creek	1	2.6	295.4	5.2
	2	0.5	116.6	7.5
	3	-1.4	21.3	11.3
5. Caulaman River	1	6.2	206.9	171.1
	2	4.2	526.4	175.2
	3	2.0	233.6	224.5
	4	0	258.3	228.2
	5	-1.75	95.9	230.3

Remarks: /1: Distance from National Highway No.7

Table 7.18 GENERAL FEATURES OF NATURAL DRAINAGE CANALS

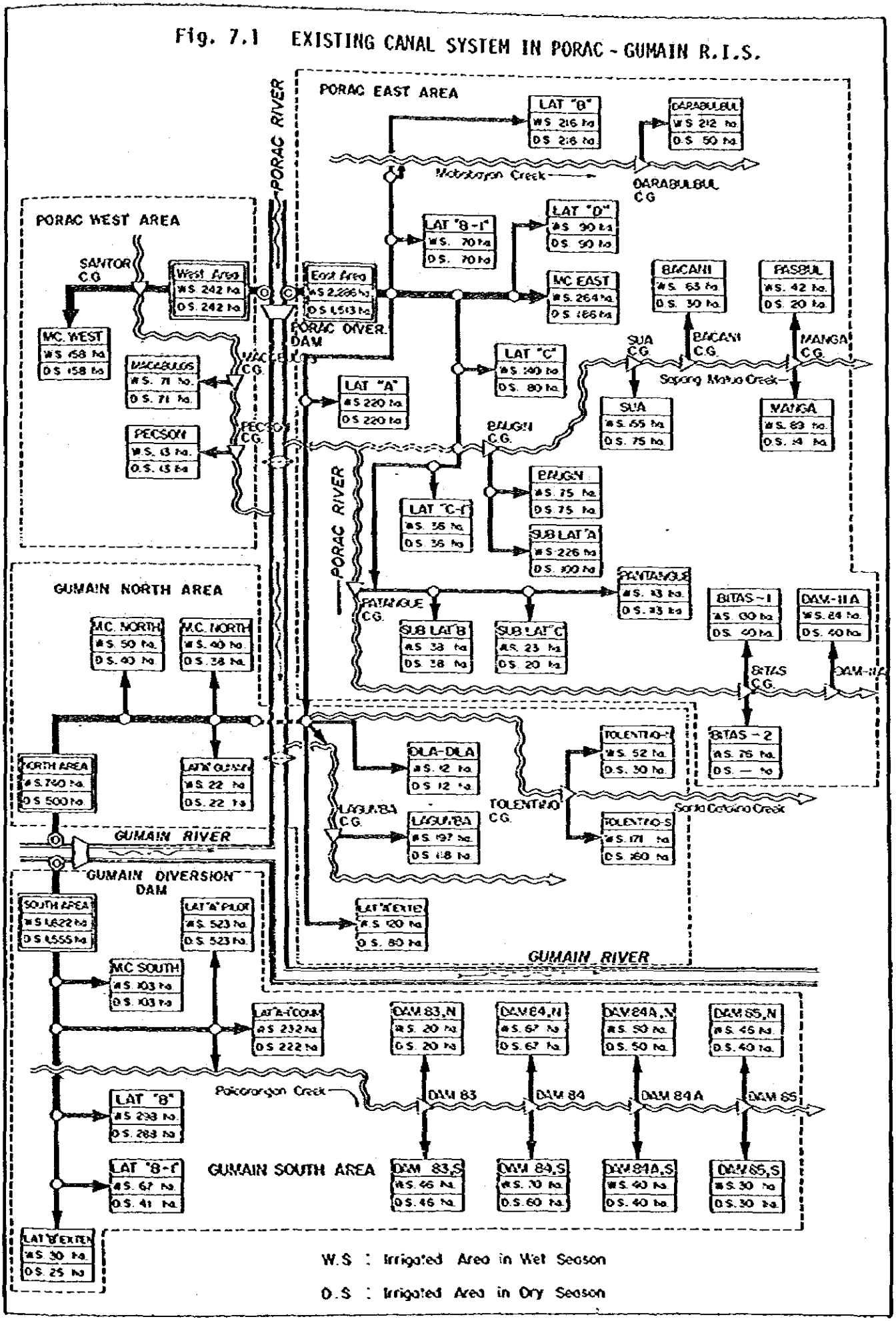
River or Creek	Length/1 (km)	Catchment Area (ha) Paddy Field	Hilly Land	Total	Design Discharge (m^3/s)	Number of Structure required Rehabilitation Works Bridge	Culvert
I) Porac River Irrigation System							
1. Guagua River	7.8	1,190	1,950	3,140	57.6	1	1
2. San Antonio River	9.7	810	220	1,030	14.3	1	-
3. Santa Monica Creek	4.8	440	150	690	8.4	-	1
4. Santa Tomas Creek	3.0	260	200	460	7.5	-	1
5. Lubao Creek	5.7	320	60	380	5.0	-	-
6. Porac River (Old)	10.8	560	530	1,090	18.4	1	-
7. Santa Catalina River	7.7	940	220	1,160	15.8	1	-
8. Santa Maria Creek	2.3	660	130	790	10.5	-	1
9. Cabangcalan Creek	5.4	450	100	550	7.4	-	1
10. Florida Blanca	7.6	320	520	840	15.4	-	-
(Sub-total)	(64.8)					(4)	(5)
II) Caulaman River Irrigation System							
1. Calmencita Creek	3.3	380	110	490	6.8	-	-
2. Saba Creek (Left)	5.0	150	630	780	15.9	-	1
3. Saba Creek (Right)	7.9	790	1,200	1,990	36.1	1	1
4. Caulaman River	22.4	960	10,000	10,960	236.0	1	1
(Sub-total)	(38.6)					(2)	(3)
III) Gumain River Irrigation System							
1. Mausu River	1.3	160	20	180	2.3	-	-
2. Palantacan Creek	2.8	180	20	200	2.5	-	-
3. Pokaranan Creek	10.0	1,680	350	2,030	27.2	2	3
4. Lauc Pao Creek	9.4	600	360	960	15.0	1	1
5. Maagua Creek	4.5	580	600	1,180	20.2	-	1
(Sub-total)	(28.0)					(3)	(5)
Total	131.4					9	13

Remarks: /1: Length within the proposed irrigation area

Table 7.19 GENERAL FEATURES OF COLLECTOR DRAIN

Collector Drain	Length (km)	Paddy Field	Hilly Land	Total	Design Discharge (m^3/s)	Confluence	Related Structures (Nos.) Bridge	Culvert
1) PRIS								
SD-P1	3.8	280	70	350	4.8	Guagua C.	1	1
P2	1.5	90	20	110	1.5	"	1	0
P3	2.5	150	30	180	2.4	Porac R.	0	2
P4	2.6	150	90	240	3.8	Santa Tomas C.	0	0
P5	3.5	10	150	160	3.5	Porac R. (old)	0	5
P6	3.0	260	70	330	4.6	Santa Catalina R.	0	0
P7	5.4	350	90	440	6.1	Santa Maria C.	0	3
P8	2.0	130	50	180	2.6	Cabangcalan C.	1	2
P9	4.3	0	150	150	3.4	"	1	8
P10	2.4	20	160	180	3.8	Gumain R.	1	4
(Sub-total)	(31.0)						(5)	(25)
2) CRIS								
SD-C1	5.8	190	240	430	7.6	Caulaman R.	0	3
C2	2.6	100	120	220	3.9	Soba C.	0	7
C3	2.8	180	120	300	4.8	Pokarana C.	0	3
C4	3.4	200	120	320	5.0	Soba C.	0	5
(Sub-total)	(14.6)							(15)
3) GRIS								
SD-G1	3.8	220	50	270	3.7	Pokaranan C.	1	0
G2	3.0	190	50	240	3.3	"	0	3
G3	2.5	210	50	260	3.5	"	0	1
G4	4.3	430	110	540	7.4	"	1	3
G5	5.6	300	340	640	11.1	Maagua C.	4	9
(Sub-total)	(19.2)						(6)	(16)
Total	64.8						11	56

Fig. 7.1 EXISTING CANAL SYSTEM IN PORAC - GUMAIN R.I.S.



W.S : Irrigated Area in Wet Season

O.S : Irrigated Area in Dry Season

Fig. 7.2 EXISTING CANAL SYSTEM IN CAULAMAN R.I.S.

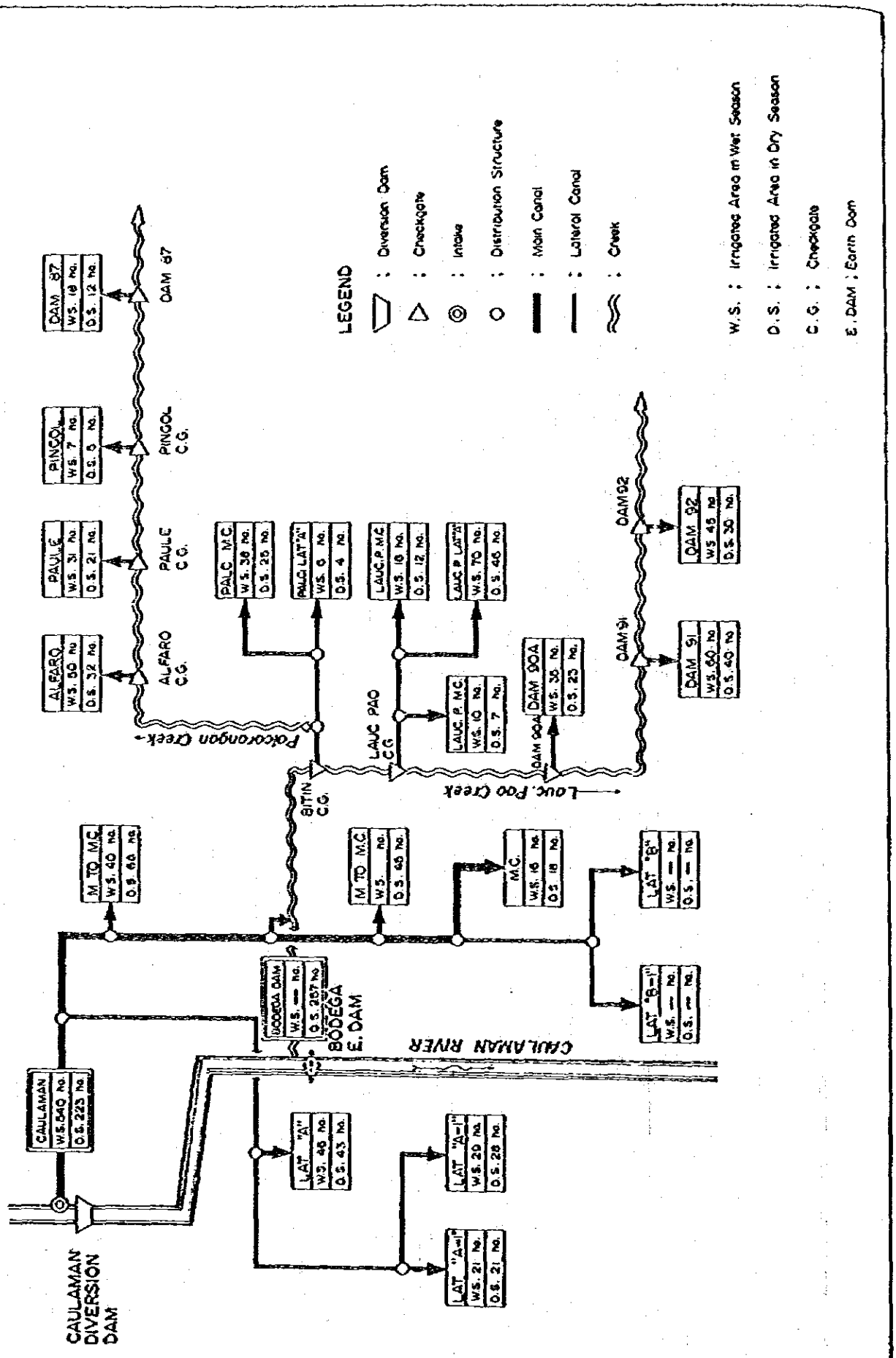


Fig. 7.3 CROP COEFFICIENT OF PADDY

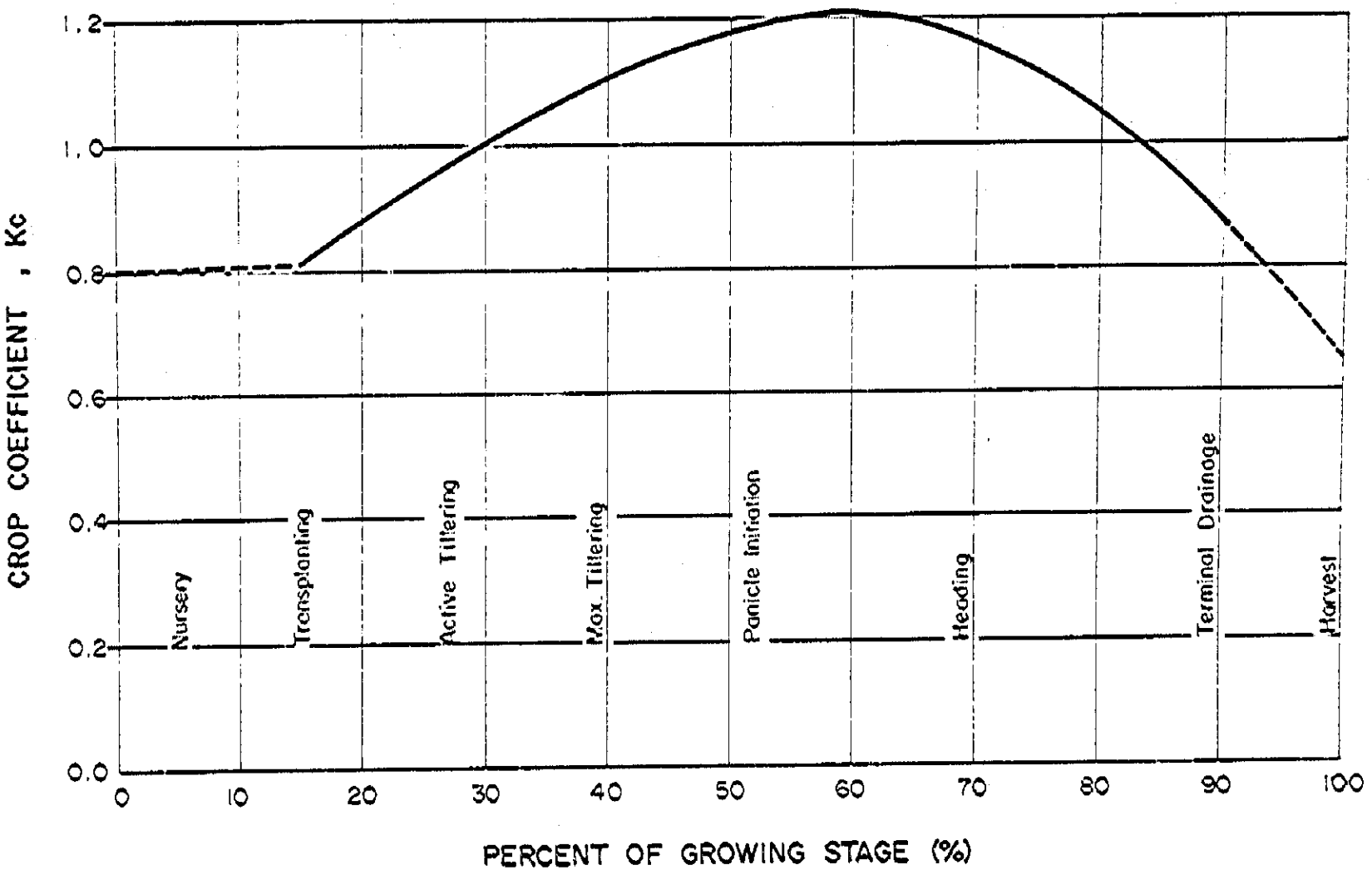


Fig. 7.4 CROP COEFFICIENT OF SUGARCANE

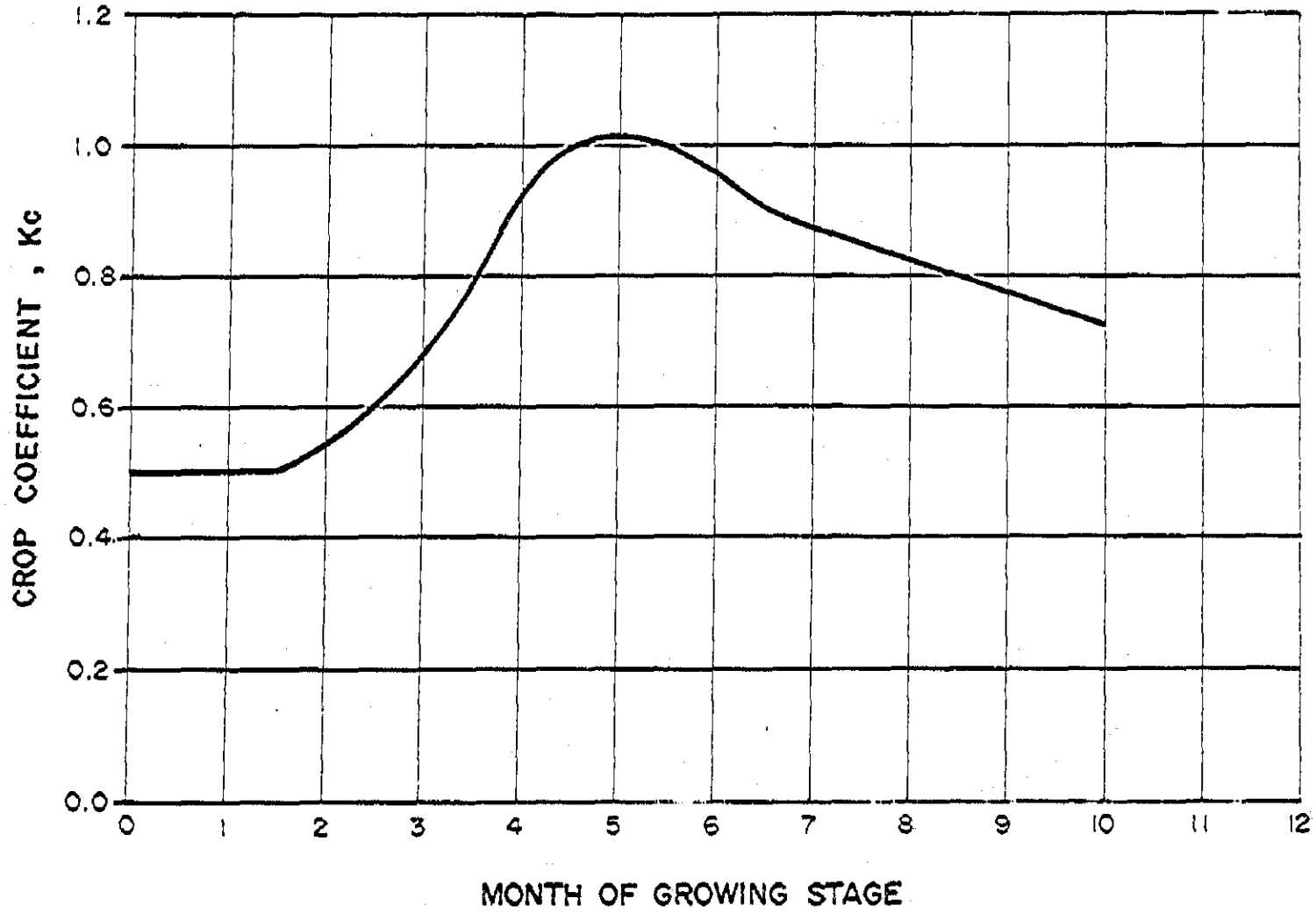


Fig. 7.5 CROP COEFFICIENT OF VEGETABLES

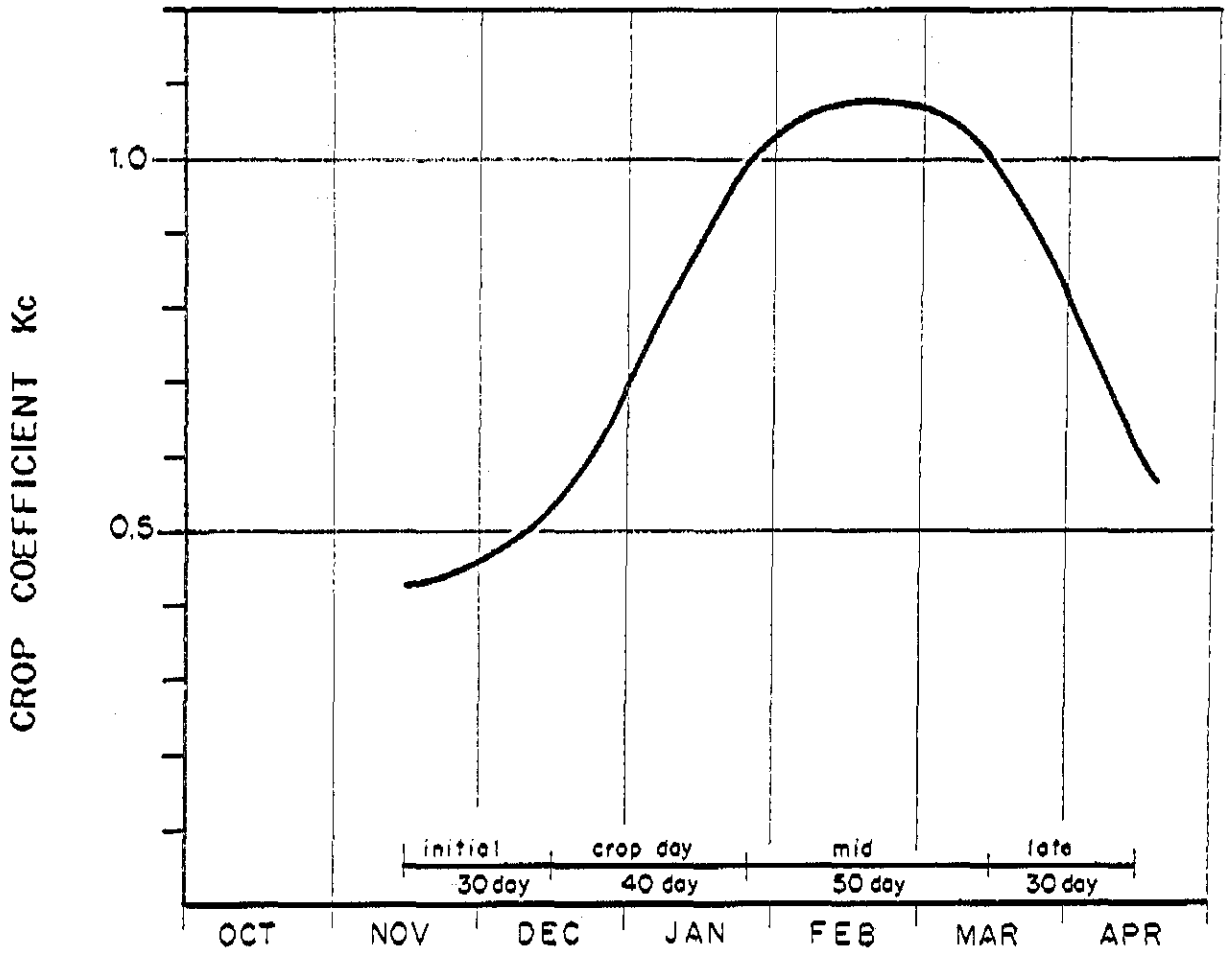
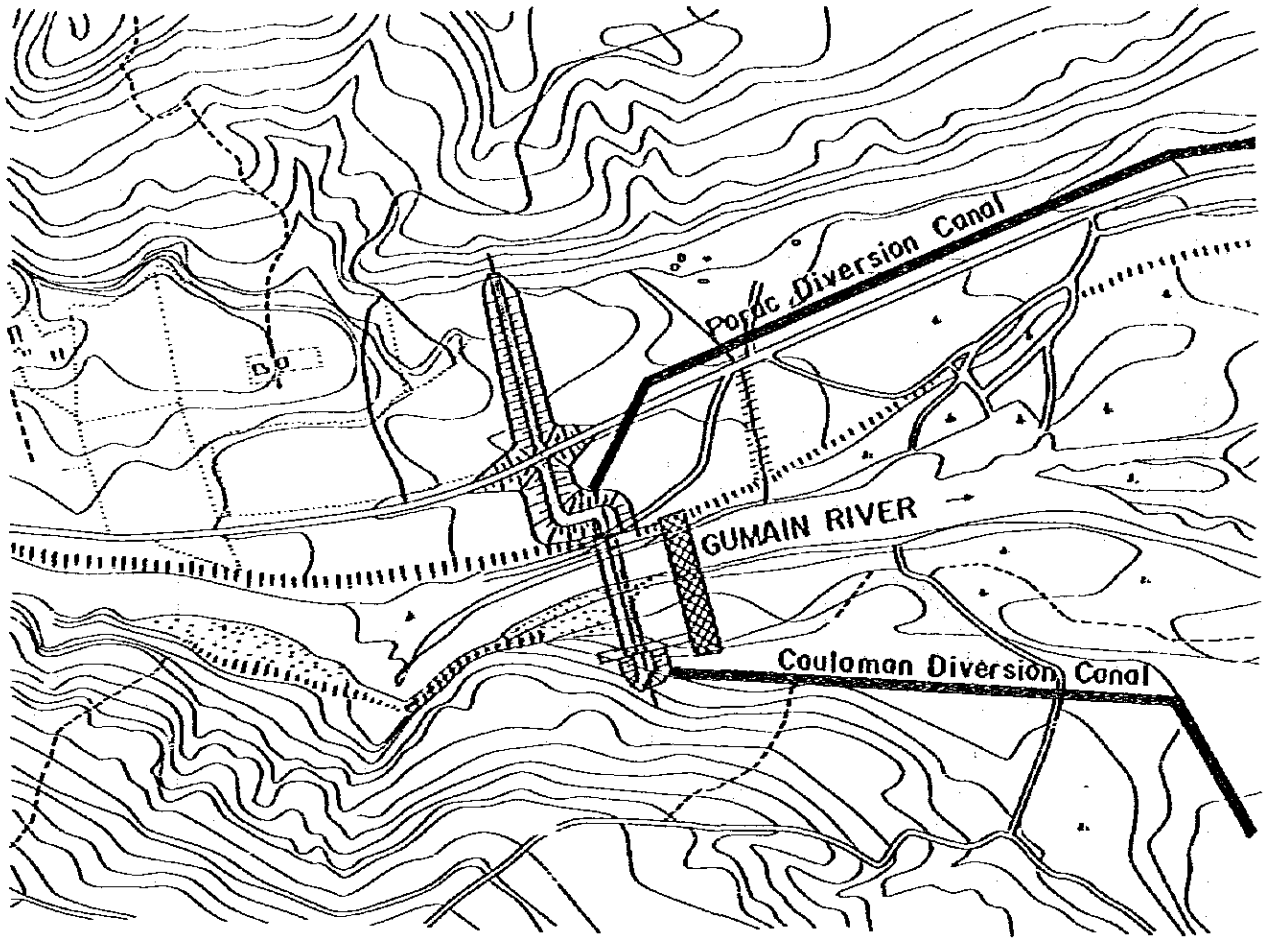


Fig. 7.6 (1) DIVERSION METHOD, ALTERNATIVE PLAN 1



GENERAL FEATURES

1. Design Flood; 2,000 m^3/sec (Return Period 100-year)
2. Flood Water Level; FWL 51.00 m
3. Dam Type; Ogee Type Dam
4. Crest Elevation; EL. 45.00 m
5. Crest Length; 80.00 m
6. Scouring Sluice;
   - Right Side 3.0 x 4.0 m
   - Left Side 4.0 x 4.0 m
7. Intake;
   - Right Bank 15x2.0 m x 6 Nos.
   - Left Bank 15x1.5 m x 4 Nos.
8. Dike Elevation; EL. 53.00 m
9. Dike Length; 270 m

Fig. 7.6 (2) DIVERSION METHOD ALTERNATIVE PLAN 2

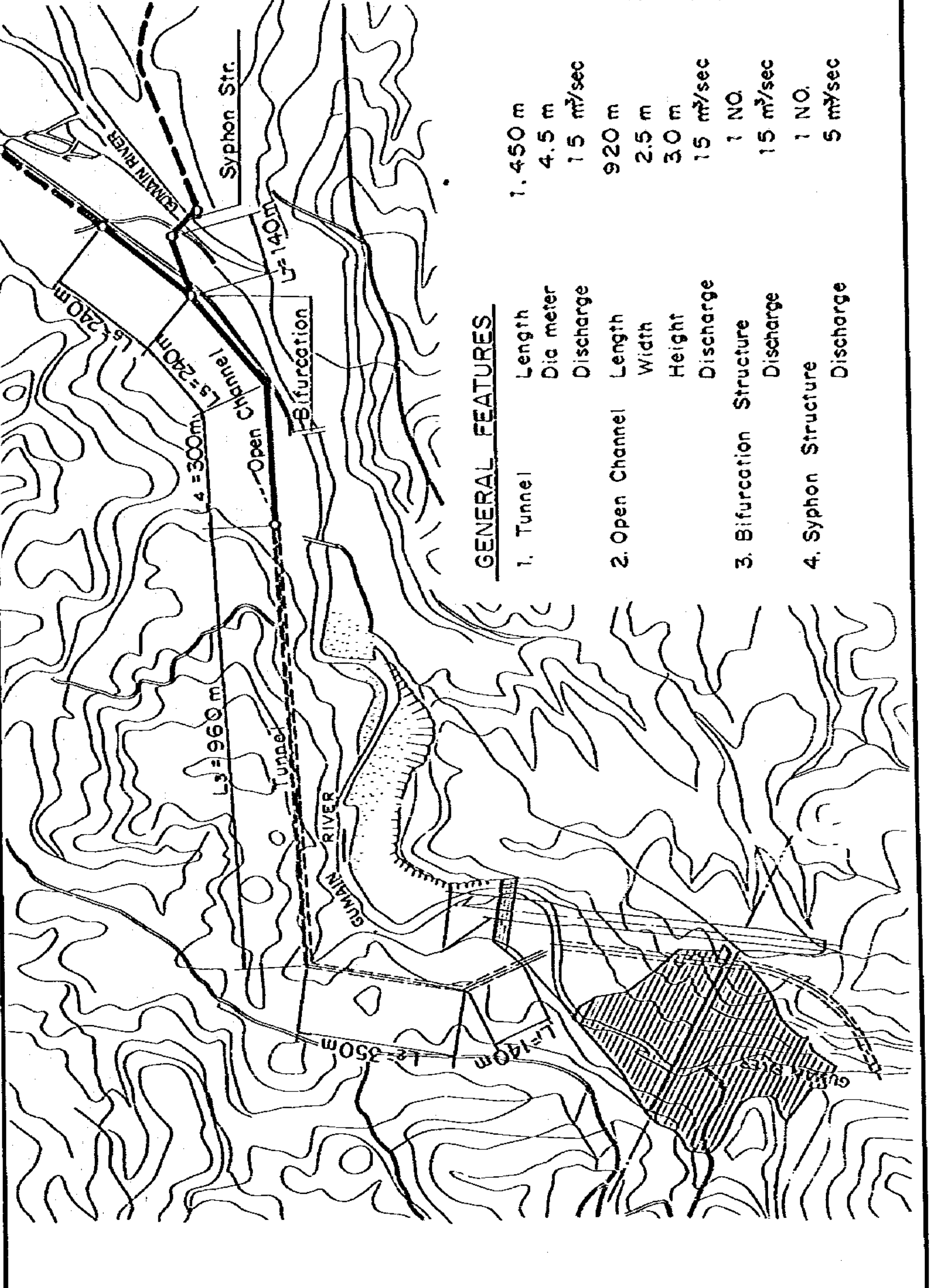


Fig. 7.7 IRRIGATION DIAGRAM FOR PROPOSED IRRIGATION SYSTEM

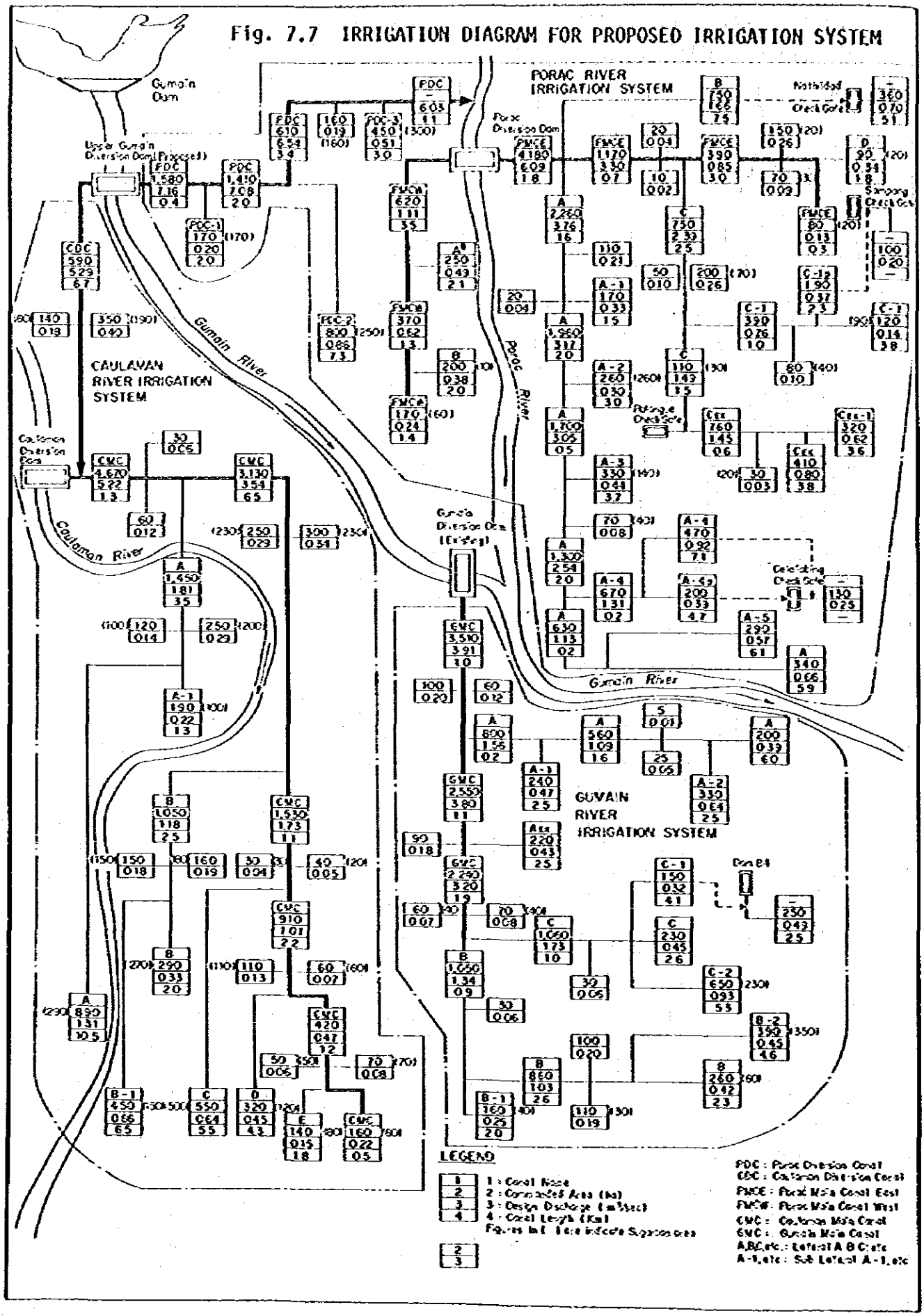


Fig.7-8 PROPOSED DRAINAGE SYSTEM

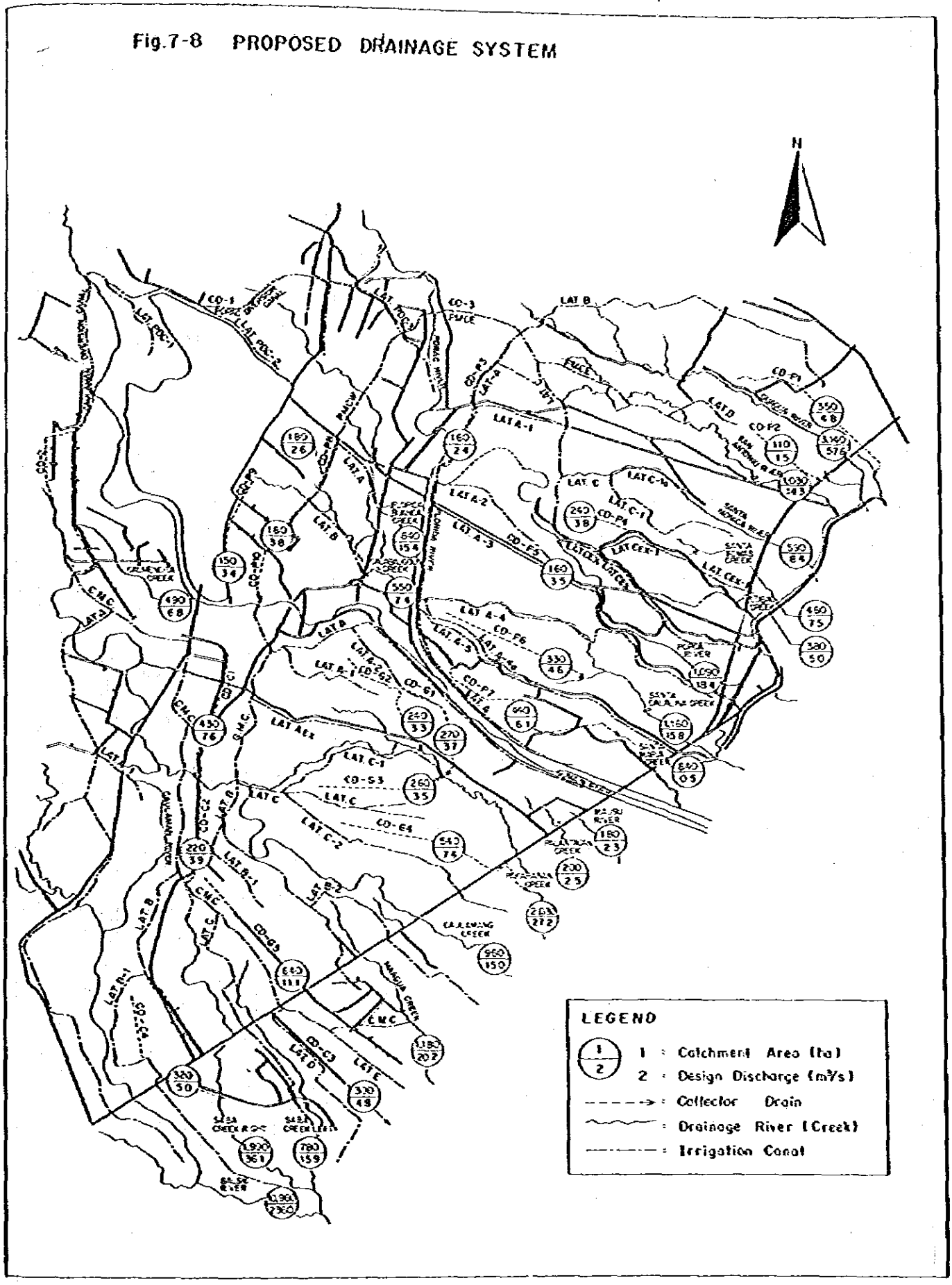
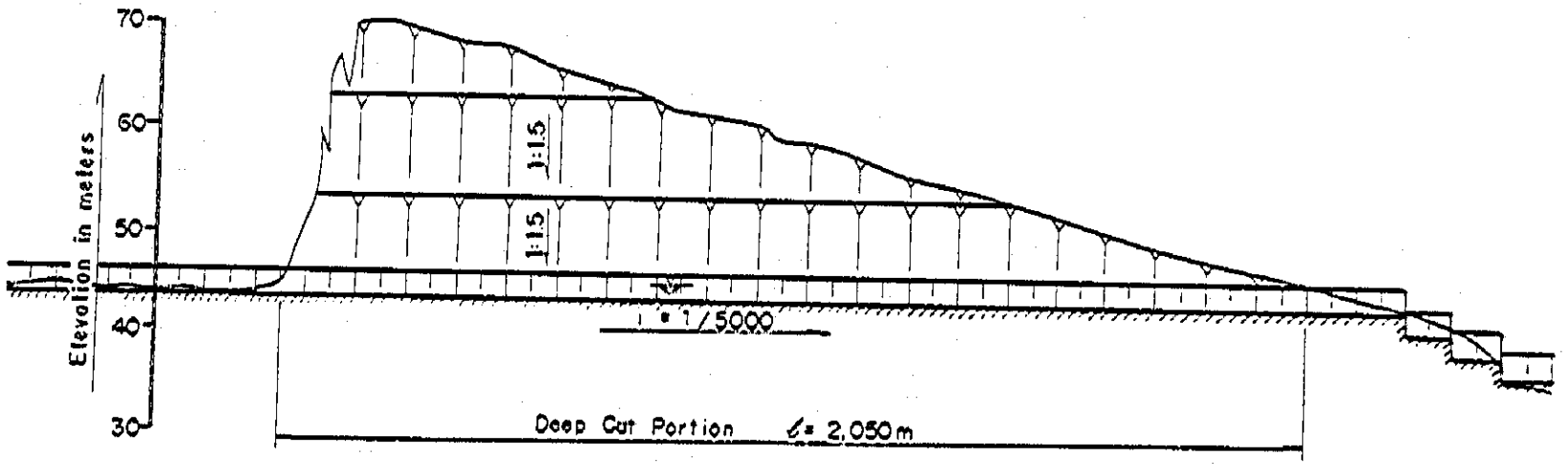
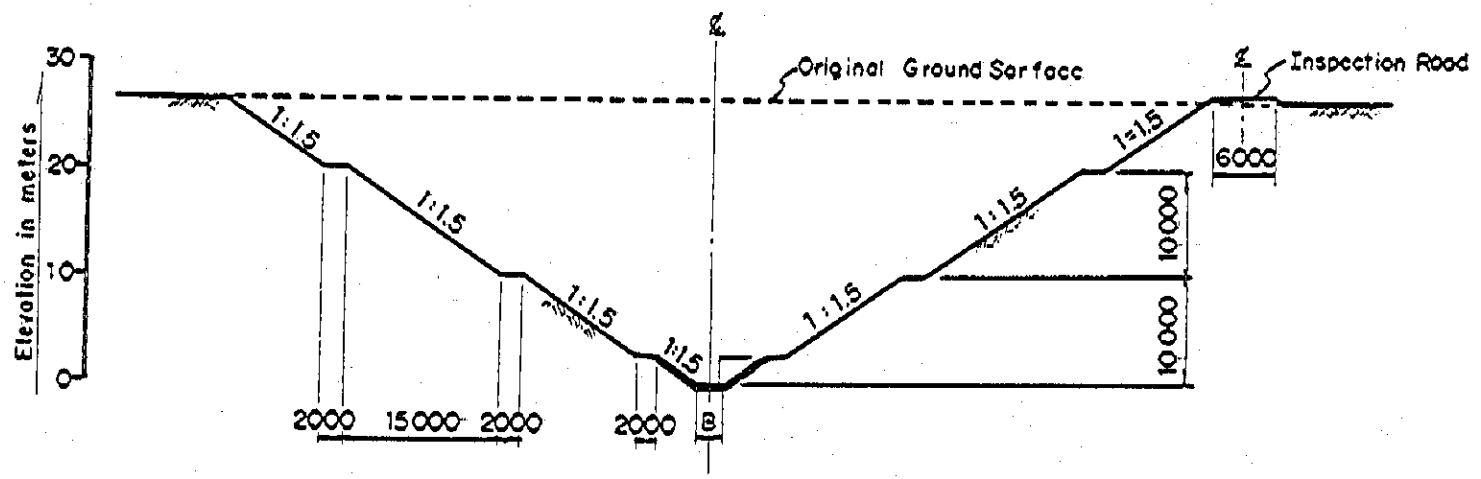


Fig. 7.9 (1) CONSTRUCTION METHOD FOR PORAC DIVERSION CANAL, PLAN-I

(Trapezoidal concrete lined channel)



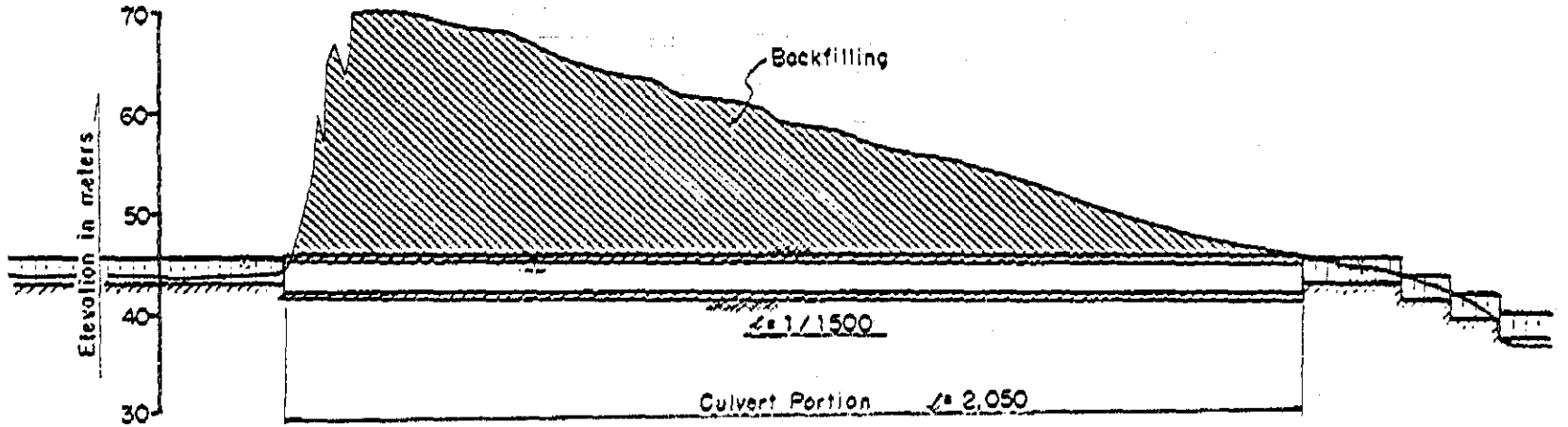
PROFILE



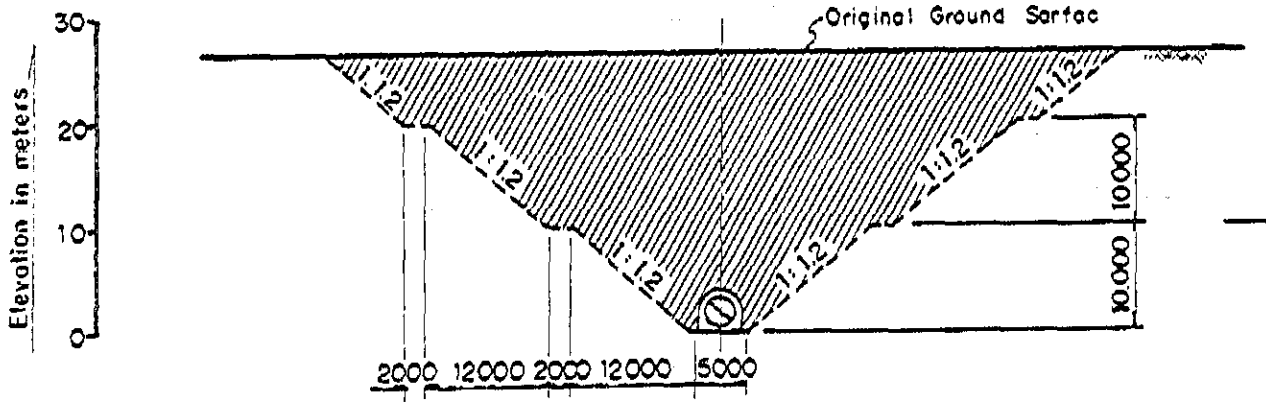
TYPICAL SECTION

Fig. 7.9 (2) CONSTRUCTION METHOD FOR PORAC DIVERSION CANAL, PLAN - 2

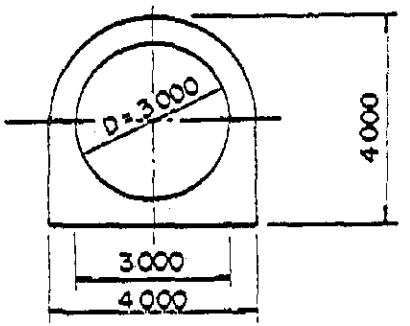
(Reinforced concrete barrel channel)



PROFILE



TYPICAL SECTION



BARRE SIZE

Fig. 7.10 TYPICAL FARM LAYOUT FOR PADDY FIELD

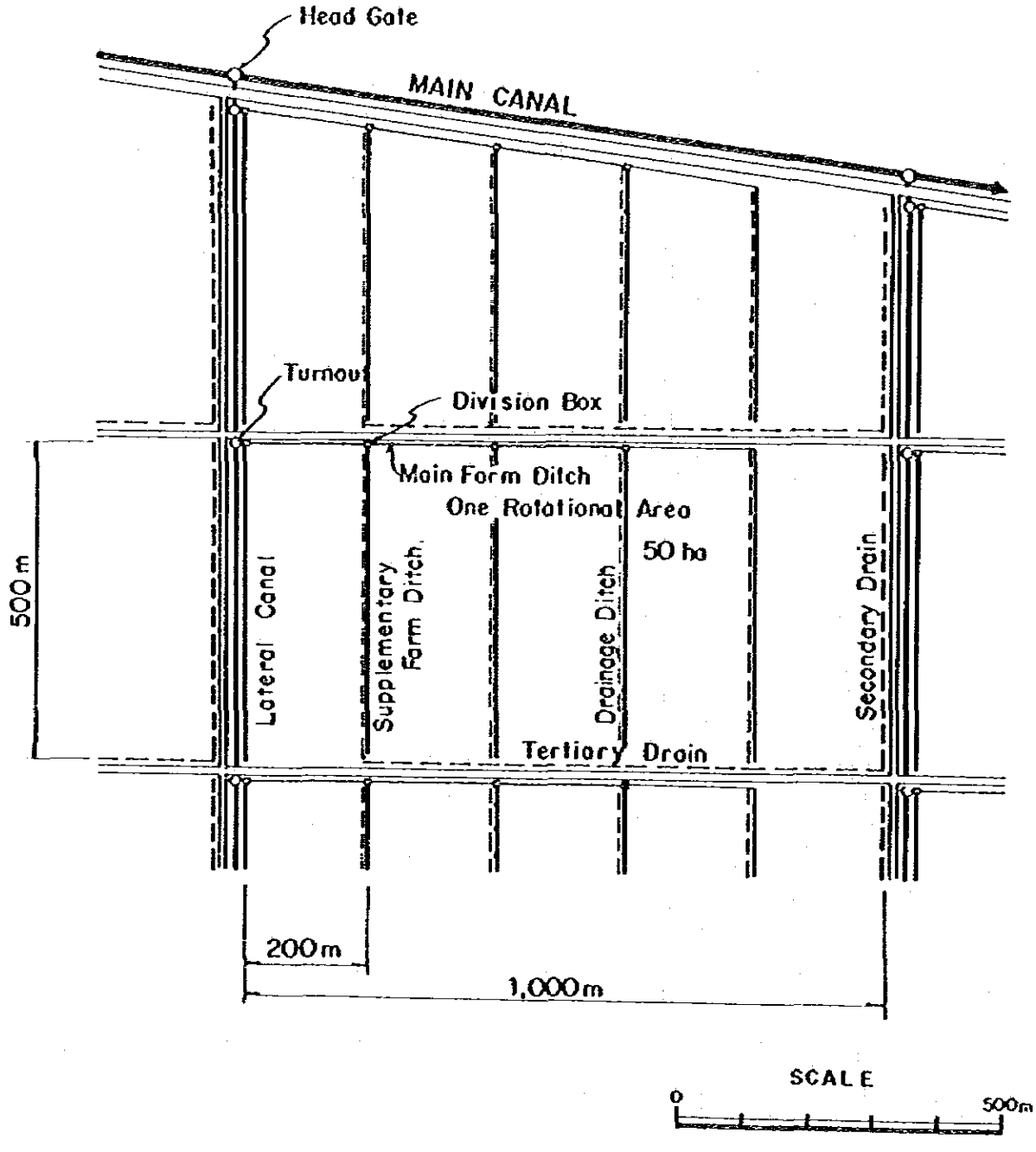
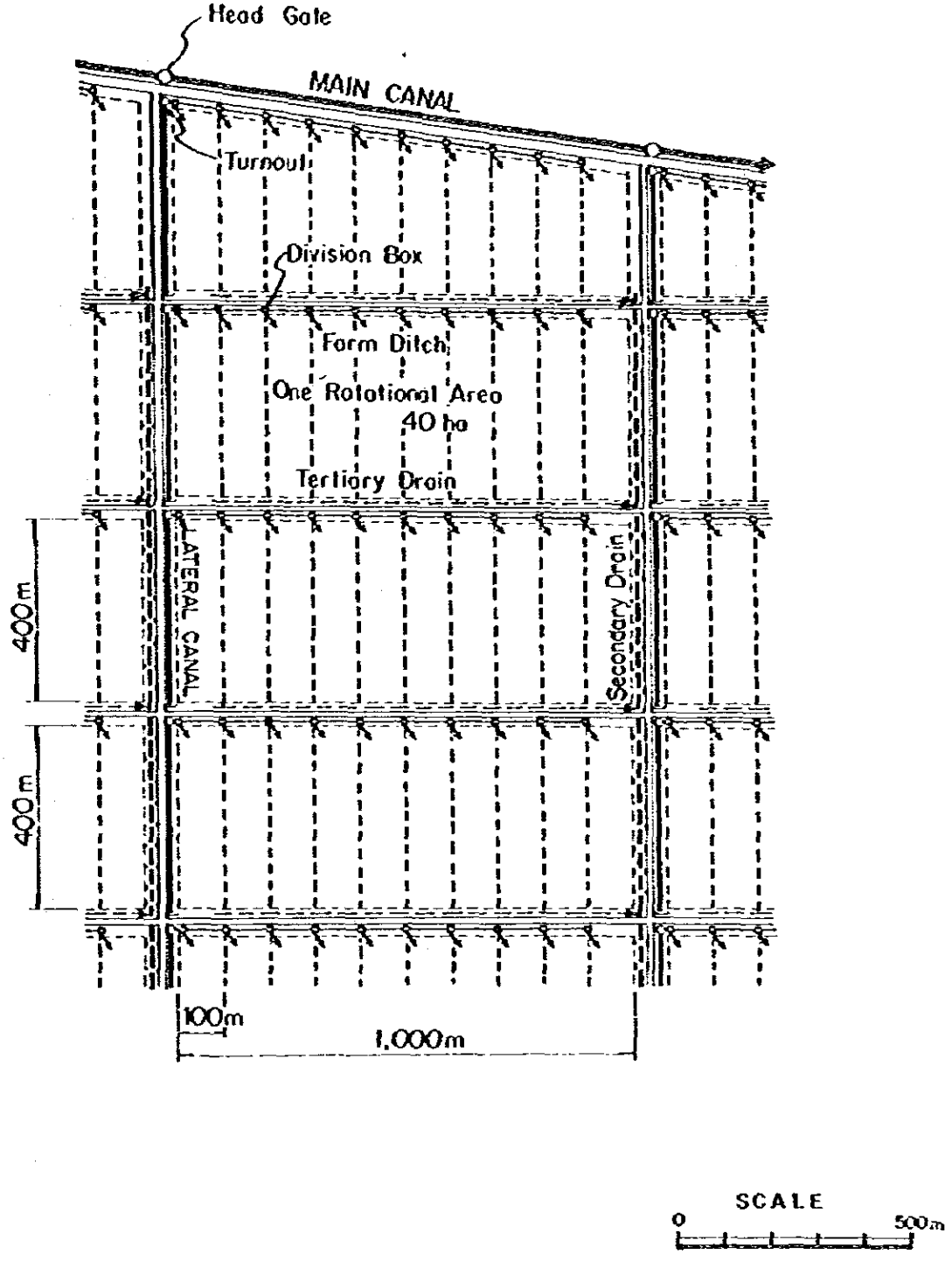


Fig. 7.11 TYPICAL FARM LAYOUT FOR SUGARCANE FIELD



APPENDIX VIII

HYDROPOWER

APPENDIX VIII HYDROPOWER

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CHAPTER 1 GENERAL

Effective use of indigenous resources for energy such as water and geothermal is one of the most important strategy in energy development of the Philippines.

The Gumain River Irrigation Project is primarily formulated for irrigation but would include construction of a storage dam of about 108m high and a reservoir with gross capacity of 110×10^6 m^3.

The hydropower scheme would aim at generating power by harnessing the head produced by dam construction and water released for irrigation. In this Appendix, the viability of such a hydropower scheme was examined. The hydropower scheme must not in any way hinder proposed irrigation scheme and the study was made only for the proposed optimum irrigation development plan.

CHAPTER 2 POWER SUPPLY AND DEMAND AROUND THE STUDY AREA

2.1 Present Condition

The area subject to electric power supply by the proposed Gumain power station is confined to the south-western part of Pampanga Province shown in Fig. 8.1 taking into account the present power supply system, scale of power demand and prospective installed capacity of Gumain power station.

The present power supply for the study area has been carried out by two organizations holding franchises under National Electrification Administration (NEA). One is Pampanga Electric Cooperative Inc. (PELCO II) in Guagua and the other is Mansons Corporation (MANSONS) in Floridablanca. Both own no generating plants and have been purchasing electric power from National Power Corporation (NPC) through Luzon Grid as shown in Fig. 8.2

PELCO II receives electric power through Guagua substation and is serving for 7 municipalities, that is, Guagua, Sexmoan, Lubao, Santa Rita, Porac, Bacolor and Mabalacat. Total number of barrios under the said municipalities is 169 and out of them 165 barrios have been energized as of 1983. The remaining 4 barrios will be served near future.

Table 8.1 presents histrical energy consumption record of PELCO II. The population receiving power supply service was estimated at about 407,000 as of 1983. Total energy consumption in 1983 reached to 43.7 GWh and peak power demand to 10.8 MW. Among consumptions classified by types, residential use occupied 72.7% of the total. Electrification rate of residential customers came to 83.5% in 1983. The average annual growth rate of energy consumption for the period from 1980 to 1983 shows considerably high value of 19.2%. Then, average power rate and energy loss rate are presented in Table 8.3 and 8.4 respectively. According to the tables, average power rates in 1983 were estimated at 0.60 pesos/kWh for energy purchased from NPC and 1.01 pesos/kWh for energy sold to consumers. Energy loss rate is over 30% for the total energy purchased.

On the other hand, MANSONS has been supplying electric power to a municipality of Floridablanca. As of 1983, 25 barrios were energized and 7 more barrious are scheduled to be served in the future. Historical energy consumption record of MANSONS is shown in Table 8.2 The population of service area was estimated at about 42,500 as of 1983. Total consumption in 1983 reached to 9.0 GWh and peak power demand to 2,650 kW. Out of total consumption, industrial demand occupied majority of 68.4% which almost came from demand of National Sugar Development Corporation (NASUDECO). While, the residential demand is only 25.5% of the total, however its proportion to total demand is gradually increasing with increase of population in the area. Electrification rate of residential customers was 73.0% as of 1983. Average annual growth rate of total energy consumption is 5.5%, which is rather lower than that of customer number of 9.6%. This is because NASUDECO still has a majority in energy consumption. Average power rate of MANSONS was estimated at 0.59 pesos/kWh for the energy purchased from NPC and 0.95 pesos/kWh for the energy sold as shown in Table 8.3 They are almost same as those of PELCO II. Energy loss rate was 24.9% on an average for recent 4 years as seen in Table 8.4.

Consequently, the present power demand of the study area is 13.5 MW in peak power and 52.8 GWh in energy, which may be larger enough than output of the proposed Gumain power station that is roughly estimated at 25 to 30 GWh based on the irrigation water release from the reservoir.

2.2 Demand Forecast

On the future power demand of the study area, it is forecasted based on the historical energy consumption records of PELCO II and MANSONS, and projection of population in the area.
Table 8.5 gives the forecasted power demand of the supply area which covers 8 municipalities listed before served by PELCO II and MANSONS. According to the result, power demand of the said area in 1993 was estimated at about 203 GWh in Energy and 46 MW in peak power.

CHAPTER 3 THE SCHEME

3.1 Basic Layout of Facilities

Fig. 8.3 shows the basic layout of facilities for power generation. According to the preliminary design for the main dam and appurtenant structures, one large diversion tunnel would be constructed on the right bank of the river and this would also be used as an irrigation water release facility.

Power generation facilities would be arranged to be compatible with this design and to minimize the construction cost. The power station would be sited at outlet of diversion tunnel on the right bank of the river to use the tunnel as a waterway, as well as topographic and geological conditions. For the waterway, the following three plans conceivable were studied and the most economical one was selected. The schematic diagram of each plan is illustrated in Fig. 8.4.

Plan A: Construction of exclusive waterway with surge tank

Plan B: Use of diversion tunnel and provision of surge tank

Plan C: Penstock only

They were compared from the viewpoints of cost and benefit as shown in Table 8.6 and Plan C was selected as the best one.

Then, power generated by Gumain power station would be conveyed to the existing Basa substation to connect with NPC's Luzon grid. For this purpose the Basa substation would have to be extended.

3.2 Selection of Optimum Installed Capacity

3.2.1 Methodology

As stated before, Gumain Project would be developed primarily for irrigation and therefore water use in the present power scheme would be strictly constrained by the irrigation water requirement. In this study, only water released for irrigation and/or spilled would be available for power generation and no special releases for power would be made.

The optimum installed capacity was selected to give the maximum net benefit. However, the unit construction cost per kWh is also an important index for selection of optimum scale for a power scheme such as the Gumain Project which cannot provide a firm power output due to preferential water use for irrigation and of which the power benefit can only be assessed in terms of energy output. Such optimum installed capacity is found through comparative study.

3.2.2 Criteria

For the comparison study, the following technical and economic criteria were applied.

(1) Reservoir Water Level

Applying the proposed irrigation plan, reservoir water level conditions were set as below:

F.W.L.	El. 153.5 m
L.W.L.	El. 100.0 m

Tail water level for power was set at El. 60 m taking into account the elevation of river bed.

In view of the range of available head and discharge, a horizontal shaft Francis turbine would be the most appropriate. This would have the following operating constraints to avoid unfavourable behavior of turbine in operating such as cavitation.

a) Allowable range of head, 65% to 125% of design head

b) Allowable minimum turbine discharge, 40% of rated turbine discharge

To meet the above requirements, minimum reservoir water level, which is defined as the water level below which operation of the power station should be stopped, was set at El. 108.6 m. From this the rated water level was set at El. 131.1 m, which was the mid-point of drawdown for power generation.

(2) Operation Mode

Since there is no regulating capacity for daily operation at the proposed Gumain diversion dam site, peaking operation is not possible and firm operation following irrigation water release was adopted. From consideration of water levels, the following operation mode was applied.

For reservoir water level above rated water level, the rated power output (= installed capacity) would be secured whenever irrigation water requirements exceed the required turbine discharge. Conversely whenever the reservoir water level is below the rated water level, the rated power output would no longer be secured.

The number of units to be installed was taken as two, in view of the wide variation in turbine discharge, economics and risk dispersion.

(3) Available Water for Power Generation

As mentioned before, the available water for power generation would be irrigation water released and water spilled out from reservoir. No extra water release for power would be allowed.

(4) Power Output and Energy Output Computation

The power and energy output were computed by the following equations:

$$P = 9.8 \times \eta \times He \times Q \quad \cdots\cdots\cdots\cdots \quad (8.1)$$

$$E = P \times T \quad \cdots\cdots\cdots\cdots \quad (8.2)$$

where, P: Power output (kW)
η: Combined efficiency (= 0.8)
He: Effective head (m)
Q: Turbine discharge (m^3/sec)
E: Energy output (kWh)
T: Operation time (= 24 hours)

(5) Effective Head and Turbine Discharge

The effective head is given by subtracting loss head from the gross head. In this study, the loss head was assumed to be 5% of gross head for rated head applying the empirical economic waterway flow velocity of 3 to 4 m/sec and it varies depending on head and turbine discharge, that is, the loss head and turbine discharge for a certain reservoir water level were determined so as to meet the following equations:

$$He = 0.05 \times H_R \times \left(\frac{Q}{Q_R}\right)^2 \quad \cdots\cdots\cdots\cdots \quad (8.3)$$

$$Q = \sqrt{\frac{H}{H_R}}\, Q_R \quad (H \leq H_R) \quad \cdots\cdots\cdots\cdots \quad (8.4)$$

$$Q = P_R/(9.8 \times \eta \times (H - He)) \quad (H > H_R) \quad \cdots\cdots\cdots \quad (8.5)$$

where, He: Head loss (m)
H_R: Rated head (m)
Q: Turbine discharge (m^3/sec)
Q_R: Rated turbine discharge (m^3/sec)
H: Head for a certain reservoir water level (m)
P_R: Rated output (= Installed capacity) (kW)

(6) Cost Estimate

The direct construction cost of the power generation facilities was estimated from the estimated work quantities and unit construction cost investigated as of March 1984.

Engineering costs and administration costs were assumed to be 10% of direct construction cost. Physical contingency was taken as 10% of the sum of direct construction cost plus engineering costs and administration costs. Also, operation and maintenance cost was assumed to be 2.5% of direct construction cost.

For computation of annual costs, a discount rate of 10% and life time of 40 years are applied.

(7) Power Benefit

The installed capacity of Gumain power station would be less than 10 MW and as such would be implemented by NEA according to the governmental regulations. In case of NEA's developments, power supply is usually made by construction of diesel power plants or energy purchases from NPC. The service area of Gumain power station already receives a power supply through NPC's Luzon grid. Also as Gumain power station has no firm output to be evaluated due to the reasons mentioned before and as only energy produces benefits, the power value to assess power benefit is represented by cheaper cost as between the fuel cost of diesel plant and the energy purchase cost from PELCO II and MANSONS. The said purchase cost was estimated to be 0.6 P/kWh (= 0.0429 US$/kWh) at the price level of early 1984 based on the sales records. While, the fuel cost of diesel plant was estimated as follows:

Diesel oil price	:	0.32 US$/ℓ
Fuel consumption rate	:	0.28 ℓ/kWh
Fuel cost	:	0.0896 US$/kWh

Fuel cost of diesel plant is more expensive than NPC's sales price, so a power value of 0.0429 US$/kWh was adopted for the present study.

3.2.3 Optimum Installed Capacity

Based on the methodology and criteria mentioned above, a comparative study was made for the following 6 cases of installed capacity:

Case No.	Installed Capacity (kW)
1	8,000
2	7,000
3	6.000
4	5,000
5	4,000
6	3,000

The results are presented in Table 8.7 to 8.8 and summarized in Fig. 8.5 and below.

Case No.	Installed Capacity (kW)	Annual Net Benefit (10^3 US$)	Unit Construction Cost (US$/kWh)
1	8,000	99	0.305
2	7,000	143	0.292
3	6,000	154	0.286
4	5,000	139	0.285
5	4,000	103	0.291
6	3,000	56	0.304

As seen in the above table, Case 3 gives the maximum net benefit and also its unit construction cost is almost same as the lowest one of Case 4. Therefore, the installed capacity of 6,000 kW (3,000 kW x 2) was selected as an optimum one, and in this case, the annual energy output was estimated to be 27.3 GWh. The internal rate of return (IRR) for this case of development was calculated at 10.6%.

3.3 Further Consideration

(1) Water Use Mode

As explained above, the water use mode in the present study was completely governed by irrigation water requirement and no unconstrained water use was allowed for power scheme. However, modification of the water use mode by introducing the power scheme should be taken into consideration if the variation of irrigation water deficit rate is negligibly and also if any firm power output can be secured or if energy output increase can be expected.

Accordingly, additional computation was made for the condition that at least one of the two units would be operated regardless of irrigation water requirement when reservoir water level is above rated water level. The result is presented in Table 8.9 and summarized hereunder.

Water Use Mode	Energy Output (GWh)	Deficit Rate (%)
Original Mode	27.3	6.82
Modified	28.0	10.65

As seen in the above table, the increase in energy output is small compared with the variation of irrigation water deficit rate which cannot be ignored, consequently it was concluded that the modification of the water use mode would not be necessarily contributable to the project.

To secure firm power is not practicable because the drawdown of reservoir exceeds the allowable range of head for the turbine. Only possibility would be to change a runner depending on the reservoir water level, but this also would not be practicable due to difficulty of operation and maintenance.

(2) Power Benefit

In this study, the power benefit was assessed from the purchase power rate of PELCO II and MANSONS after comparison with the fuel cost of diesel plant for the reason that Gumain power development would be implemented by NEA. However, if the power supply for the subject area is assumed to be carried out by NPC, the power benefit of Gumain power station should be assessed by saving in the fuel cost of thermal plant in the Luzon Grid. In that case, power value may be estimated as follows:

Type of plant	:	Coal-fired thermal
Fuel cost	:	62 US$/t
Heat value	:	11,540 BTU/Lb
Thermal efficiency	:	37%
Adjustment factor	:	1.084
kWh-value	:	0.0243 US$/kWh

The above kWh-value is much lower than power value of 0.0429 US$/kWh applied to the study. If 0.0243 US$/kWh is applied to power benefit estimation, the proposed power scheme becomes unfeasible unless some countermeasures to secure firm power is taken to increase the power value.

Table 8.1 HISTORICAL ENERGY CONSUMPTION OF PAMPANGA II ELECTRIC COOPERATIVE INC., GUAGUA

Classification		1980	1981	1982	1983	Average Annual Growth Rate (%)
(1) Residential						
(a) Population		375,821	386,000	396,400	407,100	2.7
(b) Nos. of household		60,984	62,630	64,320	66,060	2.7
(c) Nos. of customers		38,217	48,931	52,932	55,183	13.0
Ratio to (b)	(%)	62.7	78.1	82.3	83.5	-
(d) Energy consumption	(MWh)	18,526(71.9)	22,121(74.4)	25,188(74.2)	31,777(72.7)	19.7
(e) Unit consumption	(kWh)	485	452	476	576	5.9
(2) Commercial						
(a) Nos. of customers		1,376	1,425	1,638	1,606	5.3
Ratio to (1)	(%)	3.6	2.9	3.1	2.9	-
(b) Energy consumption	(MWh)	3,430	4,051	4,180	4,488	9.4
(c) Unit consumption	(kWh)	2,493(13.3)	2,843(9.6)	2,552(7.5)	2,795(6.3)	3.9
(3) Industrial						
(a) Nos. of customers		42	36	62	67	16.8
(b) Energy consumption	(MWh)	3,034(11.8)	2,604(8.8)	3,095(9.1)	5,122(11.7)	19.1
(4) Others						
(a) Nos. of customers		431	731	896	772	21.4
(b) Energy consumption	(MWh)	792(3.0)	971(3.2)	1,471(4.2)	2,321(5.3)	43.1
Ratio to (1) + (2)		3.6	3.7	5.0	6.4	-
(5) Total						
(a) Nos. of customers		40,066	51,123	55,528	57,628	12.9
(b) Energy consumption	(MWh)	25,782(100.0)	29,747(100.0)	33,934(100.0)	43,708(100.0)	19.2

Remarks: Population and Nos. of Household are estimated based on 1980 National Census and Projection Population by National Economic and Development Authority.

Table 8.2 HISTORICAL ENERGY CONSUMPTION OF MANSONS CORPORATION, FLORIDABLANCA

Classification		1980	1981	1982	1983	Average Annual Growth Rate (%)
(1) Residential						
(a) Population		39,389	40,400	41,400	42,500	2.5
(b) Nos. of household		6,259	6,420	6,580	6,740	2.5
(c) Nos. of customers		3,577	4,095	4,544	4,918	11.2
Ratio to (b)	(%)	57.1	63.8	69.1	73.0	-
(d) Energy consumption	(MWh)	1,383(18.1)	1,708(22.1)	2,054(23.7)	2,293(25.5)	18.4
(e) Unit consumption	(kWh)	387	417	452	466	6.4
(2) Commercial						
(a) Nos. of customers		329	342	329	281	-5.4
Ratio to (1)	(%)	9.2	8.4	7.2	5.7	-
(b) Energy consumption	(MWh)	289(3.7)	302(3.9)	342(3.9)	388(4.3)	11.5
(c) Unit consumption	(kWh)	851	883	1,040	1,381	17.5
(3) Industrial						
(a) Nos. of customers		17	20	21	19	3.8
(b) Energy consumption	(MWh)	5,778(75.5)	5,563(72.0)	6,122(70.7)	6,144(68.4)	2.1
(4) Others						
(a) Nos. of customers		263	260	253	287	3.0
(b) Energy consumption	(MWh)	207(2.7)	153(2.0)	145(1.7)	155(1.8)	-10.1
Ratio to (1) + (2)		6.7	5.9	5.2	5.5	-
(5) Total						
(a) Nos. of customers		4,186	4,717	5,147	5,505	9.6
(b) Energy consumption	(MWh)	7,648(100.0)	7,726(100.0)	8,663(100.0)	8,980(100.0)	5.5

Remarks: Population and Nos. of Household are estimated based on 1980 National Census and Projection Population by National Economic and Development Authority.

Table 8.3 AVERAGE POWER RATE

A. Mansons Corporation, Floridablanca

Year	Energy purchased from NPC			Energy Sold		
	Purchase (MWh)	Payment (₱ 10³)	Average Rate (₱/kWh)	Sales (MWh)	Revenue (₱ 10³)	Average Rate (₱/kWh)
1980	9,502	3,278	0.34	7,648	4,527	0.59
1981	10,299	4,386	0.43	7,726	5,376	0.70
1982	11,574	5,327	0.46	8,664	6,678	0.77
1983	12,603	7,441	0.59	8,981	8,570	0.95
			(20%)			(17%)

B. Pampanga Electric Corporative - II, Guagua

Year	Energy purchased from NPC			Energy Sold		
	Purchase (MWh)	Payment (₱ 10³)	Average Rate (₱/kWh)	Sales (MWh)	Revenue (₱ 10³)	Average Rate (₱/kWh)
1980	33,228	11,298	0.34	25,782	17,410	0.68
1981	40,210	16,953	0.42	29,747	22,510	0.76
1982	54,575	24,501	0.49	33,934	29,895	0.88
1983	64,147	38,176	0.60	43,708	44,220	1.01
			(20%)			(14%)

Remarks: Percentage values in parentheses shows average annual escalation rate.

Table 8.4 ENERGY LOSS RATE

A. Mansons Corporation, Floridablanca

Year	Energy Purchased (MWh)	Energy Sold (MWh)	Loss Rate (MWh)	Loss Rate (%)
1980	9,501	7,648	1,853	19.5
1981	10,298	7,726	2,572	25.0
1982	11,573	8,667	2,906	25.1
1983	12,602	8,980	3,622	28.7
Total	43,974	33,021	10,953	24.9

B. Pampanga II Electric Corporative, Inc., Guagua

Year	Energy Purchased (MWh)	Energy Sold (MWh)	Loss Rate (MWh)	Loss Rate (%)
1980	37,934	25,782	12,152	32.0
1981	40,586	29,746	10,840	26.7
1982	54,575	33,934	20,641	37.8
1983	64,146	43,707	20,436	31.9
Total	197,241	133,169	64,072	32.5

Table 8.5 POWER DEMAND FORECAST

Classification / Year	1983	1993	Remarks
(1) Residential			
(a) Population	449,600	603,100	
(b) Nos. of households	72,800	120,620	
(c) Nos. of Customers	60,101	120,620	
(d) Electrification rate	0.83	1.00	(c)/(b)
(e) Energy consumption (MWh)	34,070	120,600	13% growth
(f) Unit consumption (kWh)	567	1,000	6% growth
(2) Commercial			
(g) Nos. of customers	1,887	3,600	
(h) Ratio to (1)	0.03	0.03	(g)/(c)
(i) Energy consumption (MWh)	4,876	13,680	11% growth
(j) Unit consumption (kWh)	2,584	3,800	4% growth
(3) Industrial			
(k) Energy consumption	11,266	29,200	10% growth
(4) Others			
(l) Energy consumption	2,476	5,400	8% growth
(m) Ratio to (1) + (2)	0.04	0.04	(l)/{(e)+(i)}
Total energy consumption	52,688	168,900	12% growth

Energy demand; 168,900 x 1.20 = 202,700 MWh
(20% loss)

Power demand ; 202,700/(8,760 x 0.5) = 46 MW
(plant factor 0.5)

Remarks: Population includes that of area to be energized in the future.

Table 8.6 COMPARISON OF ALTERNATIVE WATERWAY PLANS

(Unit: 10^3 US$)

Item	Plan A	Plan B	Plan C (Adopted)
1. Construction			
(1) Intake	420	-	-
(2) Headrace tunnel	1,170	-	-
(3) Surge tank	330	3,630	-
(4) Penstock	610	390	1,270
Total	2,530	4,020	1,270
2. Cost difference for Plan C	1,260	2,750	0
3. Annual cost of item 2	129	281	0
4. Annual energy difference Plan C	0	1.4GWh/2	0
5. Annual energy benefit of item 4	0	60/3	0
6. Item 3 - item 5	129	221	0
7. Conditions/4			
(1) Dia. of headrace	2.1 m	(12 m)	-
(2) Length of headrace	480 m	(520 m)	-
(3) Dia. of surge tank	3.5 m	5m, 22 m	-
(4) Height of surge tank	67.5 m	100 m	-
(5) Dia. of penstock	2.1 m	2.1 m	2.1 m
(6) Length of penstock	240 m	230 m	750 m

Remarks: /1: Life time of 40 years and discount rate of 10% are assumed.

/2: Energy increase is estimated at 5% of annual output based on head loss decrease.

/3: Benefit is evaluated by power rate of 0.0429 US$/kWh (0.6 ₱/kWh).

/4: Installed capacity is 6,000 kW and maximum turbine discharge is 11.33 m^3/sec.

Table 8.7 COMPARISON OF DEVELOPMENT PLANS

Item	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Remarks
1. Installed capacity (kW)	8,000	7,000	6,000	5,000	4,000	3,000	
2. Reservoir water level (El. m)							
(1) Full water level (F.W.L.)	153.5	153.5	153.5	153.5	153.5	153.5	
(2) Rated water level (R.W.L.)	131.1	131.1	131.1	131.1	131.1	131.1	
(3) Min. water level (M.W.L.)	108.6	108.6	108.6	108.6	108.6	108.6	L.W.L. = El. 100.0 m
(4) Tail water level (T.W.L.)	60.0	60.0	60.0	60.0	60.0	60.0	
3. Rated head (m)							
(1) Gross head	71.1	71.1	71.1	71.1	71.1	71.1	
(2) Effective head	67.5	67.5	67.5	67.5	67.5	67.5	
(3) Loss head	3.6	3.6	3.6	3.6	3.6	3.6	5% of gross head
4. Max. turbine discharge (m^3/sec)	15.11	13.22	11.33	9.44	7.55	5.66	
5. Diameter of penstock (m)	2.35	2.20	2.10	1.95	1.80	1.60	
6. Power benefit							
(1) Annual energy output (GWh)	30.9	29.5	27.3	24.3	20.7	16.5	Effective energy 95%
(2) Annual benefit (10^3 US$)	1,259	1,202	1,113	990	844	672	US$0.0429/kWh (¥0.6/kWh)
7. Cost (10^3 US$)							
(1) Penstock	1,570	1,390	1,270	1,140	960	760	ℓ = 750 m
(2) Power house	1,350	1,200	1,050	900	740	580	
(3) Generating equipment	4,160	3,850	3,450	3,000	2,600	2,120	
(4) Transmission line and substation	680	680	680	680	680	680	
Sub-total:	7,800	7,120	6,450	5,720	4,980	4,140	
(5) Engineering and administration	780	712	646	572	498	414	10% of item (1) to (4)
(6) Contingency	858	783	710	629	548	455	10% of item (1) to (5)
Total:	9,438	8,615	7,806	6,921	6,026	5,009	
(7) Operation and maintenance	195	178	161	143	125	104	2.5% of item (1) to (4)
(8) Annual cost	1,160	1,059	959	851	741	616	Discount rate 10%
8. Annual net benefit (10^3 US$)	99	143	154	139	103	56	Life time 40 years
9. Unit construction cost (US$)							
(1) Per kW	1,180	1,231	1,301	1,384	1,507	1,670	
(2) Per kWh	0.305	0.292	0.286	0.285	0.291	0.304	

Table 8.8(1) RESULTS OF RESERVOIR OPERATION

(1) Installed Capacity = 8,000 kW

Year	Inflow	Water Requirement		Evapora-tion	Spill-out	Water Deficit		Power Output	Energy Output
		I.W.R.	Power			Amount	Percent		
	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(%)	(kW)	(kWh)
1958	313.49	142.72	250.49	3.44	136.24	0.00	0.00	5,406	46,710,531
1959	114.28	163.26	83.48	1.68	0.00	38.49	23.58	1,319	11,396,350
1960	326.43	134.40	193.18	2.70	105.56	0.00	0.00	3,945	34,087,263
1961	156.59	182.11	144.69	2.17	0.00	11.33	6.22	2,534	21,897,873
1962	265.24	169.68	177.80	2.65	73.83	37.69	22.21	3,461	29,910,448
1963	254.80	133.13	179.81	2.69	61.97	0.92	0.69	3,535	30,544,408
1964	212.66	117.62	144.83	3.06	0.00	0.00	0.00	2,958	25,561,808
1965	353.44	92.53	206.10	3.56	101.00	0.00	0.00	4,455	38,495,077
1966	311.66	129.11	271.01	3.11	124.48	0.00	0.00	5,675	49,038,620
1967	246.10	136.32	187.70	2.47	51.98	11.02	8.09	3,826	33,060,639
1968	190.37	166.45	153.54	2.27	19.37	24.89	14.95	3,012	26,028,387
1969	170.01	140.40	149.54	2.64	0.28	0.00	0.00	2,784	24,054,734
1970	281.81	89.54	169.58	3.21	69.79	0.00	0.00	3,668	31,691,827
1971	345.21	78.18	201.24	3.77	102.10	0.00	0.00	4,373	37,786,342
1972	481.04	129.77	221.24	3.47	316.74	0.00	0.00	4,735	40,916,749
1973	216.76	129.64	171.71	2.77	48.73	0.00	0.00	3,380	29,209,390
1974	274.94	155.67	197.96	3.26	51.87	0.00	0.00	4,063	35,104,734
1975	227.22	161.74	146.72	2.68	0.00	7.74	4.79	2,569	22,200,899
1976	252.84	135.18	224.57	3.36	81.46	0.00	0.00	4,790	41,392,069
1977	252.19	181.38	187.88	2.39	71.85	12.35	6.81	3,553	30,704,145
1978	212.00	165.02	161.81	2.15	24.10	26.63	16.14	3,157	27,281,608
1979	197.90	195.85	158.47	2.39	9.93	38.93	19.88	3,126	27,015,021
1980	172.32	183.54	148.85	2.27	1.02	35.21	19.18	2,873	24,827,689
1981	159.95	181.85	132.34	2.24	0.00	24.14	13.28	2,428	20,979,310
1982	313.71	166.84	185.61	2.94	100.45	24.54	14.71	3,789	32,740,105
Average	252.12	146.48	178.00	2.89	62.11	11.76	6.82	3,577	30,905,441

Table 8.8(2) RESULTS OF RESERVOIR OPERATION

(2) Installed Capacity = 7,000 kW

Year	Inflow	Water Requirement		Evapora-tion	Spill-out	Water Deficit		Power Output	Energy Output
		I.W.R.	Power			Amount	Percent		
	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(%)	(kW)	(kWh)
1958	313.49	142.72	233.93	3.44	149.51	0.00	0.00	5,028	43,454,934
1959	114.28	163.26	81.46	1.68	0.00	38.49	23.58	1,281	11,075,632
1960	326.43	134.40	183.65	2.70	114.01	0.00	0.00	3,718	32,126,128
1961	156.59	182.11	140.86	2.17	0.00	11.33	6.22	2,457	21,233,360
1962	265.24	169.68	173.00	2.65	77.19	37.69	22.21	3,343	28,887,617
1963	254.80	133.13	173.44	2.69	66.56	0.92	0.69	3,379	29,200,152
1964	212.66	117.62	142.14	3.06	0.64	0.00	0.00	2,889	24,961,832
1965	353.44	92.53	194.00	3.56	111.85	0.00	0.00	4,170	36,032,679
1966	311.66	129.11	250.02	3.11	142.17	0.00	0.00	5,223	45,129,866
1967	246.10	136.32	179.27	2.47	59.24	11.02	8.09	3,624	31,313,730
1968	190.37	166.45	148.72	2.27	23.00	24.89	14.95	2,890	24,970,209
1969	170.01	140.40	147.48	2.64	1.49	0.00	0.00	2,834	24,489,809
1970	281.81	89.54	159.42	3.21	77.51	0.00	0.00	4,134	29,618,421
1971	345.21	78.18	189.01	3.77	113.44	0.00	0.00	3,428	35,724,755
1972	481.04	129.77	210.85	3.47	325.17	0.00	0.00	4,499	38,873,741
1973	216.76	129.64	166.91	2.77	52.37	0.00	0.00	3,261	28,180,827
1974	274.94	155.67	186.32	3.26	56.42	0.00	0.00	3,802	32,850,840
1975	227.22	161.74	143.85	2.68	0.00	7.74	4.79	2,561	22,132,431
1976	252.84	135.18	212.51	3.36	91.13	0.00	0.00	4,558	39,387,514
1977	252.19	181.38	179.79	2.39	75.48	12.35	6.81	3,382	29,223,617
1978	212.00	165.02	155.47	2.15	29.00	26.63	16.14	3,005	25,967,340
1979	197.90	195.85	153.34	2.39	12.35	38.93	19.88	3,057	26,416,458
1980	172.32	183.54	149.90	2.27	2.23	35.21	19.18	2,798	24,178,131
1981	159.95	181.85	129.30	2.24	0.00	24.14	13.28	2,357	20,366,133
1982	313.71	166.84	180.31	2.94	104.06	24.54	14.71	3,712	32,073,507
Average	252.12	146.48	170.44	2.89	67.39	11.76	6.82	3,416	29,514,747

Table 8.8(3) RESULTS OF RESERVOIR OPERATION

(3) Installed Capacity = 6,000 kW

Year	Inflow	Water Requirement		Evapora-tion	Spill-out	Water Deficit		Power Output	Energy Output
		I.W.R. (MCM)	Power (MCM)	(MCM)	(MCM)	Amount (MCM)	Percent (%)	(kW)	(kWh)
1958	313.59	142.72	215.98	3.44	162.78	0.00	0.00	4,619	39,913,697
1959	114.28	163.26	77.71	1.68	0.00	38.49	23.58	1,261	10,903,004
1960	326.43	134.40	169.40	2.70	122.47	0.00	0.00	3,392	29,312,161
1961	156.59	182.11	130.09	2.17	0.00	11.33	6.22	2,306	19,925,094
1962	265.24	169.68	164.23	2.65	80.87	37.69	22.21	3,187	27,540,393
1963	254.80	133.13	160.25	2.69	71.93	0.92	0.69	3,080	26,612,184
1964	212.66	117.62	134.34	3.06	3.35	0.00	0.00	2,703	23,357,315
1965	353.44	92.53	178.76	3.56	123.53	0.00	0.00	3,813	32,950,393
1966	311.66	129.11	226.76	3.11	160.22	0.00	0.00	4,684	40,474,839
1967	246.10	136.32	163.90	2.47	66.49	11.02	8.09	3,286	28,395,622
1968	190.37	166.45	141.88	2.27	26.64	24.89	14.95	2,726	23,557,363
1969	170.01	140.40	140.42	2.64	2.70	0.00	0.00	2,683	23,188,235
1970	281.81	89.54	145.79	3.21	87.23	0.00	0.00	3,109	26,867,207
1971	345.21	78.18	171.48	3.77	128.80	0.00	0.00	3,724	32,182,237
1972	481.04	129.77	198.29	3.47	334.65	0.00	0.00	4,249	36,716,460
1973	216.76	129.64	156.56	2.77	56.01	0.00	0.00	3,026	26,145,959
1974	274.94	155.67	172.69	3.26	61.35	0.00	0.00	3,542	30,609,155
1975	227.22	161.74	135.12	2.68	0.55	7.74	4.49	2,378	20,551,106
1976	252.84	135.18	198.28	3.36	101.73	0.00	0.00	4,221	36,470,985
1977	252.19	181.38	165.08	2.39	79.11	12.35	6.81	3,080	26,612,044
1978	212.00	165.02	145.77	2.15	33.91	26.63	16.14	2,790	24,113,108
1979	197.90	195.85	144.87	2.39	14.92	38.93	19.88	2,862	24,734,513
1980	172.32	183.54	134.58	2.27	4.11	35.21	19.18	2,596	22,433,732
1981	159.95	181.85	118.51	2.24	0.00	24.14	13.28	2,144	18,530,761
1982	313.71	166.84	171.60	2.94	108.13	24.54	14.71	3,517	30,390,035
Average	252.12	146.48	158.49	2.89	73.26	11.76	6.82	3,159	27,299,504

Table 8.8(4) RESULTS OF RESERVOIR OPERATION

(4) Installed Capacity = 5,000 kW

Year	Inflow	Water Requirement		Evapora-tion	Spill-out	Water Deficit		Power Output	Energy Output
		I.W.R.	Power			Amount	Percent		
	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(%)	(kW)	(kWh)	
1958	313.49	142.72	194.14	3.44	176.41	0.00	0.00	4,118	35,580,894
1959	114.28	163.26	71.74	1.68	0.00	38.49	23.58	1,154	9,975,713
1960	326.43	134.40	150.07	2.70	130.93	0.00	0.00	2,958	25,563,717
1961	156.59	182.11	113.87	2.17	0.00	11.33	6.22	1,994	17,236,419
1962	265.24	169.68	150.52	2.65	85.70	37.69	22.21	2,897	25,033,326
1963	254.80	133.13	142.34	2.69	78.84	0.92	0.69	2,776	23,985,812
1964	212.66	117.62	123.48	3.06	6.96	0.00	0.00	2,525	21,818,798
1965	353.44	92.53	159.95	3.56	136.81	0.00	0.00	3,446	29,776,966
1966	311.66	129.11	200.98	3.11	178.29	0.00	0.00	4,109	35,508,046
1967	246.10	136.32	141.74	2.47	75.19	11.02	8.09	2,809	24,271,850
1968	190.37	166.45	125.84	2.27	30.28	24.89	14.95	2,384	20,599,699
1969	170.01	140.40	129.40	2.64	3.91	0.00	0.00	2,472	21,361,489
1970	281.81	89.54	129.02	3.21	98.07	0.00	0.00	2,717	23,476,183
1971	345.21	78.18	149.62	3.77	145.65	0.00	0.00	3,251	28,092,881
1972	481.04	129.77	180.18	3.47	345.20	0.00	0.00	3,837	33,157,512
1973	216.76	129.64	140.81	2.77	60.17	0.00	0.00	2,675	23,115,557
1974	274.94	155.67	155.92	3.26	66.29	0.00	0.00	3,161	27,319,140
1975	227.22	161.74	120.18	2.68	1.75	7.74	4.79	2,112	18,254,294
1976	252.84	135.18	181.49	3.36	112.60	0.00	0.00	3,853	33,295,361
1977	252.19	181.38	145.46	2.39	83.19	12.35	6.81	2,718	23,488,837
1978	212.00	165.02	127.72	2.15	38.82	26.63	16.14	2,459	21,246,179
1979	197.90	195.85	132.05	2.39	18.54	38.93	19.88	2,573	22,233,803
1980	172.32	183.54	120.38	2.27	6.52	35.21	19.18	2,292	19,803,876
1981	159.95	181.85	105.13	2.24	0.00	24.14	13.28	1,874	16,199,117
1982	313.71	166.84	158.14	2.94	113.02	24.54	14.71	3,213	27,761,075
Average	252.12	146.48	141.99	2.89	79.73	11.76	6.82	2,815	24,326,262

Table 8.8(5) RESULTS OF RESERVOIR OPERATION

(5) Installed Capacity = 4,000 kW

Year	Inflow	Water Requirement		Evapora-tion	Spill-out	Water Deficit		Power Output	Energy Output
		I.W.R.	Power			Amount	Percent		
	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(%)	(kW)	(kWh)
1958	313.49	14.272	167.34	3.44	190.88	0.00	0.00	3,499	30,239,729
1959	114.28	163.26	62.69	1.68	0.00	38.49	23.58	1,020	8,815,140
1960	326.43	134.40	129.48	2.70	140.36	0.00	0.00	2,508	21,670,319
1961	156.59	182.11	96.23	2.17	0.00	11.33	6.22	1,645	14,220,445
1962	265.24	169.68	132.36	2.65	91.32	37.69	22.21	2,487	21,494,513
1963	254.80	133.13	121.97	2.69	86.06	0.92	0.69	2,362	20,411,850
1964	212.66	117.62	109.87	3.06	11.48	0.00	0.00	2,200	19,008,339
1965	353.44	92.53	138.18	3.56	152.13	0.00	0.00	2,943	25,429,118
1966	311.66	129.11	172.70	3.11	197.55	0.00	0.00	3,450	29,808,065
1967	246.10	136.32	116.54	2.47	84.85	11.02	8.09	2,282	19,723,443
1968	190.37	166.45	108.65	2.27	33.91	24.89	14.95	2,013	17,399,974
1969	170.01	140.40	115.35	2.64	6.27	0.00	0.00	2,180	18,838,512
1970	281.81	89.54	111.60	3.21	108.90	0.00	0.00	2,305	19,918,598
1971	354.21	78.18	126.97	3.77	162.51	0.00	0.00	2,775	23,803,474
1972	481.04	129.77	158.48	3.47	356.92	0.00	0.00	3,337	28,839,934
1973	216.76	129.64	121.76	2.77	66.98	0.00	0.00	2,262	19,550,144
1974	274.94	155.67	136.71	3.26	72.42	0.00	0.00	2,712	23,439,607
1975	227.22	161.74	104.93	2.68	2.96	7.74	4.79	1,827	15,786,875
1976	252.84	135.18	160.15	3.36	124.80	0.00	0.00	3,338	28,843,373
1977	252.19	181.38	121.94	2.39	89.09	12.35	6.81	2,234	19,302,399
1978	212.00	165.02	106.40	2.15	44.25	26.63	16.14	2,022	17,472,320
1979	197.90	195.85	115.10	2.39	22.16	38.93	19.88	2,197	18,988,464
1980	172.32	183.54	103.63	2.27	8.92	35.21	19.18	1,939	16,761,564
1981	159.95	181.85	90.69	2.24	0.00	24.14	13.28	1,602	13,847,202
1982	313.71	166.84	136.39	2.29	121.30	24.54	14.71	2,720	23,503,492
Average	252.12	146.48	122.65	2.89	87.04	11.76	6.82	2,394	20,684,676

Table 8.8(6) RESULTS OF RESERVOIR OPERATION

(6) Installed Capacity = 3,000 kW

Year	Inflow	Water Requirement		Evapora-tion	Spill-out	Water Deficit		Power Output	Energy Output
		I.W.R.	Power			Amount	Percent		
	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(%)	(kW)	(kWh)
1958	313.49	142.72	136.53	3.44	206.23	0.00	0.00	2,790	24,114,074
1959	114.28	163.26	50.93	1.68	0.00	38.49	23.58	806	6,965,060
1960	326.43	134.40	105.61	2.70	151.18	0.00	0.00	1,953	16,879,298
1961	156.59	182.11	77.51	2.17	0.00	11.33	6.22	1,266	10,945,967
1962	265.24	169.68	110.14	2.65	98.58	37.69	22.21	1,987	17,174,579
1963	254.80	133.13	99.50	2.69	94.24	0.92	0.69	1,861	16,081,985
1964	212.66	117.62	92.20	3.06	17.60	0.00	0.00	1,821	15,735,259
1965	353.44	92.53	112.75	3.56	168.64	0.00	0.00	2,386	20,617,257
1966	311.66	129.11	140.53	3.11	218.11	0.00	0.00	2,692	23,265,087
1967	246.10	136.32	91.69	2.47	95.05	11.02	8.09	1,743	15,062,643
1968	190.37	166.45	88.26	2.27	37.55	24.89	14.95	1,583	13,685,620
1969	170.01	140.40	99.10	2.64	8.68	0.00	0.00	1,805	15,603,757
1970	281.81	89.54	92.03	3.21	119.74	0.00	0.00	1,849	15,975,407
1971	345.21	78.18	103.44	3.77	108.56	0.00	0.00	2,260	19,532,598
1972	481.04	129.77	130.56	3.47	369.60	0.00	0.00	2,687	23,223,944
1973	216.76	129.64	103.20	2.77	74.23	0.00	0.00	1,833	15,844,795
1974	274.94	155.67	115.41	3.26	79.19	0.00	0.00	2,203	19,040,668
1975	227.22	161.74	90.11	2.68	4.16	7.74	4.79	1,539	13,297,424
1976	252.84	135.18	132.04	3.36	139.29	0.00	0.00	2,642	22,834,998
1977	252.19	181.38	96.12	2.39	95.12	12.35	6.81	1,699	14,686,920
1978	212.00	165.02	82.74	2.15	51.37	26.63	16.14	1,530	13,223,797
1979	197.90	195.85	94.53	2.39	26.44	38.93	19.88	1,737	15,015,978
1980	172.32	183.54	85.61	2.27	11.40	35.21	19.18	1,547	13,372,192
1981	159.95	181.85	74.93	2.24	0.00	24.14	13.28	1,253	10,833,034
1982	313.71	166.84	111.92	2.94	130.95	24.54	14.71	2,153	18,607,796
Average	252.12	146.48	100.70	2.89	95.12	11.76	6.82	1,905	16,464,806

Table 8.9 RESULTS OF RESERVOIR OPERATION MODIFIED WATER USE MODE, INSTALLED CAPACITY = 6,000 KW

Year	Inflow	Water Requirement		Evapora-tion	Spill-out	Water Deficit		Power Output	Energy Output
		I.W.R.	Power			Amount	Percent		
	(MCM)	(MCM)	(MCM)	(MCM)	(MCM)	(%)	(kW)	(kWh)	
1958	313.49	142.72	216.59	3.29	162.78	0.00	0.00	4,548	39,302,481
1959	114.28	163.26	67.07	1.44	0.00	71.71	43.93	1,132	9,781,461
1960	326.43	134.40	182.67	2.69	109.65	0.00	0.00	3,642	31,470,611
1961	156.59	182.11	132.12	1.78	0.00	43.25	23.75	2,239	19,347,677
1962	265.24	169.68	163.10	2.58	76.97	37.69	22.21	3,187	27,539,485
1963	254.80	133.13	165.70	2.53	52.55	8.16	6.13	3,330	28,778,454
1964	212.66	117.62	143.41	2.77	0.00	0.00	0.00	2,834	24,491,596
1965	353.44	92.53	197.23	3.38	82.94	0.00	0.00	4,253	36,754,133
1966	311.66	129.11	226.76	3.11	160.22	0.00	0.00	4,684	40,474,839
1967	246.10	136.32	177.75	2.45	52.28	11.02	8.09	3,530	30,504,110
1968	190.37	166.45	141.72	2.20	22.52	28.39	17.06	2,751	23,772,792
1969	170.01	140.40	131.82	2.13	0.00	12.25	8.73	2,436	21,051,034
1970	281.81	89.54	163.51	2.96	64.72	0.00	0.00	3,442	29,746,156
1971	345.21	78.18	208.94	3.45	99.41	0.00	0.00	4,505	38,927,816
1972	481.04	129.77	194.41	3.14	289.88	0.00	0.00	3,979	34,383,440
1973	216.76	129.64	161.14	2.54	30.79	0.00	0.00	3,110	26,870,750
1974	274.94	155.67	188.74	3.05	40.96	0.00	0.00	3,765	32,537,680
1975	227.22	161.74	134.45	1.88	0.00	23.71	14.66	2,272	19,633,133
1976	252.84	135.18	196.21	3.15	79.60	0.00	0.00	4,055	35,039,300
1977	252.19	181.38	166.17	2.32	61.28	12.35	6.81	3,184	27,514,408
1978	212.00	165.02	151.55	2.15	25.75	26.63	16.14	2,951	25,503,084
1979	197.90	195.85	140.26	2.26	7.70	45.41	23.19	2,748	23,746,317
1980	172.32	183.54	138.62	2.19	0.00	38.73	21.10	2,610	22,558,316
1981	159.95	181.85	118.55	1.65	0.00	72.42	39.82	2,033	17,570,558
1982	313.71	166.84	181.21	2.93	94.98	24.54	14.71	3,703	31,996,773
Average	252.12	146.48	163.59	2.56	60.55	6.31	10.65	3,237	27,971,857

Fig. 8.1 POWER SUPPLY AREAS OF PELCO II AND MANSONS

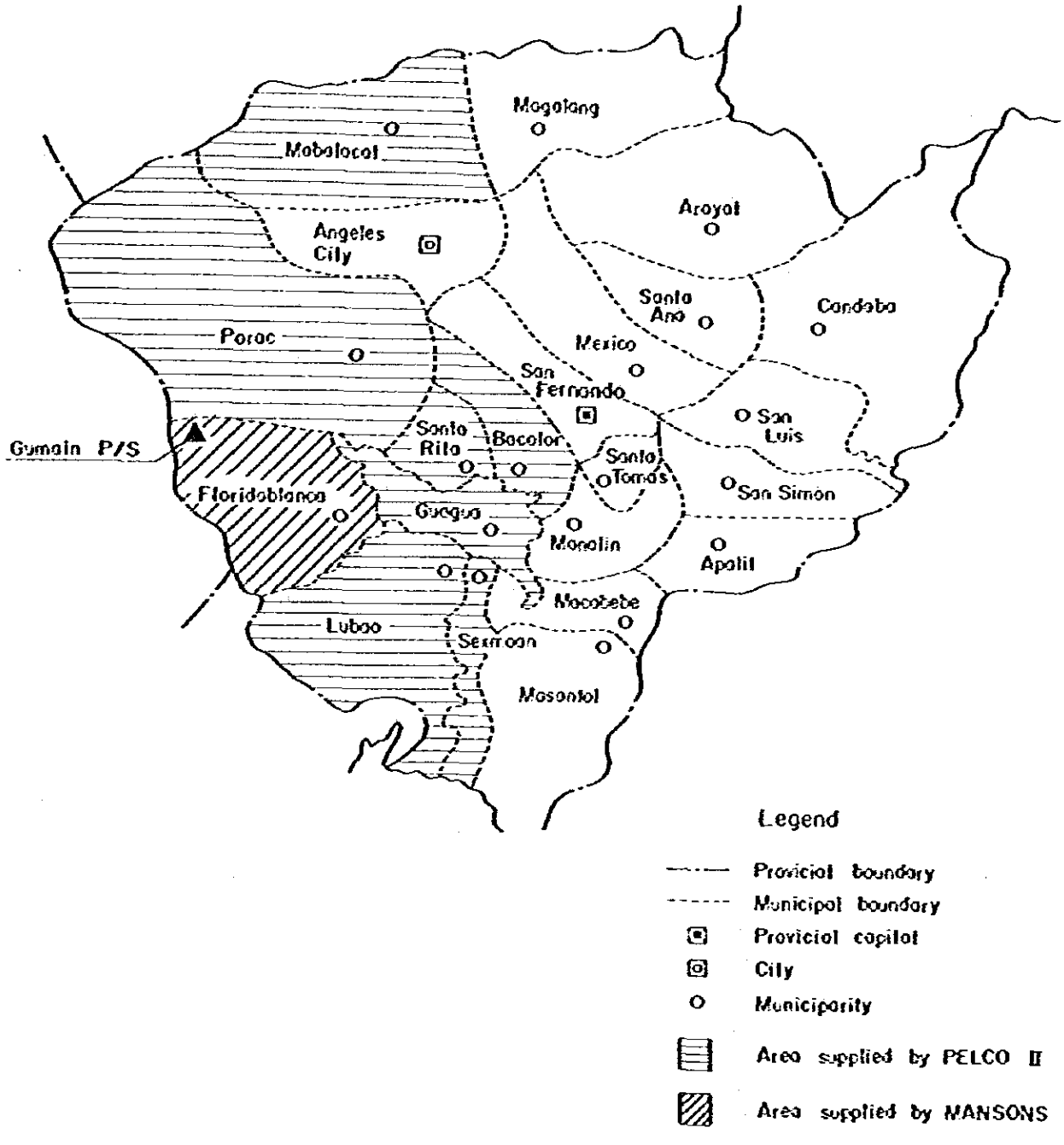


Fig. 8.2 EXISTING TRANSMISSION LINE OF LUZON GRID AROUND PROJECT AREA

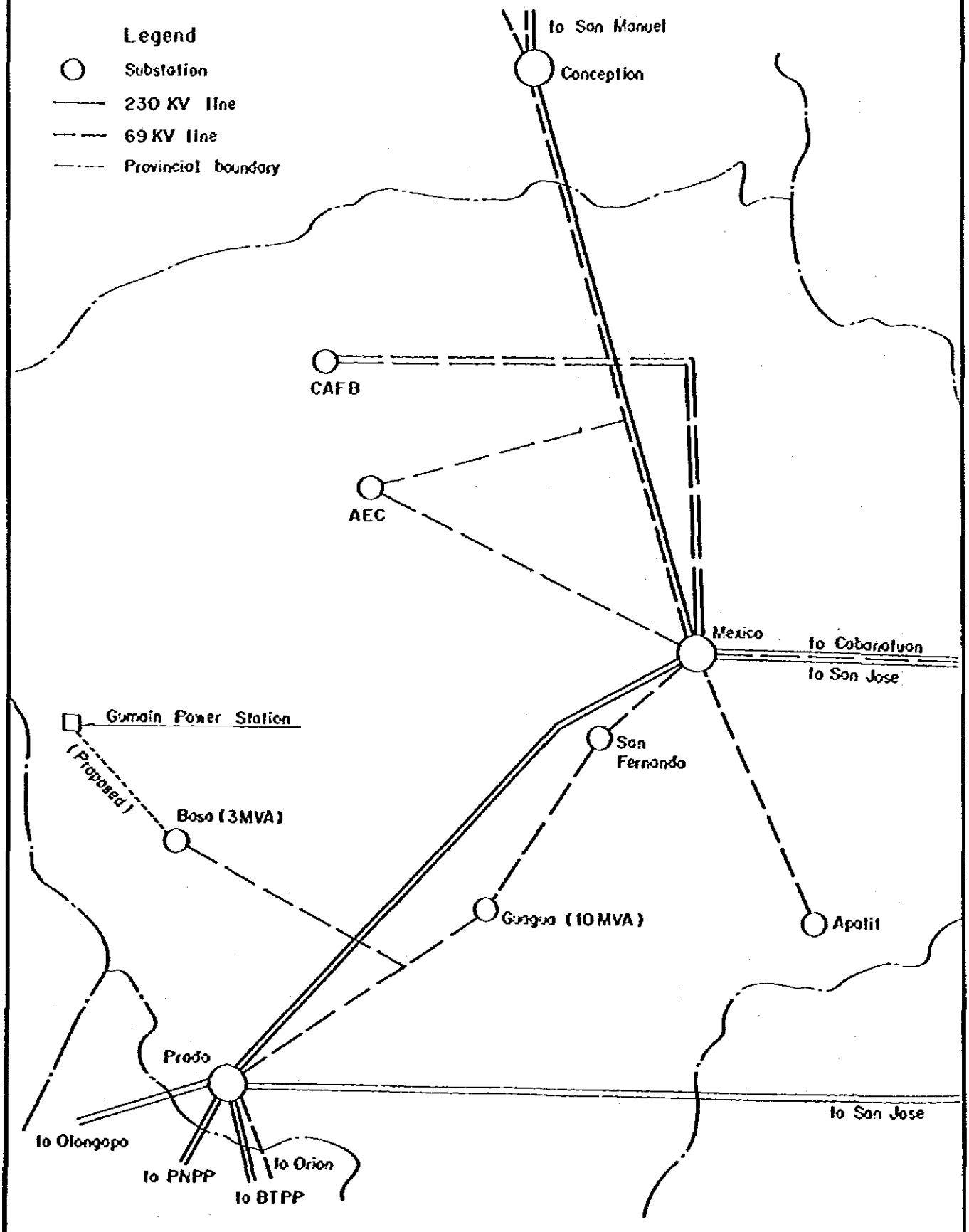


Fig. 8.3 GENERAL LAYOUT OF POWER GENERATING FACILITIES

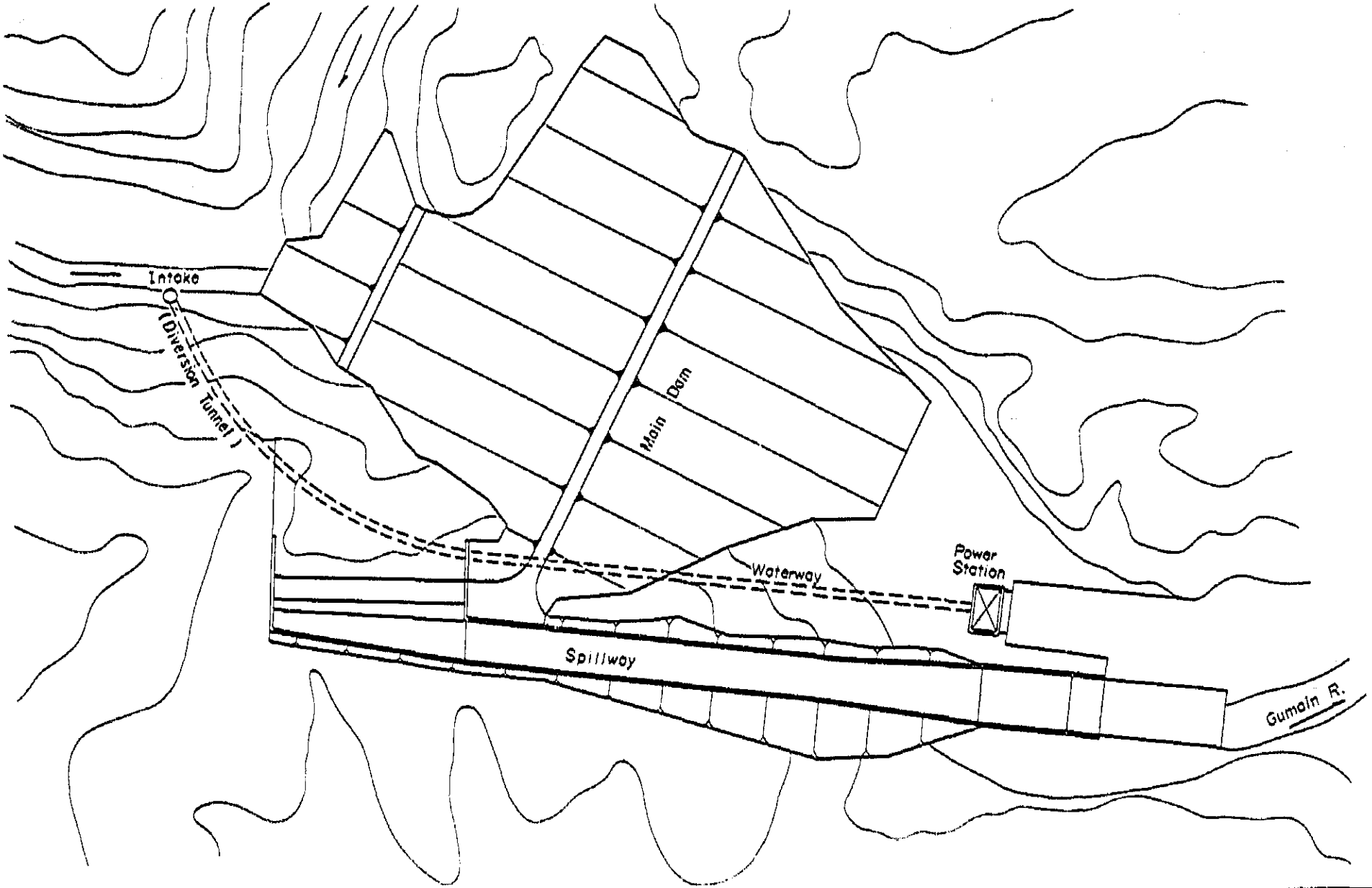
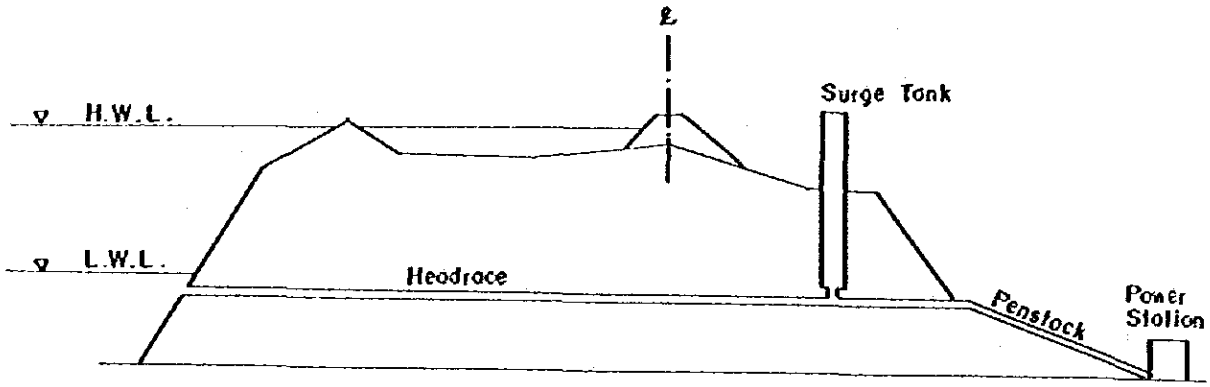
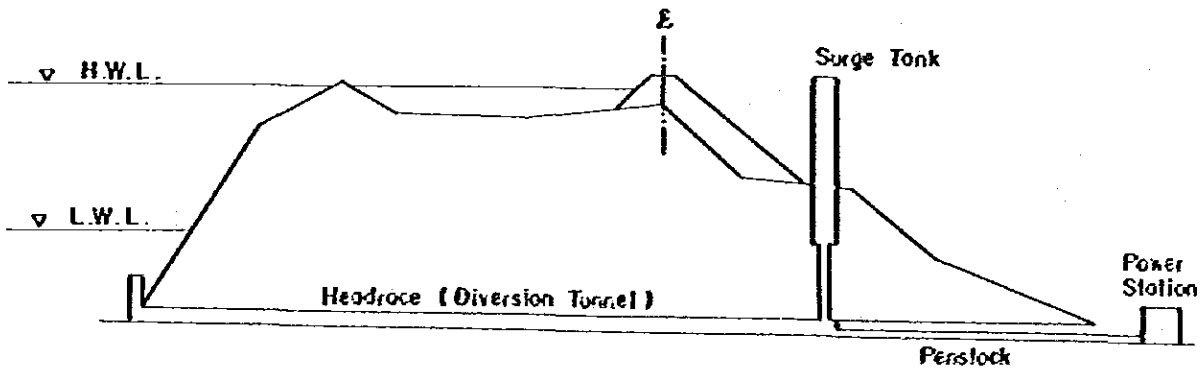


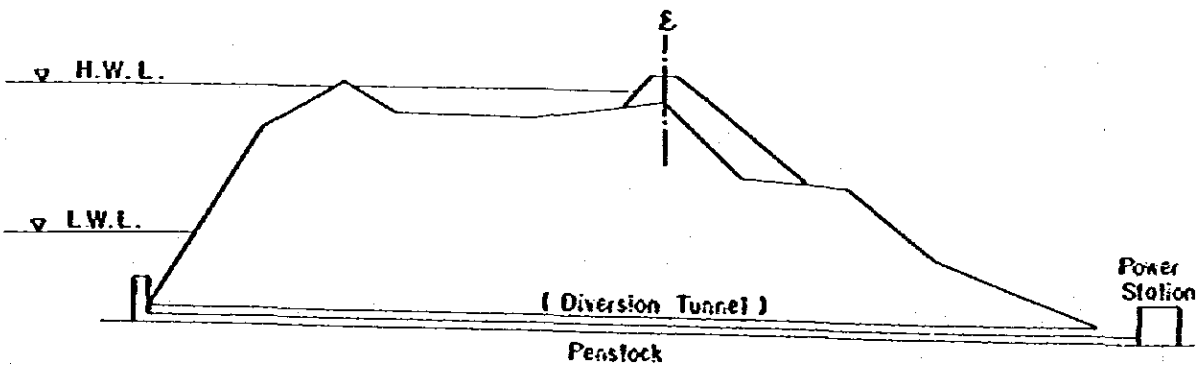
Fig. 8.4 SCHEMATIC DIAGRAM OF ALTERNATIVE WATERWAY PLANS



Plan A

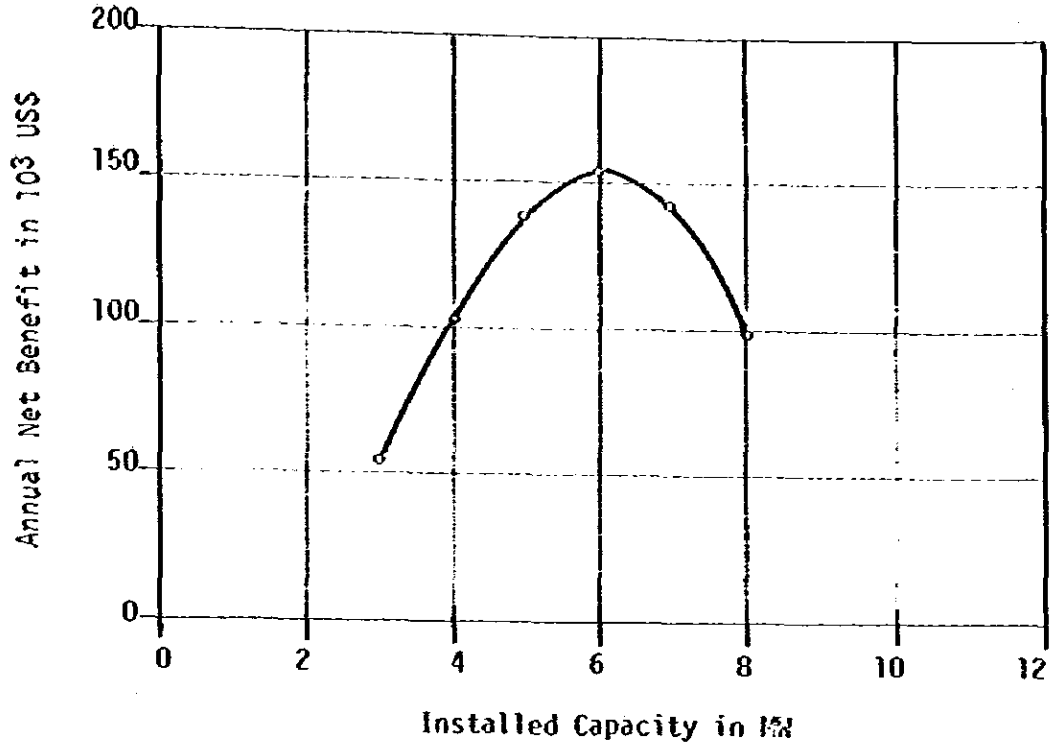


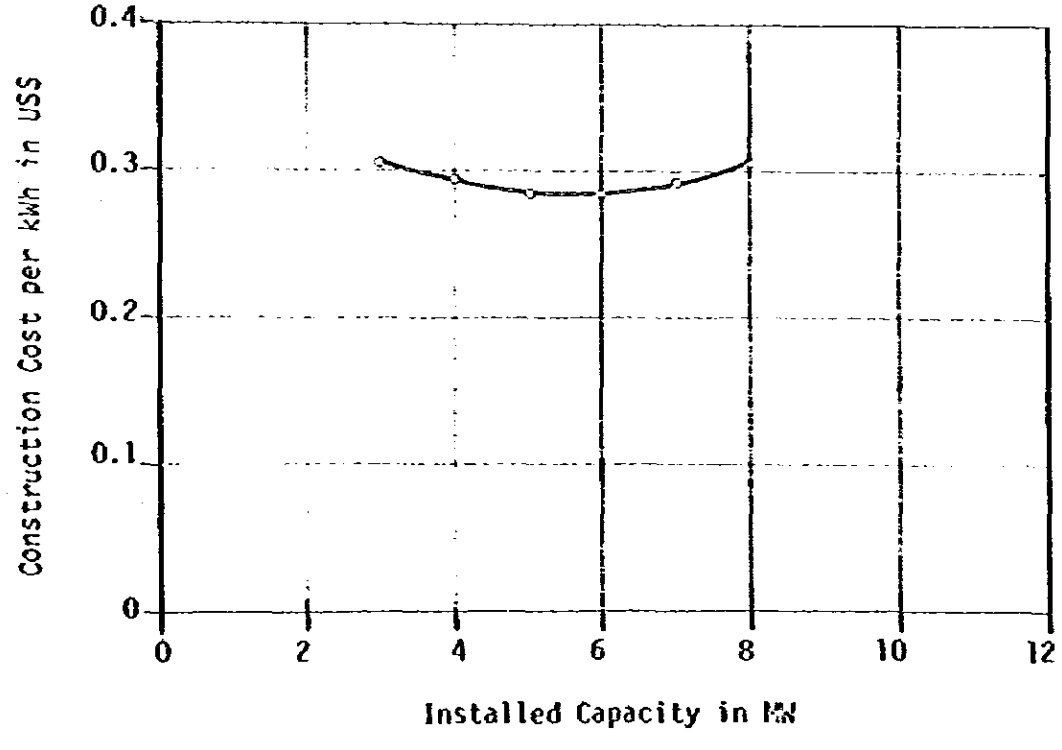
Plan B



Plan C

Fig. 8.5 RELATION BETWEEN INSTALLED CAPACITY AND ANNUAL NET BENEFIT





APPENDIX IX

ORGANIZATION AND MANAGEMENT

APPENDIX IX ORGANIZATION AND MANAGEMENT

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APPENDIX IX ORGANIZATION AND MANAGEMENT

CHAPTER 1 ORGANIZATION FOR PROJECT EXECUTION

The National Irrigation Administration (NIA) has responsibility for planning, developing, operating and managing of all national irrigation systems in the country. The organizational structure of NIA is presented in Fig. 9.1. NIA's activities are managed by a Board of Directors and an Administrator; the latter is assisted by four Assistant Administrators.

The NIA will become the executing agency for the Gumain River Irrigation Project. It will be responsible for design, construction of project works and supervision for the project. The Assistant Administrator for Project Development and Implementation will be responsible for overall execution of the project, who will coordinate activities of all relevant governmental agencies in connection with the implementation of the project.

The Project Executing Office during the construction stage will be established in the Porac-Gumain River Irrigation System Office having a existing irrigation system of 4,900 ha in the project area. This existing irrigation office will be reorganized to be responsible both for the project implementation and for the operation and management of the existing irrigation system. The Caulaman River Irrigation System Office, which has also an existing irrigation system in the project area, will be integrated with this new office. The proposed organization chart is as shown in Fig. 9.2. A project manager of the proposed organization will manage all field works of the project, assisted by four divisions; construction division, engineering division, operation and maintenance division and administrative division. Necessary staff will be supplied by the NIA head office and Region III office of NIA.

The operation and maintenance division is responsible for the management of existing irrigation system during the construction period. In addition, the setting-up of farmer's organization is also carried out by this division during the construction period.

CHAPTER 2 OPERATION AND MAINTENANCE OF THE PROJECT

2.1 Organization and Management of Existing Irrigation System

2.1.1 General

There exist two national irrigation systems in the project area; i.e. the Porac-Gumain River Irrigation System (PGRIS) and the Caulaman River Irrigation System (CRIS)

The PGRIS composed of two diversion dams: Porac dam located at Pulungmasle, Guagua; and Gumain dam located at San Pedro, Floridablanca. The Porac and Gumain dams were constructed in the year 1954 to 1956, respectively. Both dams contained two main canals; Porac East and West Canals, Gumain North and South Canals, and these canals extend for a total length of 18.3 km. The irrigation service area in recent years averages about 4,900 ha in the wet season and 3,800 ha in the dry season. The whole system could serve the municipalities of Floridablanca, Guagua, Lubao and portion of Sta. Rita in the province of Pampanga. The head office of the system was built in the town of Floridablanca.

The CRIS was originally designed to irrigate 2,000 ha of paddy field in the municipalities of Floridablanca and Lubao in Pampanga Province and in the municipalities of Dinalupihan and Hermosa in Bataan Province. The system, which was completed in 1968, is now capable of irrigating only about 500 ha in both the wet and the dry seasons. A part of the original service area was converted to residential area and sugarcane land, while some parts are now served by communal irrigation systems. The Caulaman diversion dam is the main facility, and there are supplementary dams and checkgates diverting additional water independent of the main diversion dam. Some of the existing facilities are deteriorated and need rehabilitation works. The head office of this system is located in the town of Dinalupihan.

The details of irrigation and drainage facilities for both systems are given in Appendix V.

2.1.2 Organizational Structure

The existing organizational structures of the PGRIS and the CRIS are presented in Fig. 9.3. The Assistant Administrator for Operations, NIA has an overall responsibility for both irrigation systems through Region III office (regional office of NIA). These existing irrigation systems are headed by an Irrigation Superintendent who undertakes overall supervision and direction of operation and management of the systems. Under the Irrigation Superintendent, there are three sections in the PGRIS and four sections in the CRIS. Major staff for management of the irrigation system consist of assistant irrigation engineer, water master, gatekeeper, ditchtender, heavy equipment operator and administrative staff such as accounting clerk, cashier, storekeeper, etc. The number of these posts in both irrigation systems as of March 1984 is presented in Table 9.1.

The work loads of their staffs for operation and maintenance works are estimated as shown in the following table. In this table, 13 national irrigation systems having high efficiency of more than 70% for irrigation fee collection were selected from all national irrigation systems, in order to evaluate the work load of both PGRIS and CRIS.

	PGRIS and CRIS			13 National Irrigation Systems (ha/person)
	Area (ha)	No. of Staff (person)	Work Laod (ha/person)	
Water Master	5,430	7	780	1,040
Ditchtender	5,430	30	180	170
Gatekeeper	5,430	6	910	1,460

As shown in the above table, the work loads of PGRIS and CRIS are relatively low in comparison with other 13 national irrigation systems except ditchtender.

2.1.3 Management of Operation and Maintenance

The PGRIS and the CRIS have similar management systems for operation and maintenance of their irrigation facilities, though there is a great difference in the service area between them. The general management system is presented in Fig. 9.4. Major operation and maintenance works of existing irrigation systems consist of the following five items;

(1) Planning of Irrigation Schedule

The irrigation schedule is prepared by the Assistant Irrigation Engineer. The general procedure of planning in the present system is as follows: i) the Assistant Irrigation Engineer receive the report from each Water Master which indicates information concerning the area to be irrigated by the system, kind of crop to be planted and the possible start date for water delivery; ii) based on the reports, the Assistant Irrigation Engineer prepares a tentative plan of water allocation for the whole area considering the water resources; iii) the tentative plan is reviewed by the Water Master and vi) the reviewed plan is finalized by the Assistant Irrigation Engineer and submitted to the Water Master after approval by the Irrigation Superintendent.

(2) Control of Irrigation Water Delivery

For the control and monitoring of the irrigation water delivery, the guidelines are set-up by the Assistant Irrigation Engineer through the detailed operation rule on a daily, weekly and monthly basis. The decisions for water control at diversion points under the operation section are made on daily basis by the following information submitted from the Water Master: i) weekly progress of farming activity

containing the hectarage under land soaking, land preparation, normal irrigation, terminal drainage and the area harvested and ii) daily records of discharges at major diversion points and rainfall.

(3) Maintenance and Repair

Maintenance and repair works for irrigation facilities are classified into two categories. One is the rehabilitation or improvement works of facilities and usually undertaken during non-irrigation period. The other is daily routine works to keep facilities in good operating conditions.

At present, the rehabilitation works do not carry out sufficiently due to lack of budget. Problems noted in daily routine works are deficiencies in daily maintenance and minor repairs.

(4) Irrigation Service Fee Collection

Fee collection is made from each individual water user. Bills for the irrigation service fee collection are prepared by billing clerks during about 3 months from the end of land preparation to the beginning of terminal drainage. Distribution of these bills is carried out during about 40 days from the beginning to the end of terminal drainage. Collection of fee starts at the middle of the period of terminal drainage. For evaluation of fee exemption, cancellation of bills on lots with total crop failure is conducted during about 40 days from half a month before start of terminal drainage to the middle of the terminal drainage period.

(5) Administrative Work and Set-up of Farmers' Organization

The Administrative Section deals in principle with general affairs including personnel and records, accounting, cash general services, property and procurement. In addition to the above works, Farmer-Irrigators' Organization (FIO) are being federated in rotational areas with the assistance of the Assistant Irrigation Engineer.

2.1.4 O&M Facilities

The number of O&M equipment in both the PGRIS and the CRIS as of March 1984 is shown in Table 9.2. Out of 16 service vehicles such as jeep; pick-up and truck, except for mortorcycle, 7 vehicles are in need of repairs. On the other hand, there are 6 heavy equipments such as mobile crane, grader, bulldozer, etc., however, only one bulldozer is workable in both the irrigation systems.

As for communication equipment such as VHF radio, walkie-talkie, etc., they are not available in either irrigation system. The communication between field and irrigation office is made by vehicles.

2.1.5 Financial Status

The irrigation service fees collected from water-users are the major sources of revenue in the PGRIS and the CRIS. In principle, the rates of irrigation service fees are to be fixed so as to cover the following costs: i) total repayment of public investment for irrigation facilities without interest, ii) operation and maintenance costs of the system and iii) marginal costs such as incentives/bonus to be paid to the personnel participating in irrigation service fee collection. The rates of irrigation service fee are as follows:

- Wet season crop: 2 cavans of paddy per ha
- Dry season crop: 3 cavans of paddy per ha

The annual collection amount from 1981 to 1983 averages ₱513,000 for the PGRIS and ₱83,000 for the CRIS, as shown in Table 9.3. The collection efficiency rate is 34% and 46%, respectively and these are lower than the average rate in all national irrigation systems. Although several reasons such as low capacity-to-pay of farms, lack of farmer's perception of NIA services, etc., are considered, the biggest one is the insufficient supply of irrigation water.

The O&M cost of the existing irrigation system can be classified into two items: personnel expenses and other expenses including spare parts and materials, gasoline and oils, etc., as indicated in Table 9.4. The annual amount of the O&M cost from 1981 to 1983 averages ₱758,000 for the PGRIS and ₱129,000 for the CRIS. Most of these O&M costs are occupied by personnel expenses which account for 94%, on an average for both irrigation systems.

Based on the amount of irrigation fee collected and the O&M cost as mentioned above, the financial status of the existing irrigation systems is analyzed as below:

	1980	1981	1982	Average
1) PGRIS				
- Revenue	377	509	653	513
- O&M Cost	665	849	760	758
- Balance	-288	-340	-107	-245
2) CRIS				
- Revenue	68	90	90	83
- O&M Cost	114	141	131	129
- Balance	-46	-51	-41	-46

As shown in the above table, the balance of budget of the existing irrigation systems situated at deficit condition, and this condition will continue in the future, if the problems of irrigation fee collection as mentioned above cannot be solved.

2.1.6 Farmers' Perception on Irrigation Services

In order to grasp the farmers' perception on the irrigation services of the existing irrigation systems, a questionnaire survey was made for 59 representative farmers who are members of PGRIS and CRIS. Major questions to the farmers consist of the following three items; i) feeling of satisfaction to the present irrigation services, ii) communications between farmers and PGRIS/CRIS, and iii) the situation regarding payment of the irrigation fee.

For the present irrigation services, it is noticeable that 54% of all representative farmers answered "slightly satisfied", and 34% expressed dissatisfaction. And farmers stated the following reasons on these answers: i) inadequate supply of water, ii) defective irrigation facilities and iii) lack of information and dissemination. As for the communication between farmers and PGRIS/CRIS, the farmers have poor contact with PGRIS/CRIS staff. The reasons for such a regrettable situation are mainly lack of time because of busy daily works and poor comprehension of the staff. For the question relating to the irrigation fee, most of farmers understood that a irrigation fee was charged for operation and maintenance of the irrigation systems. However, the present collection efficiency of irrigation fee estimating at 34% for PGRIS and 46% for CRIS is very low as compared with other national irrigation systems. According to the explanation by the farmers, this low efficiency in collection of fee is due to i) inadequate supply of irrigation water, ii) insufficient farm income and iii) lack or delay of information in fee collection

2.2 Proposed Organization and Maintenance Plan

2.2.1 General

After the completion of construction work on the project, the project executing office will be reorganized into the operation and management office which is responsible for the operation, maintenance and other services as follows:

1) Operation and maintenance of irrigation and drainage facilities including the Gumain dam and reservoir.

2) Collection of the irrigation service fee.

3) Various services such as training, extension, etc.

The proposed management plan is formulated in due consideration of the previous study/1 on the improvement of existing irrigation system (PGRIS) in the project area.

2.2.2 Proposed Organization and Staffing

(1) Proposed Organization

The proposed organizational structure of the O&M office is presented in Fig. 9.5. This office consists of the following six sections:

1) Administrative Section
   - Personnel, accounting, cashiering and general affair services

2) Repair and Maintenance Section
   - Repair and maintenance of facilities

3) Operation Section
   - Planning of irrigation schedule
   - Water distribution and control
   - Hydrological measurement

4) Billing and Collection Section
   - Billing and collection of irrigation fee

5) Farmers' Assistance Section
   - Guidance and training to water users
   - Assistance to FIG/FIA management

6) Dam and Reservoir Section
   - Operation and monitoring of dam and reservoir

The Operation Manager will be responsible for management of the irrigation system through these sections. The O&M office will set up at the place of the existing PGRIS office where it is located in the town of Floridablanca. Taking into consideration the smooth and effective operation of irrigation water supply, it is proposed that the irrigation service area is administratively divided into three systems as shown in Fig. 9.6. However, it is recommended that any branch offices are not established in the project area because the operation and maintenance works should be carried out through a short channel, though a considerable numbers of field and working station are built in the area. The O&M office and the farmers' organizations to be established in the project area are required to be closely interlinked for the smooth and effective operation of irrigation water supply. For this purpose, it is proposed that a Coordination

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/1: Feasibility Study Report on the Improvement Project of 18-National Irrigation System, NIA, 1984.

Committee would be instituted between the O&M office and the representative of farmers' organizations. As for the representative of farmer's organizations, many mers, organization will be established in the project area as mentione later. Therefore, in order to expedite proceedings smoothly, it is recommended that these organizations will be federated into one representative organization, namely the Federal Farmer-Irrigators' Association (FFIA).

Besides the above coordinating function on irrigation water control in the whole project area, the Coordination Committee will be responsible for the crop rotation schedule and the harvesting schedule of sugarcane. The proposed cropping pattern of paddy field in the dry season consists of paddy and vegetable cultivations, and the rotation of these crops is carried out among farmers. The overall crop rotation schedule will be made by the Coordination Committee. Harvested cane must be milled at the sugar mill factory as soon as possible because delayed cane will cause sucrose deterioration. Therefore, the harvesting schedule of sugarcane should be commensurate with the daily milling capacity and be coordinated between sugar mill and sugarcane planters. The coordination of harvesting schedule will also be made by the Coordination Committee.

(2) Staff and Staffing Pattern

The staff necessary for the O&M office are estimated at about 235 persons as shown in Table 9.5.

As for field personnel for control and monitoring of irrigation water supply, one Ditchtender will manage 200 ha, while one Assistant Water Management Technician or Water Master (AWMT/WM) will supervise four Ditchtenders (800 ha). Then, one Irrigation Engineer will be in-charge of one system with six to eight AWMT/WMs. One gatekeeper will operate two head gates. Check gates and turnouts are operated by Ditchtenders. In addition to is staff, it is proposed that one Irrigation Association Organizer (IAO) will be assigned to each 2,000 ha or by each ten FIAs to be organized in the whole project area. Their work loads are summarized in the following table:

Item	O&M Office of the Project		13 National Irrigation Systems (ha/Person)
	No. of Staff (Persons)	Work Load (ha/Person)	
Irrigation Engineer	3	5,580	-
AWMT/WM	21	800	1,040
Ditchtender	84	200	170
Gatekeeper	12	1,400	1,460
IAO	8	2,090	-

The work load of AWMT/WM is as determined in the Memorandum Circular No. 2, and the work load of Ditchtender and Gatekeeper are estimated on the basis of the work loads prevailing in the 13 National Irrigation Systems with an irrigation fee collection efficiency of more than 70%. The IAO is the new post in the Farmers' Assistance Section, who is responsible for guidance and training to the water users and assistance to the management of FIAs.

2.2.3 Management Plan for Operation and Maintenance

Major management works of the O&M office consist of planning of irrigation schedule, control of irrigation water delivery, maintenance and repair, irrigation service fee collection, assistance to farmers' organizations and administration. The details of the proposed plans are given below:

(1) Planning of Irrigation Schedule

Planning of irrigation schedule will be prepared at the Operation Section by three stages as follows:

a) Long-term Plan

The long-term irrigation plan will be prepared once every 3 to 4 years. This plan will define the targets such as total irrigated area, irrigation efficiency, reservoir volume to be attained at the end of planning year, irrigation fee collection rate, crop production and specific targets for maintenance.

b) Yearly Plan

Before the start of the wet season, usually from March to May, the yearly plan will be prepared for the coming wet and dry seasons in accordance with the long-term plan. Several alternative statistical studies will be included in this planning procedure. The alternative studies will be made, for example, for combinations of irrigated crop area and irrigation schedule against a drought year, a normal year and a rainy year of appropriate probability.

c) Seasonal Plan

A seasonal plan for the wet season will be included in the said yearly plan. A seasonal plan for the dry season will be prepared in line with the yearly and long-term plans.

The planning and evaluation will be the responsibility of the Planning and Evaluation Unit under the Operation Section. A hydrologist will be assigned in this section, and statistical analysis for previous seasons be included in the evaluation report which will be issued yearly.

(2) Control of Irrigation Water Delivery

The Water Distribution and Control Unit under the Operation Section will be responsible for delivery and control of irrigation water. In order to ensure efficient management of irrigation water delivery, introduction of centralized monitoring system and the establishment of operation rule are proposed.

The control of irrigation water delivery under the centralized monitoring system is expressed by the following work flow:

a) Data Collection

The data required for the operation are farming activity and hydrological data such as hourly rainfall, river water level, canal water level, gate opening, reservoir water level and inflow/outflow from the Gumain Dam.

b) Data Processing

Major activities of the data processing are composed of three items; i) necessary dimensions required for the operation, ii) preparation of operation plan by execution of the water balance simulation and iii) management of operational and hydrological data for recording.

c) Water Management and Operation Plan

The water management and operation plan will be prepared at each system level in accordance with the seasonal irrigation plan. The plan will consist of the following three items; i) seasonal management plan, ii) monthly management plan and iii) weekly operation plan. The seasonal management plan will clarify the proposed irrigation area, irrigation schedule, cropping calendar, etc. After the irrigation starts, the seasonal management plan will always be checked and corrected by the daily water balance study, and the monthly management plan for water distribution will be prepared for the next month. The weekly operation plan will be made for the operation of the following week from the result of water balance study for the previous week based on the operation monitoring records. This plan will indicate the amount of irrigation water delivery required at each point of the field.

d) Operation and Monitoring

According to the weekly operation plan, the field personnel will set the irrigation facilities to control the irrigation water delivery. It should be noted that the minimum operation term is not a day but week. So that the control facilities will be set at the beginning of the week and will not be changed except in case of an order from the Operation Section. The irrigation water distribution and hydrological features will be monitored by the field personnel and field monitoring station through the wireless radio system.

The establishment of the operation rule aims at achieving the highest irrigation efficiency, equitable distribution of irrigation water and equality of control in each irrigation system. The proposed operation rule is as follows:

a) Unit operation period is one week. The control structures in a system will be set according to the weekly operation plan on the first day of the week (unit operation period), and there will be no change of control within the week unless daily rainfall exceeds 30 mm/day.

b) If rainfall amount of more than 30 mm/day is monitored, the irrigation supply will be stopped for the appropriate irrigation system from the next day until the end of the week (unit operation period).

c) At the beginning of weekly operation, the daily water balance for the previous week will be reviewed based on farming activity, daily rainfall and the amount of water supplied. At this time, some modifications to the original weekly operation plan are made, if necessary. On the first day of the week after the review, the control order will be transmitted from the Water Distribution and Control Unit to the field personnel by the wireless radio system.

d) As for farming activity, the field investigation is required by field personnel. Major survey items are kind of crop, crop variety, actual farming area and start and end of transplanting or seeding of crops.

e) The condition of flow and water distribution will be monitored by the patrol of field personnel and through the Water Distribution and Control Unit. If the distribution is found to be skewed from the schedule, necessary readjustment will be ordered from the Distribution and Control Unit to the field personnel.

f) At the time of terminating the irrigation supply during the week and readjustment on the first day of the week, the procedure and order of gate operation will be finalized through the experience in practice in the field.

In addition to the above operation rules, it is necessary to establish the operation rules in the case of emergency. Emergency operation will be classified into three cases as follows; i) typhoon, ii) troubles at main receiver/transmitter and iii) troubles at major control points. In the case of typhoon, the operation rule will be prepared corresponding to the signal number issued from PAGASA. In case of the machinery trouble, one of the base stations other than the dam station will take over the troubled station's tasks. As for the third case, the detailed operation rule will be prepared assuming possible occurrence of troubles at each major control point such as Gumain storage dam, diversion dams, etc.

In order to realize this operation rule, it is necessary to fulfill several conditions. The daily water balance should be made to decide the amount of irrigation water supply for the next week in accordance with the preceding week's operation. The micro-computer will be utilized for this purpose. The order for controlling or changing the control structures should be quick and simple. The wireless radio communication system will be utilized for this purpose.

(3) Maintenance and Repair

With regard to the maintenance activities, it is recommended to be carried out by two organizations; i) the O&M office and ii) the Farmer-Irrigators' Association (FIA). As mentioned in Chapter 3, about 57 FIAs will be established in the project area. The area covered by one FIA will be approximately less than 200 ha or under the sub-lateral. Minor maintenance and repair works for irrigation facilities under sub-lateral will be transferred to the FIA. These works will be vegetation control, small scaled desilting, lubrication of turnout gates, etc. Engineering support will be given by the staff of the O&M office.

Repair and maintenance works of the O&M office will be concentrated on the major irrigation and drainage facilities including the Gumain storage dam. The Repair and Maintenance Section will be responsible for these works. It is proposed that the daily maintenance activities would be intensified with cooperation between the Repair and Maintenance Section and the Operation Section. The field operational personnel under the Operation Section will be given responsibility over daily maintenance works which would always be required as soon as possible.

(4) Irrigation Service Fee Collection

Collection of irrigation fees is vital to the corporate life of the irrigation and drainage facilities, since it is considered as a major source of finance for operation and maintenance cost.

In normal cases, the rates of irrigation fees on irrigation systems operated and maintained by the NIA are determined under the Memorandum Circular #61, Series 1974 as follows:

1) For rice crops in gravity irrigation system;
   - 2 cavans of paddy per ha for the wet season crop,
   - 3 cavans of paddy per ha for the dry season crop, and
   - 3 cavans of paddy in case of a third crop.

2) For rice crops in pump irrigation systems;
   - 3 cavans of paddy per ha for the wet season crop,
   - 5 cavans of paddy per ha for the dry season crop, and
   - 5 cavans of paddy in case of a third crop.

3) For annual crops such as sugarcane and bananas; the cash equivalent at prevailing government price to 5 cavans of paddy per ha in gravity irrigation systems and 8 cavans of paddy per ha in pump irrigation systems.

4) For all other crops; the same rates as those for rice crops.

In case of the Gumain River Irrigation Project having a storage dam, following special rates of irrigation service fee are applied under the Board Resolution #2358 - 74 as follows:

1) For rice crop; 2.5 cavans per ha for the wet season crop, 3.5 cavans per ha for the dry season crop, and 3.5 cavan per ha in case of a third crop.

2) For annual crops; the cash equivalent at prevailing government price to 6 cavans per ha.

3) For other crops; the same rate as that of rice crop.

At present, irrigation service fees are collected directly from individual farmers by bill collectors or deputized collectors. However, in order to alleviate the burden on the O&M office, it is recommended that the Farmer-Irrigators' Associations (FIA) to be established in the project area should collect irrigation service fees themselves and remit these to the O&M office. In principle, the documents necessary for irrigation fee collection will be prepared by the O&M office and delivered to beneficiary-farmers through the FIAs. To systemize record keeping for irrigation fee collection, it is necessary that the list of beneficiary-farmers, their addresses, status of payment, etc. should be arranged as basic data.

The present system of irrigation fee collection has the following two items; i) penalty charge of 1% per month for non-payment of irrigation service fee and ii) exemption from irrigation service fee. The present penalty charge of 1% per month seems too low to discharge the deliquency effectively, considering the current interest rate of loans (18 - 24% per annum or 1.5 - 2% per month) and penalties imposed for non-payment of tax (surcharge of 10 - 20% and interest at the rate of 14 - 20% per annum). Therefore, it is recommended to impose heavier penalty in case of willful neglect. As for exemption from payment of irrigation service fee, it is very hard for the O&M office to administer the Board Resolution approving exemption from irrigation fees on damaged crop (in case of 40 cavan or less per ha) because of the procedural, managerial and financial constraints. Virtually, this kind of problem arising from a natural calamity, which is mostly considered as "force majeure", is often beyond the control and guarantee of an irrigation system. It is, therefore, expected that such matters related to the stabilization of livelihood of farmers should be solved considering various remedial measures such as crop insurance, natural disaster relief fund, accident compensation, etc., which were already established in and around the project area.

(5) Administrative Work and Farmers' Assistance

Administrative works will consist of personnel, accounting, cashiering and other general affairs services. As mentioned in Chapter 3, about 230 Farmer-Irrigators' Groups and 57 Farmer-Irrigators' Associations will be set up for the smooth operation and maintenance of irrigation water supply. For active and effective management, the assistance to these farmers' organizations will be required. The Farmers' Assistance Section will be responsible for the guidance of those organizations and the training of water users. Monitoring and evaluation on the effects of irrigation development are also conducted by this section.

2.2.4 O&M Facilities

The list of facilities for operation and maintenance is shown in Table 9.6. Major O&M facilities are equipments for monitoring system, heavy equipment such as bulldozer, motor grader, etc. and vehicles.

For the control of irrigation water delivery, the introduction of a centralized monitoring system is proposed as mentioned in the previous section 2.2.3. This monitoring system is a remote monitoring system but not a remote control system. The general concept of the proposed monitoring system in the O&M office is shown in Fig. 9.7. The monitoring system comprises a central station and several field stations.

The central station will be established in the Operation Section, and this station will be equipped with a micro computer and its accessories such as floppy disc-memory, disc-drive, printer, etc. Major functions of this station are; i) collection of water management data from field stations and processing those data, ii) computer processing of the water balance and statistical and other necessary calculations, iii) storing the water management data in the floppy disc-memory and iv) filing through printer. For the processing of billing, irrigation fee collection, and other administrative matters, the Billing and Cellection Section and the Administrative Section can be done by the computer facilities.

As for field stations, there are two types, one is the stations such as the reservoir dam station, diversion dam stations and major head gate stations. These field stations will work as the field head quarters which will receive the control order from the central station, and transmit to the field personnel. The other one is the stations facilitated with the measuring devices such as rainfall and water level gauges. The function of these stations is only to collect and transmit data to the central station. The list of the stations is summarized as follows:

	No. of Facilities	No. of Station
Central station	-	1
Field station		
- Reservoir dam	1	1
- Diversion dam and head gate	29	12
- Water level gauge	4	4
- Rainfall gauge	5	5

In order to maintain good liaison between the central staion and the field stations, the wireless radio system will be introduced as a communication network. The proposed system will be the VHF symplex wireless radio network. Hydrological data are the key data for operation. The setting-up of hydro-meteorological stations is necessary together with the introduction of communication system. It will be required to arrange the communical rule between the O&M office and other agencies such as PAGASA, PHILSUCOM, etc. concerning the transfer of hydro-meteorological data.

At present, the existing irrigation systems in the project area have some O&M equipment, however, these will be depreciated before the commencement of operation and maintenance of the project. Therefore, all O&M equipment listed in Table 9.6 will be newly purchased by the O&M office.

CHAPTER 3 FARMERS' ORGANIZATION

3.1 General Profile of Farmer and Farmers' Organization in the Project Area

The number of farm households in the project area amounts to 4,830/1 households for rice cultivation farmer and 210/1 households for sugarcane planter. As mentioned in Appendix IV, their average farm sizes are estimated at 2.3 ha and 27.0 ha, and typical farm sizes are 1.3 ha and 4.0 ha, respectively. With respect to land tenurial status, about 54% of the total rice cultivation farmers are occupied by lessee and 77% of the total sugarcane planters are owner operator.

In order to instigate farmers' participation in operation and maintenance of the irrigation system, Farmer-Irrigators Organizations (FIO) have been instituted in the PGRIS area under the assistance of the PGRIS office. According to the data obtained from the PGRIS office, there exist at present 9 FIOs in the PGRIS area with a total membership of 891 farmers covering about 910 ha.

3.2 Plan of Farmers' Organization Set-up

3.2.1 General

In order to ensure the irrigation development and to manage smoothly and effectively the operation and maintenance of irrigation system, the institution of the Farmer-Irrigators' Group (FIG) and the Farmer-Irrigators' Association (FIA) has been promoted by the NIA. These farmers' organizations play a key role in the promotion of irrigated agriculture through the implementation of sustained and effective farm level water management program and proper system of operation and maintenance. According to the basis policy on farmers' organization of the NIA, FIG and FIA will be instituted in the project area.

/1: The number of farm household in the project area is estimated as below:

$$\left\{\begin{array}{c}\text{Total farm household} \\ \text{in the study area}\end{array}\right\} \times \left\{\frac{\text{Farm land in the project area}}{\text{Farm land in the study area}}\right\}$$

Rice cultivation farmer: 5,230 households x 11,000 ha/11,900 ha
= 4,830 households

Sugarcane planter : 250 households x 5,750 ha/6,800 ha
= 210 households

3.2.2 Proposed Farmers' Organization

As mentioned in Section 3.1, the farming type in the project area consists of the following two types; i.e. the rice cultivation farmers and the sugarcane planters. The consumption pattern of irrigation water is quite different between them. For the set-up of farmers' organizations, therefore, the following two organizations are considered:

(1) Organization of Rice Cultivation Farmer

For the operation and maintenance of the irrigation and drainage systems in the on-farm level, the FIG will be organized by beneficial farmers. The FIGs are established by each rotational area of about 50 ha consisting of 20 farm households on an average in the project area. These FIGs are federated into the FIA. According to the criteria of the NIA, FIA is organized to cover 500 - 700 ha as a standard size. However, it seems that this standard size is too large, considering the number of farmers to be mobilized in a short time. Therefore, it is proposed to determine the optimum size of FIA from the standpoint of establishment of a cohesive face-to-face association. In view of this, the FIA is proposed to be established at the rate of about one association per 200 ha of irrigation block controlled by a sub-lateral. The number of FIGs and FIAs for rice cultivation farmers will reach about 220 and 55 organizations, respectively.

(2) Organization of Sugarcane Planter

Sugarcane planters in the project area vary widely in farm size from 4 ha to 150 ha. Therefore, it is proposed that the FIG will be established as a unit of 20 sugarcane planters. As for the FIA, five FIGs are federated into one FIA. The number of FIG and FIA is estimated at about 10 and 2, respectively.

The FIA will be administered by a Board of Directors, composed of five members; President, Vice President, Secretary, Treasurer, and Auditor. The Board of Directors will have entire charge of the affairs and properties of the FIA and general management of those activities and operations. For its smooth operation, three sections, namely O&M, Fee Collection and General Services Sections will be created under this Board as illustrated on Fig. 9.8.

It is recommended that those FIAs will be federated into one representative farmer's organization, namely, the Federal Farmer-Irrigators' Association (FFIA). For the planning of irrigation schedule and crop rotation schedule, the O&M office and the water users will be closely interlinked. Such inter-linkage by each irrigation unit such as rotational area, the area covered by sub-lateral, etc. will be carried out through the perfect liaison between the AWMT/WM and the FIAs. And then, the overall plan on those schedules in the whole irrigation service area will be made between the O&M offices and the FFIA.

3.2.3 Activities of FIA and O&M Office Responsibility

Legally, the FIA will be formed as non-stock corporations. In concrete terms, the activities of FIA are summarized below;

1) Cleaning and maintenance of irrigation and drainage canals and related structures in the irrigation service area,

2) Scheduling of water delivery within the FIA area,

3) Preparation of report on irrigated area,

4) Check of collection bills for all FIA members, and

5) Collection of irrigation service fees and remittance them to the O&M office.

In return for the cooperative activities of FIA, the O&M office will be, as a rule, responsible for; i) providing the required volume of irrigation water, ii) taking charge of major repairs to the irrigation and drainage facilities, iii) granting management and maintenance costs for the area controlled by a sub-lateral, iv) providing maps and other documents necessary for fee collection, and v) giving incentives/bonus to the FIAs which attain the highest efficiency rates in irrigation fee collection.

With regard to the above item v), at present, the NIA gives incentives to the FIA in accordance with the following criteria:

1) If the FIA achieves the efficiency of fee collection of more than 70%, incentive is applied in the following manner:

Efficiency	Incentive
70 - 79%	1% of total amount of collection
80 - 85%	2% "
86 - 90%	3% "
91 - 95%	4% "
96 - 100%	5% "

2) If the FIA pays their back account, the NIA gives two percent (2%) of their total collection.

3.2.4 Schedule of Farmers' Organization Set-up

As shown in Fig. 9.9, the implementation schedule of farmers' organization set-up will be executed for the period of six years under construction stage, after preparation of parcellary maps in the project area.

The preparation of the parcellary map necessary for setting-up of the farmers' organization will be made by the field survey during the period of 18 months from January 1987 to June 1988, based on the cadastral maps prepared by the Ministry of Agrarian Reform. Based on this parcellary map, the FIG will be organized firstly, for each rotational area step by step. The setting-up of FIG will be carried out over a period of six years during the construction stage, starting from January 1988 and finishing in December 1992. The FIA will be established in parallel with the organizing the FIG. As for the setting-up of the FFIA, it will be finally instituted in December 1992. During the construction stage, the project executing office would function as the FFIA instead. With regard to the existing farmers' organization, there are 9 FIOs in the project area. These would be reorganized into the FIG which would be newly established in the project area.

In the process of setting up the FIG and the FIA, the farmers will not be disciplined sufficiently for management. Therefore, prior to and after organization of the farmers into an association, it is indispensable to conduct the following training at each stage of development:

1) An information course for farmers on the project orientation,

2) A project comprehensive course for orienting farmers on the benefits and organizational requirements of the project,

3) An effective training course for farmer-leaders, and

4) A refresher training course for farmers and farmer-leaders.

Table 9.1 OFFICERS' STAFF IN THE EXISTING IRRIGATION SYSTEMS (AS OF MARCH, 1984)

Speciality	PGRIS/1	CRIS/2
Irrigation Superintendent	1	1
Assistant Irrigation Engineer	1	1
Watermaster (AHMT)	6	1
Gatekeeper	5	1
Ditchtender	24	6
Heavy Equipment Operator	1	0
Driver	3	1
Cashier	1	1
Accounting Clerk	1	1
Bill Collector	2	1
Bill Clerk	2	1
Clerk	1	2
Storekeeper	1	1
Janitor	1	1
Total	47	16

Remarks: /1: Porac Gumain River Irrigation System
/2: Caulaman River Irrigation System

Table 9.2 O&M FACILITIES

(As of Dec., 1983)

Type of Equipment	Condition	PGRIS Total	PGRIS Grand Total	CRIS Total	CRIS Grand Total
(1) Light Equipment					
1. Jeep	A - 1	1		1	
	A - 3	3	4	0	1
2. Pick-up	A - 1	3	3	2	2
3. Stake Truck	A - 1	1			
	A - 3	1	2	1	1
4. Cargo Truck	A - 1	0	0	1	1
5. Dump Truck	A - 2	1		0	
	A - 3	0	1	1	1
6. Motorcycle	A - 1	6	6	0	0
(2) Heavy Equipment					
1. Mobile Crane - PBH R125	A - 3	1	1	0	0
2. Tractor - TD-9	A - 2	1	1	0	0
3. Grader	A - 3	1	1	0	0
4. Dozer	A - 1	0		1	
	A - 3	1	1	0	1
5. Cat Loader	A - 2	0	0	1	1

Remarks: A-1: Good Condition
A-2: Need minor repair
A-3: Need major repair

Table 9.3 IRRIGATION FEE COLLECTION IN THE EXISTING IRRIGATION SYSTEMS

Description		1980	1981	1982	Average
PGRIS					
Service Area					
- Wet	(ha)	4,866	4,900	4,900	4,889
- Dry	(ha)	4,237	3,600	3,600	3,812
Total	(ha)	9,103	8,500	8,500	8,701
Irrigation Fee					
- Collectible	(₱10³)	1,459	1,413	1,597	1,490
- Collection	(₱10³)	377	509	653	513
Efficiency	(%)	25.8	36.0	40.9	34.4
CRIS					
Service Area					
- Wet	(ha)	568	529	533	543
- Dry	(ha)	622	401	417	480
Total	(ha)	1,190	930	950	1,023
Irrigation Fee					
- Collectible	(₱10³)	195	164	180	180
- Collection	(₱10³)	68	90	90	83
Efficiency	(%)	34.9	54.9	50.0	46.1

Source: PGRIS and CRIS office

Table 9.4 OPERATION AND MAINTENANCE COST

(Unit: ₱10³)

Item	PGRIS			CRIS		
	1980	1981	1982	1980	1981	1982
I) Personnel Expenses	612.1	813.4	703.5	105.8	134.6	121.9
1) Salaries	388.9	393.2	316.7	45.5	51.9	46.7
2) Government Share	28.7	14.9	24.6	4.3	4.9	4.4
3) Wage	35.3	22.5	43.4	18.7	21.3	19.3
4) Cost of Living Allowance	104.4	278.2	208.2	21.6	36.0	32.1
5) Amelioration Allowance	10.6	42.7	45.7	6.4	7.3	6.5
6) Representation Allowance	1.2	2.4	2.4	1.8	1.8	2.4
7) Incentive Allowance	43.0	53.7	55.2	7.5	11.3	9.6
8) Pag-ibig Fund	-	5.8	7.3	-	0.1	0.9
II) Other Expenses	53.2	35.3	56.1	8.6	6.7	8.9
1) Traveling Expenses	10.0	2.9	-	1.5	0.9	1.0
2) Sundries & Other Expenses	10.7	5.5	4.8	0.8	0.2	0.3
3) Supplies & Materials, Spare Parts	12.5	2.3	20.1	2.8	1.6	1.8
4) Gasoline & Oil, Collection Expenses and Others	20.0	24.6	30.9	3.5	4.0	5.8
Total	665.3	848.7	759.6	114.4	141.3	130.8
Ratio of Personnel Expenses (%)	(92.0)	(95.8)	(92.6)	(92.5)	(95.3)	(93.2)

Source: PGRIS and CRIS offices

Table 9.5 PERSONNEL REQUIREMENT IN THE O&M OFFICE

	Staffs		Number
1)	Project Manager		1
		- Secretary	1
2)	Operation Engineer/1		1
3)	Administrative Section	- Administrative assistant	1
		- Personnel aide	1
		- Accounting clerk	1
		- Cashier	1
		- Property custodian	1
		- Clerk	4
		- Storekeeper	1
		- Typist	1
		- Utilityman	1
		- Security guard	3
		- Janitor	2
4)	Repair and Maintenance Section	- Supervising engineer	1
		- Engineer	1
		- Mechanic	2
		- Geodetic engineer	1
		- Electrician	1
		- Carpenter	1
		- Mason	1
		- Heavy equipment operator and driver	30
		- Foreman	1
		- Laborer	5
5)	Operation Section	- Irrigation engineer	3
		- Hydrologist	1
		- Computer engineer	1
		- AKMT/KM	21
		- Ditchtender	84
		- Gatekeeper	12
		- Ratio operator	1
		- Clerk	1
		- Typist	1
		- Measurement aide	5
6)	Billing and Collection Section	- Collection representative	1
		- Bill collector	2
		- Irrigation fee collector	3
		- Typist	1
7)	Farmer's Assistance Section	- Agronomist	1
		- Irrigation association organizer	20
8)	Dam and Reservoir Section	- Assistant operator	1
		- Operator aide	12
		Total	235

Remarks: /1: Operation engineer is in charge of both the Operation Section and the Dam and Reservoir Section.

Table 9.6 PROPOSED O & M FACILITIES

Item	Number
1) O & M Equipment	
1.1 Heavy Equipment	
- Back-hoe shovel (0.35 m^3)	2
- Bulldozer (11 tons)	1
- " (5 tons)	2
- Motor Grader (Blade 3 m)	2
- Soil Compactor (90 kg)	3
- Vibration Roller (5 tons)	1
- Tire Roller (10 - 20 tons)	1
- Portable Concrete Mixer (0.2 m^3)	2
- Concrete Vibrator (ø32 mm)	4
- Submergible Pump (ø150 mm)	2
2.2 Light Equipment	
- Dump Truck (8 tons)	4
- " (2 tons)	6
- Truck (Pickup Type, 2 tons)	2
- Trailer Truck (15 tons)	1
- Jeep (4-wheel Drive)	8
- Motorcycle	40
2.3 Others	
- Micro Computer	1
- Automatic Rain Gauge	2
- Automatic Water Level Gauge	2
- Current Meter	6
- Radioset	1
- Walkie-Talkie	15
- Repair Shop Tools	Various
2.4 Spare Parts	Various
2) O & M Quarter and Motor Pool	(1,500 m^2)

Fig. 9.1 ORGANIZATION CHART OF NIA

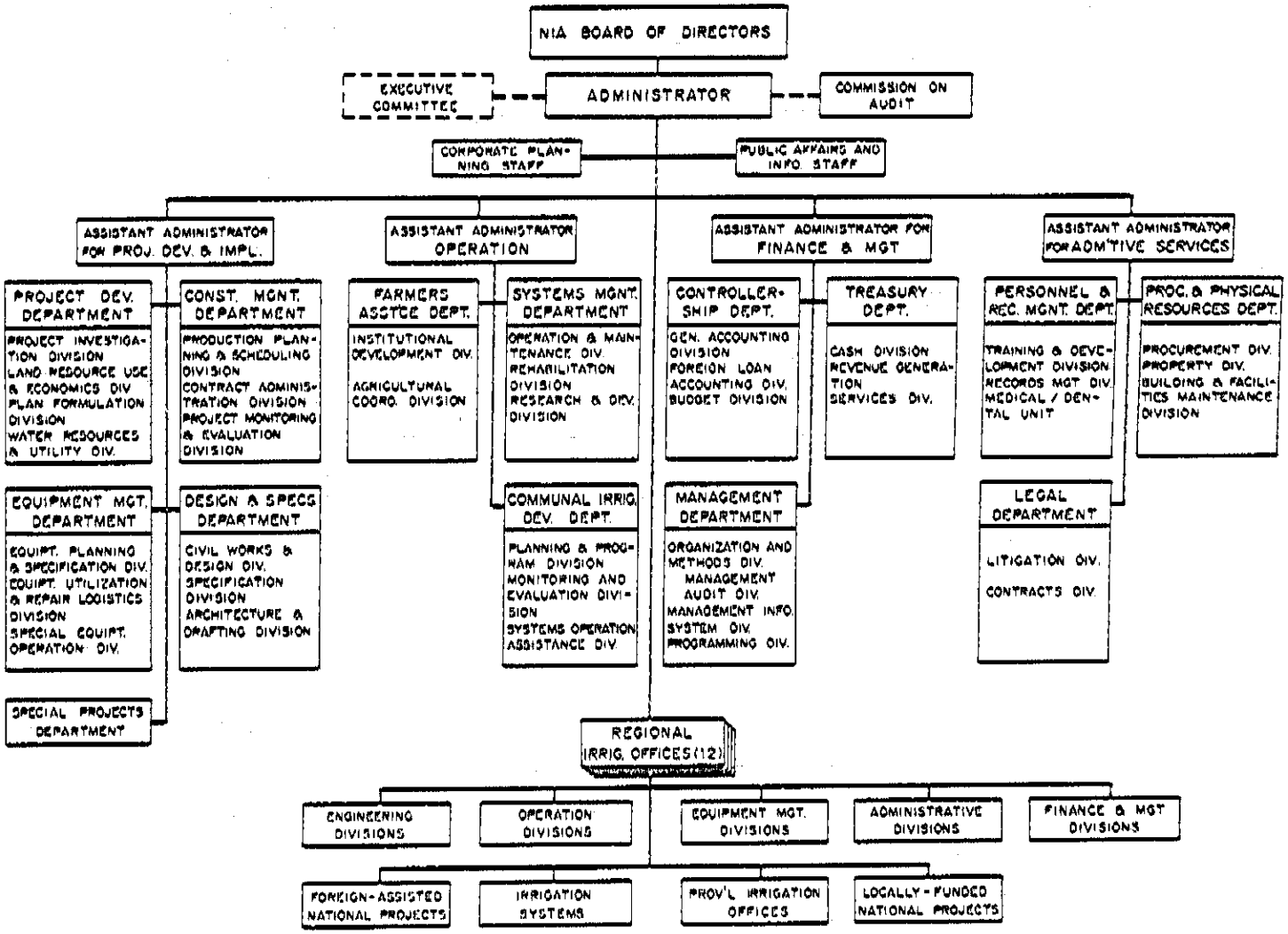


Fig. 9.2 PROPOSED ORGANIZATION OF PROJECT EXECUTING OFFICE

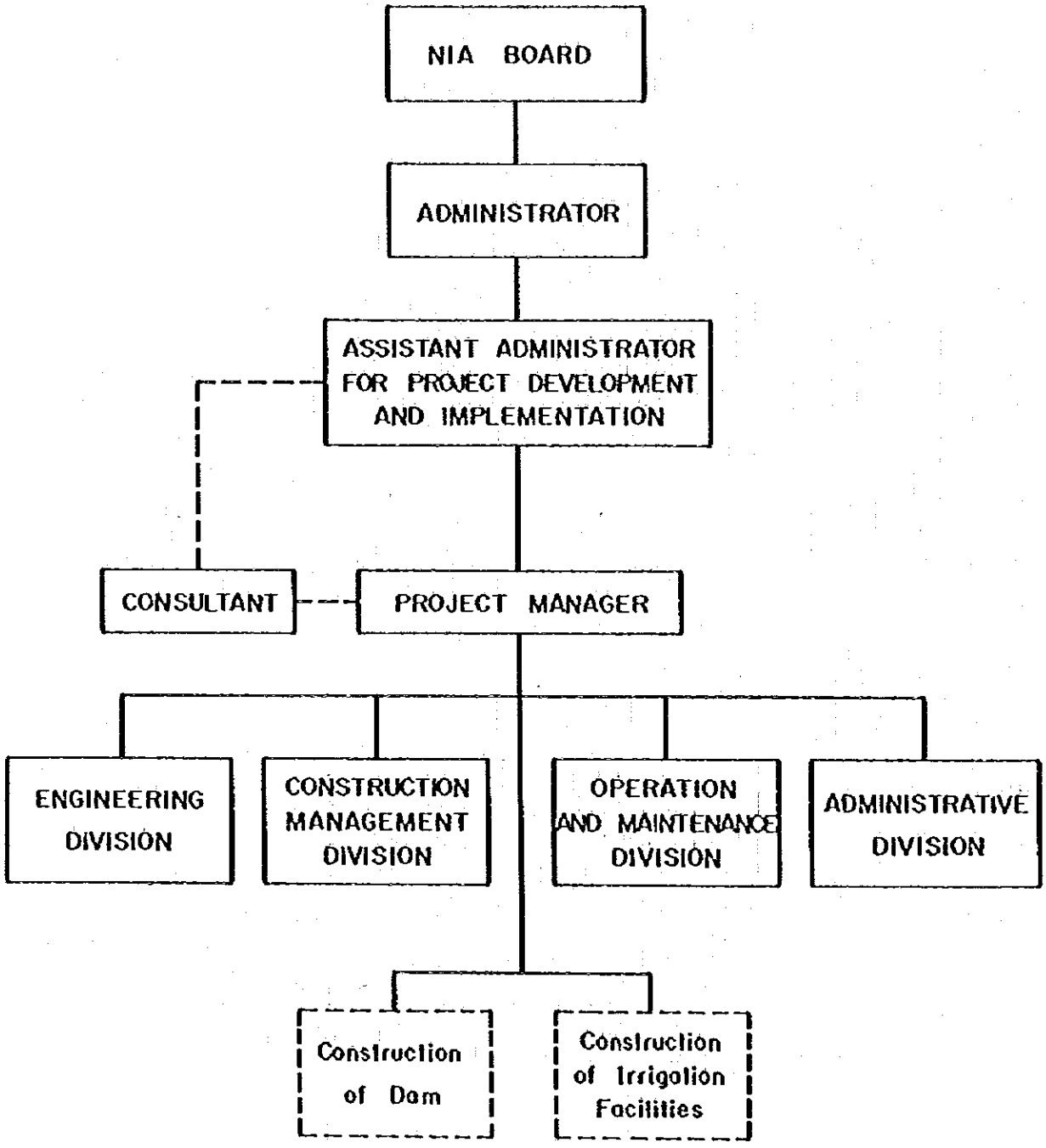


Fig. 9.3 ORGANIZATION CHART OF PGRIS AND CRIS

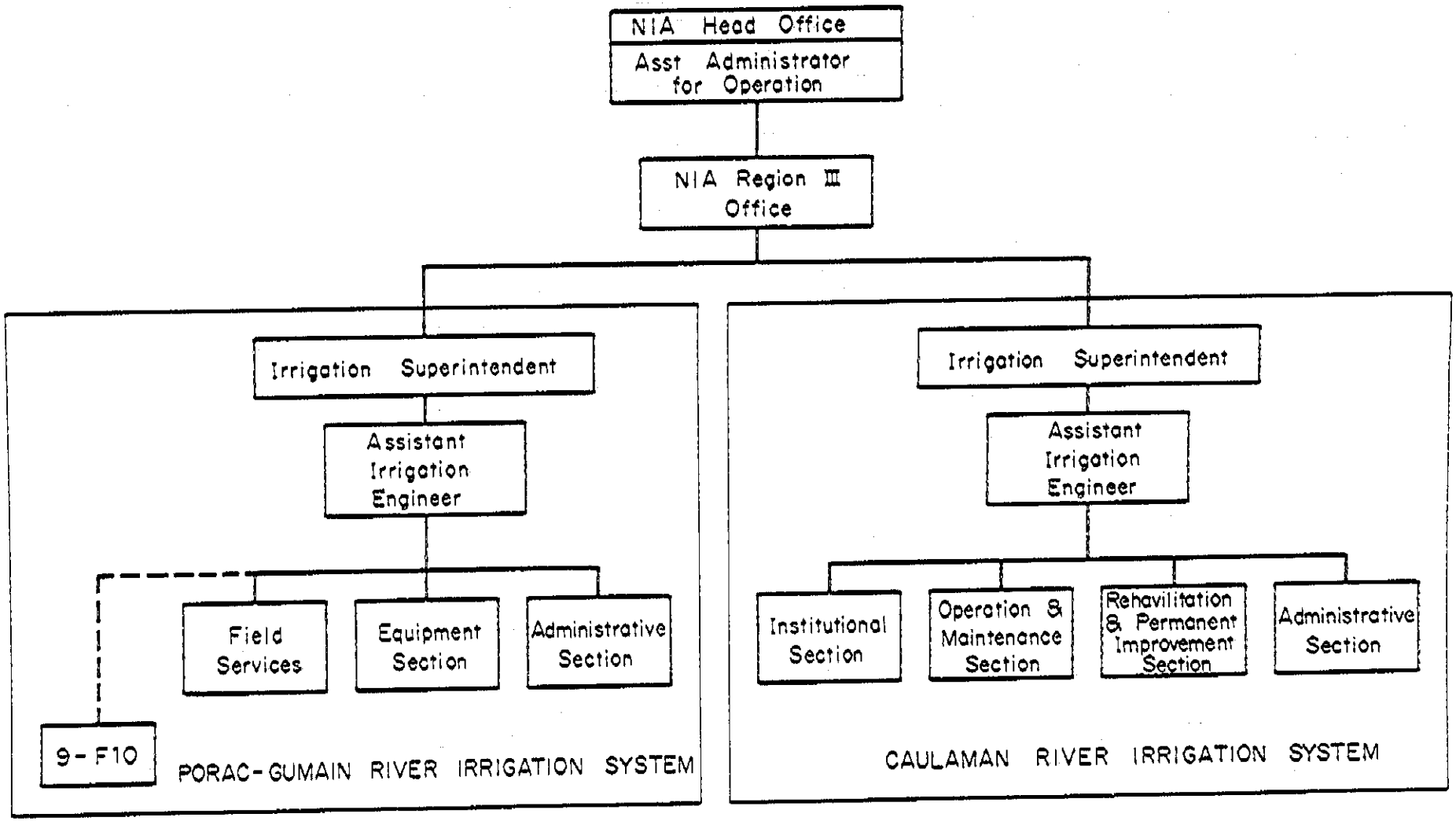


Fig. 9.4 ANNUAL ACTIVITY NETWORK FOR IRRIGATION SYSTEM MANAGEMENT

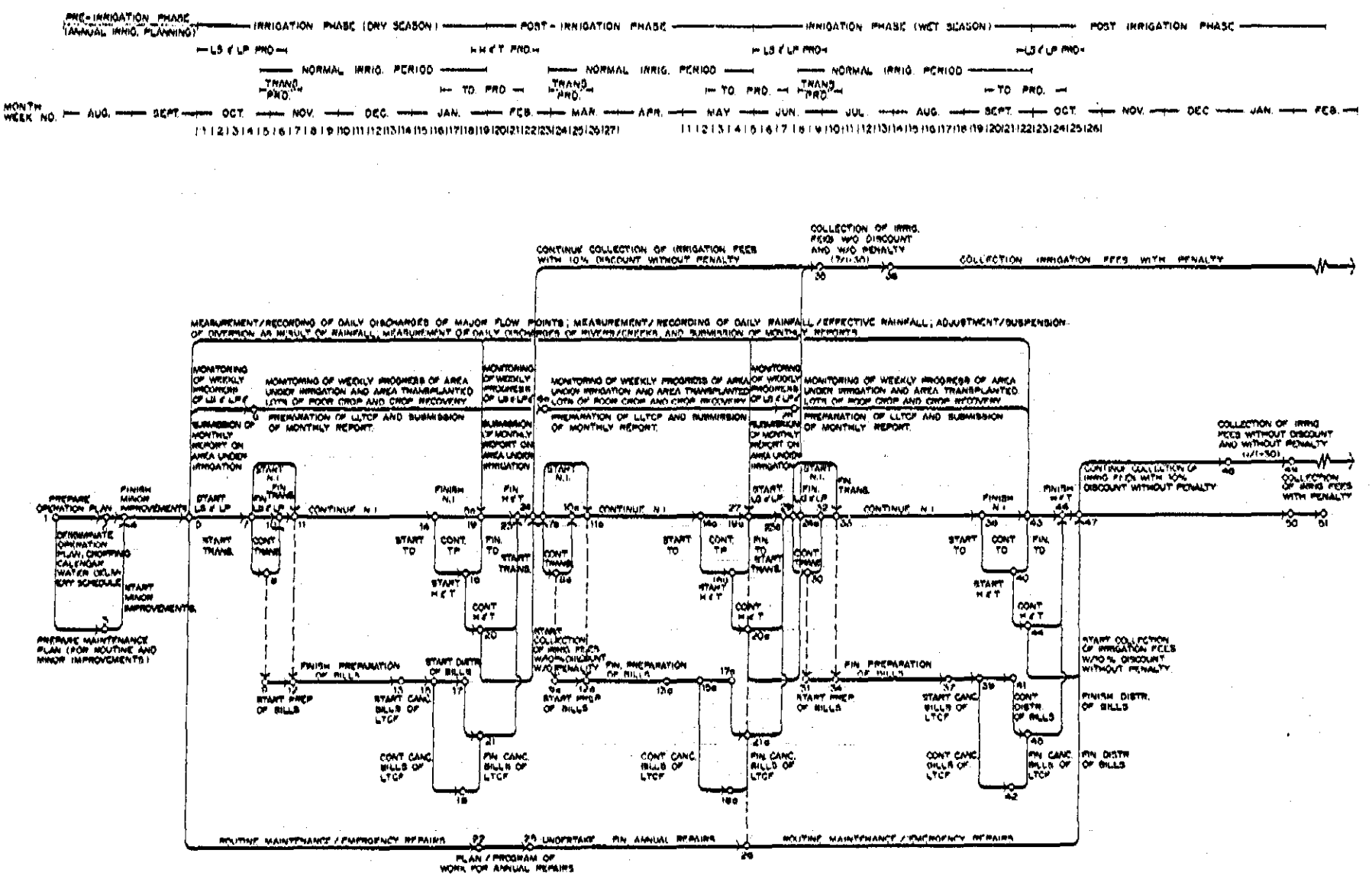


Fig. 9.5 PROPOSED ORGANIZATION FOR OPERATION AND MAINTENANCE

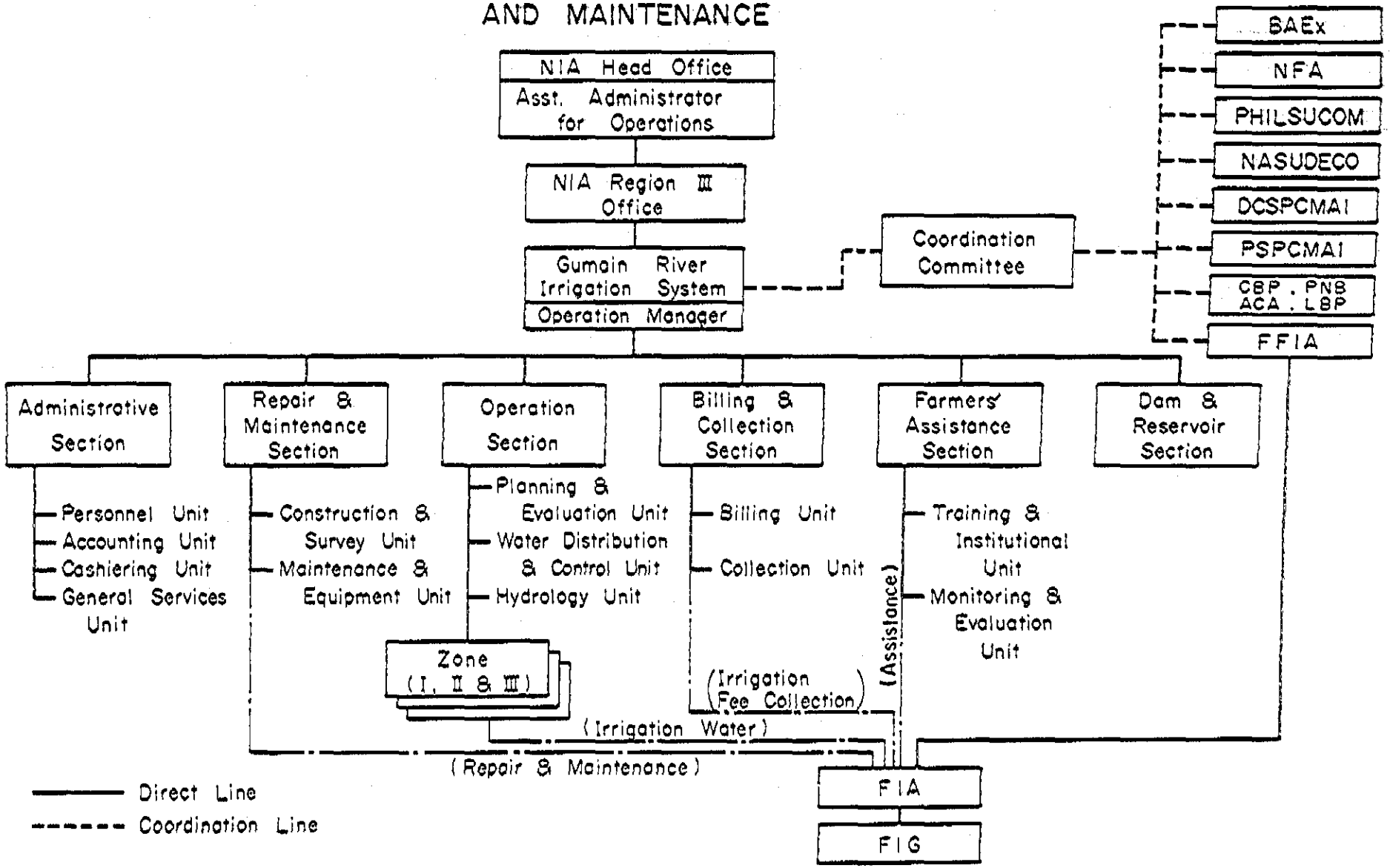


Fig.9.6 RELATION BETWEEN IRRIGATION NETWORK AND IRRIGATION DISTRICT

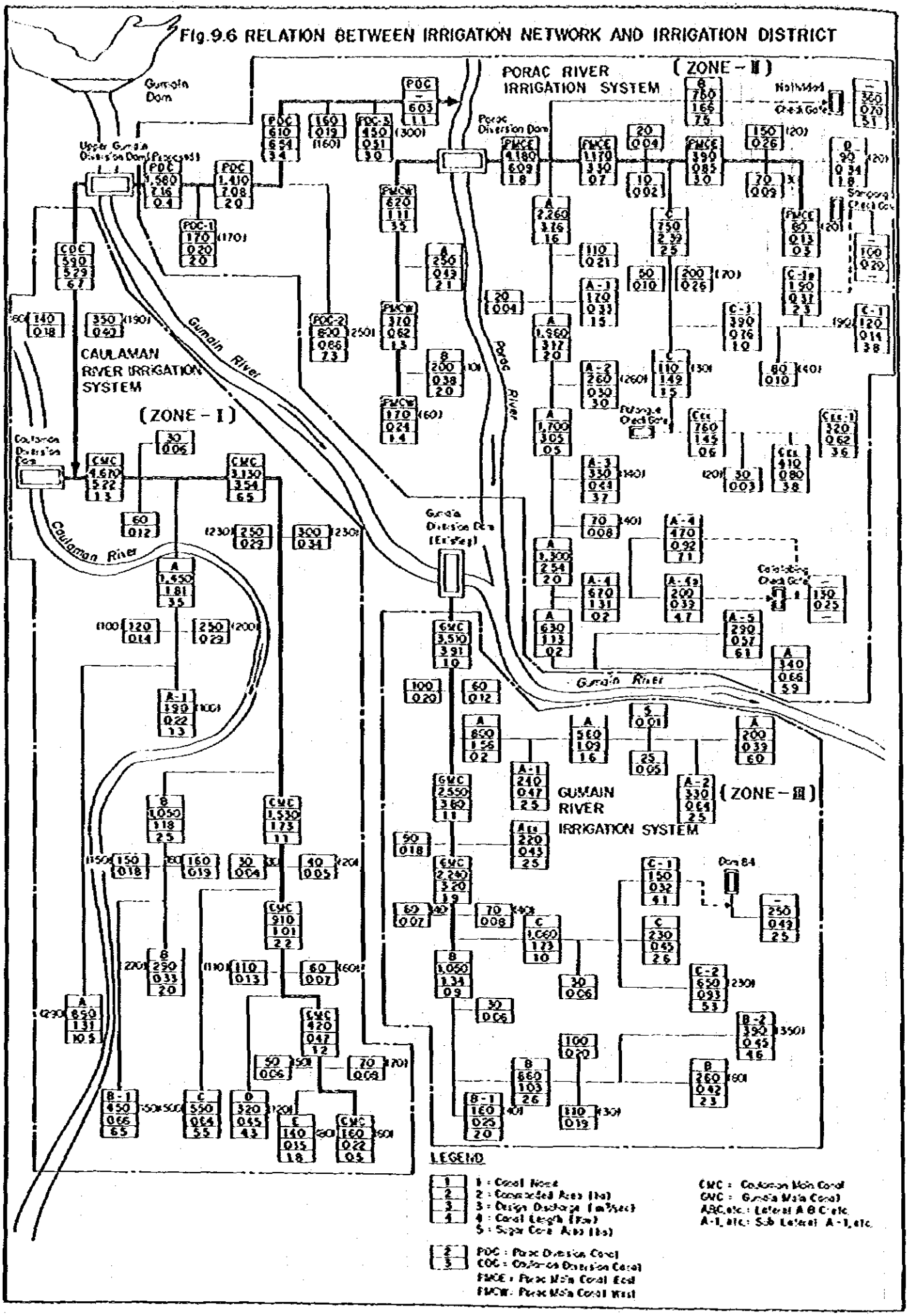


Fig.9.7 GENERAL CONCEPT OF OPERATION AND MONITORING SYSTEM

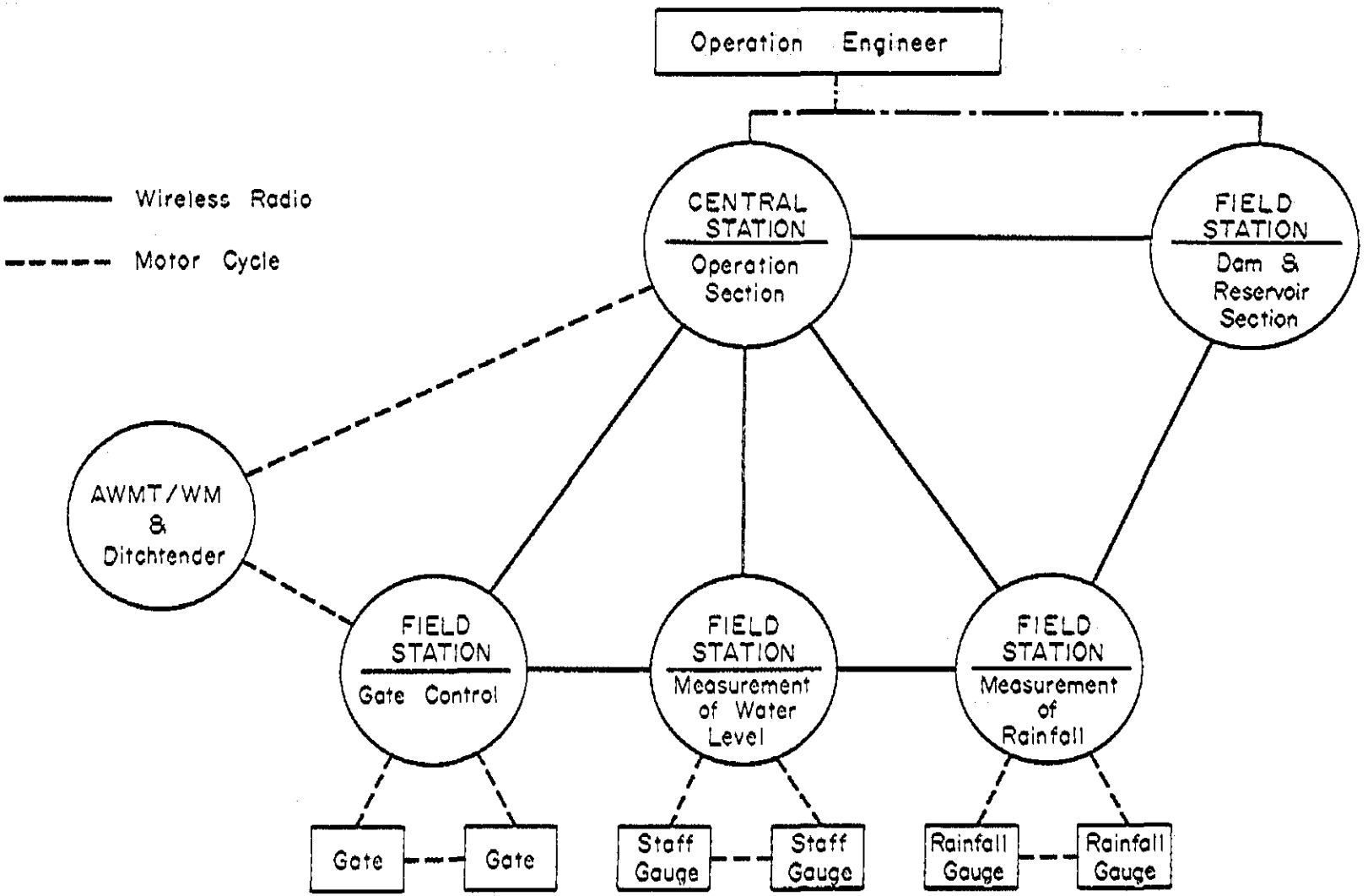


Fig.9.8 PROPOSED ORGANIZATION CHART OF FARMER IRRIGATION ASSOCIATION

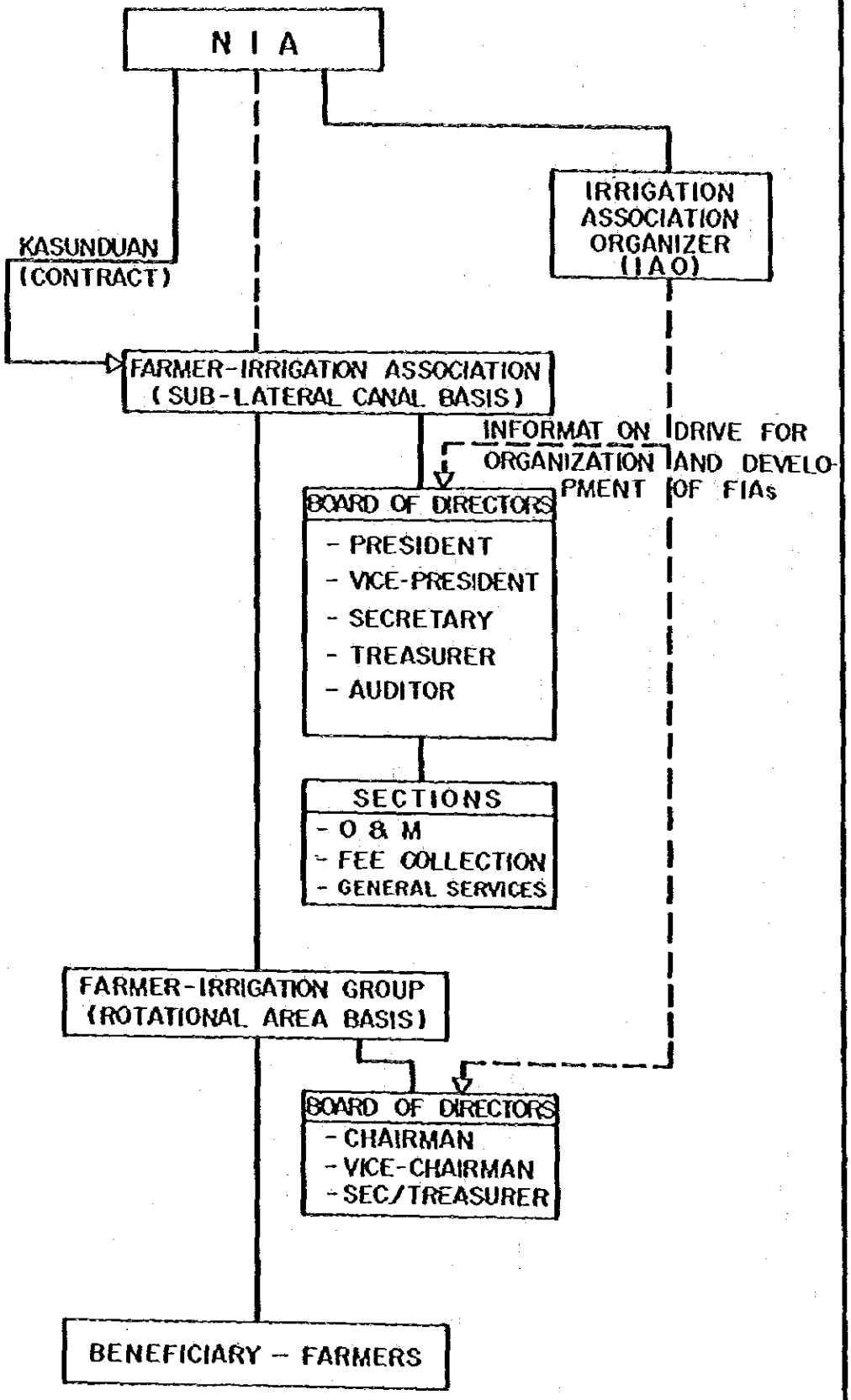
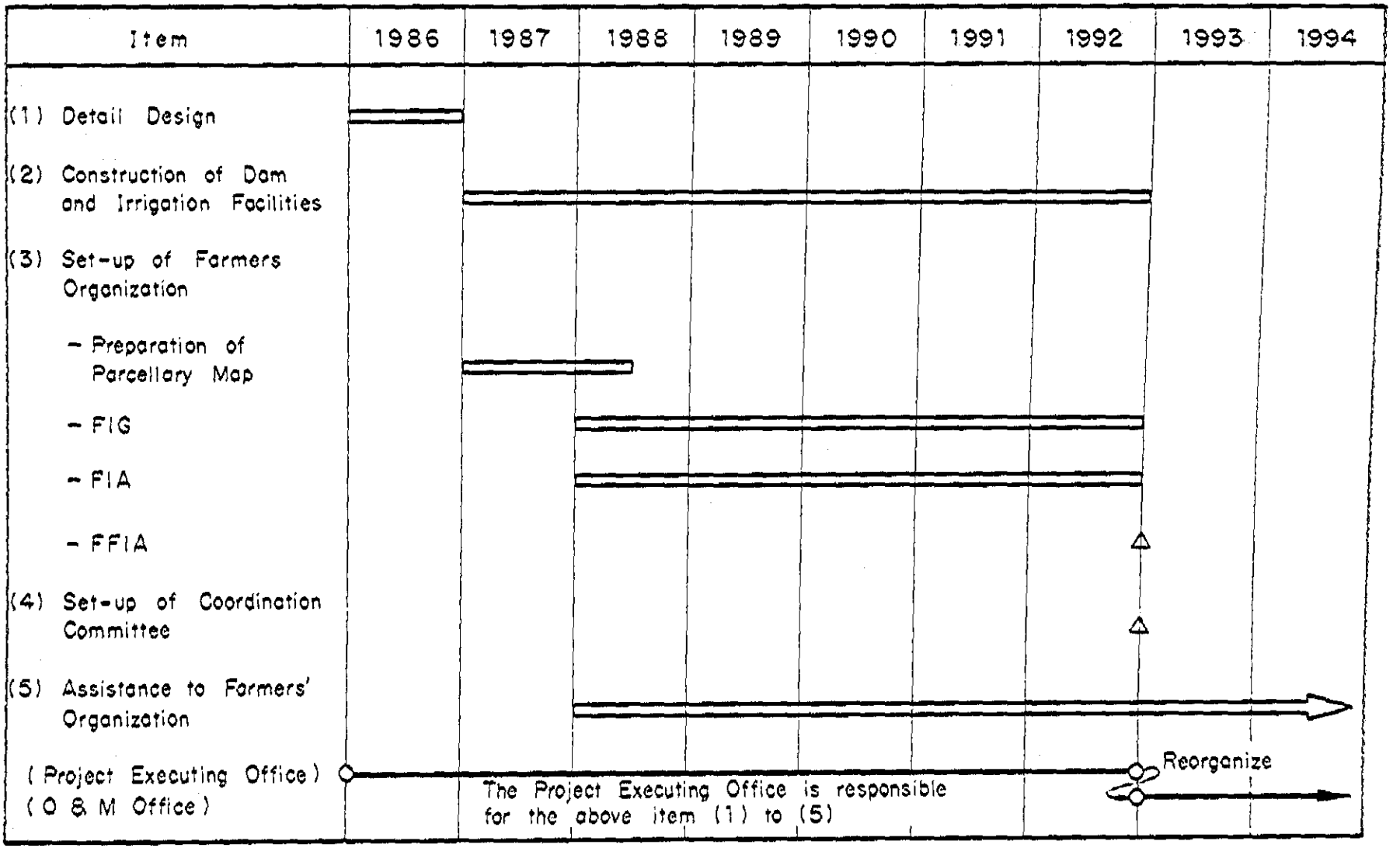


Fig. 9.9 SCHEDULE OF FARMER'S' ORGANIZATION SET-UP



APPENDIX X

CONSTRUCTION PLAN AND COST ESTIMATE

APPENDIX X CONSTRUCTION PLAN AND COST ESTIMATE

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APPENDIX X CONSTRUCTION PLAN AND COST ESTIMATE

CHAPTER 1 CONSTRUCTION PLAN

1.1 General

Construction works of the Project consist of new construction works and improvement works. New construction works are Gumain dam, upper Gumain diversion dam, Porac and Caulaman diversion canals and so forth. Improvement works are mainly rehabilitation of existing facilities and earth works relation with irrigation and drainage canals. On-farm development works, such as construction works of small canals, land leveling, setting up of small gates, farm road networks and others are also executed as a irrigation and drainage facilities.

As these construction works of the Project are mainly concerned with earth works, due attention must be paid to the characteristics of earth materials which directly affect earth moving plan, selection of construction equipment, specification of dam embankment and so forth. Major construction works having big volume of earth moving would be executed by heavy construction machineries and the remaining minor works be implemented by manpowers to increase the employment opporunity of the local people in and around the project area.

1.2 Basic Assumption of Construction Planning

1.2.1 Conversion Rate of Earth Volume

Earth volumes are changeable according to the natural conditions as they are. Naturally placed earth materials would increase the volume after excavation and decrease after compaction. These changes of volume should be considered for estimation of produced volumes by construction machinery or earth moving plan. The conversion rates of earth volumes are assumed as follows:

Abbreviation	Class of Earth	Apparent Unit Weight	Conversion Rate		
			In Place	In Loose	In Compaction
S	Sand	1.7	1.00	1.20	0.95
N/S	Normal Soil	1.6	1.00	1.25	0.90
C/S	Clayey Soil	1.8	1.00	1.35	0.90
G & W/R	Gravel & Weathered Rock	1.9	1.00	1.20	1.00
R	Excavated Rock	2.5	1.00	1.50	1.20

1.2.2 Basic Method of Earth Works

Earth works consist of excavating, loading, hauling, spreading and compacting. Since there are various methods for these earth works, due consideration must be made on the choice of the suitable method. Earth works of the big volumes would have to be depended on a heavy duty equipment.

Following equipments would be basically introduced on these earth works of the project.

Earth Works	Earth Materials	Proposed Equipments
Excavation	Sand, Normal Soil, Gravel Weathered Rock, Rock	Bull-Dozer, Back-Hoe Shovel Ripper-Dozer, Back-Hoe Shovel Blasting & Bull-Dozer
Loading	Any Kind of Materials	Tractor Shovel, Back-Hoe Shovel
Hauling	- do -	Dump Truck
Spreading	- do -	Bull-Dozer
Compacting	Impervious Materials Coarse Materials Normal Soil	Tamping Roller Vibration-Roller, Tire Roller Compactor, Tamper

1.2.3 Workable Days

Earth works are mostly affected by rainfall. Since embankment of impervious materials of dam are controlled by moisture density, special attention must be paid to excute the construction works for rainly days. Suspention days of these earth works caused by rainfall are assumed as following criteria according to the daily rainfall intensity.

Daily Rainfall Intensity (mm/day)	Suspention of Work (day)
0 - 10	0
10 - 30	1
30 - 50	2
50 - 100	3
more than 100	4

Annual mean workable days were estimated on the basis of the above criteria and the rainfall records in Basa Air Base for recent 10 years, and the computed result is shown as follows:

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1974	31	27	29	30	27	16	20	10	28	20	22	29
1975	27	28	31	29	28	27	29	15	24	20	29	28
1976	31	27	31	30	21	23	22	15	17	28	29	31
1977	28	28	31	27	28	28	19	20	13	31	26	31
1978	31	28	31	30	28	24	20	8	18	21	30	31
1979	31	28	31	30	28	24	23	15	27	27	30	31
1980	31	29	31	30	29	25	18	26	19	28	25	31
1981	31	28	31	30	31	15	23	23	28	24	29	31
1982	31	28	31	30	31	26	15	18	21	30	30	31
1983	31	28	31	28	31	29	25	25	16	26	29	31
Total	303	279	308	294	282	237	214	175	211	255	279	305
Workable Days	30.3	27.9	30.8	29.4	28.2	23.7	21.4	17.5	21.1	25.5	27.9	30.5

The result shows that less than 25 days of general workable days concentrate in the wet season from June to October. Therefore, workable days for impervious materials were decided to be 25 days in the dry season and 22 days in the wet season, and total 285 days in a year.

1.3 Gumain Dam Construction

1.3.1 Earth Moving Plan

From the result of the soil mechanical and geological investigations, each zone material of the dam would be obtained from the following places:

Zone	Place
Zone 1	Borrow Area 1 (N/S), Spillway (N/S)
Zone 2	Q-1 (W/R, R), Spillway (R), Dam (W/R, R)
Zone 3	Q-1 (R), Dam (R)
Filter	River Deposit (Sand)
Riprap	River Deposit (Gravel)

Taking into account these usable materials, conversion rate of earth, most economical construction method, etc., the earth moving plan for the dam is confirmed as shown in Table 10.1.

1.3.2 Construction Procedure of the Dam

Prior to the excavation of dam foundation, diversion tunnel should be constructed to prevent from flood during the dam construction. Excavation of dam foundation would be started from both abutments because of having steep slope, and after completion of the works, excavation of the river bed would be conducted. Foundation treatment should be made from river bed in order to enable earlier dam embankment works and remaining both sides treatment works might be gradually carried out prior to the dam embankment. Excavation of spillway would be executed in paralled to the dam embankment, because the useful excavated materials are planned to haul directely to the dam, and concrete works would be carried out after completion of the excavation.

1.3.3 Construction Method

(1) Diversion Tunnel

As a diameter of the tunnel is rather big, excavation works would be divided into two sections of upward and downward. Excavation of upper section would be executed by blasting and picking, and excavated materials be gathered by bull-dozer, loaded by side dump loader and hauled by dump-truck. After one cycle of the excavation, iron support with sheet pile should be immediately set up around the excavated face. Concrete lining of upper section would be executed by using steel form after completion of the excavation. Excavation and concrete lining of down section would be proceeded after completion of above upper section of concrete lining.

(2) Excavation of Dam Foundation

Stripping and normal soil excavation would be mainly made by bull-dozer and back-hoe shovel, while weathered rock be excavated by ripper-dozer. Rock materials would be broken by blasting and gathered by bull-dozer. After excavated, these materials would be loaded by tractor shovel or back-hoe shovel and hauld by dump-truck to the stock yard or the spoil area.

(3) Foundation Treatment

After excavation of the dam core trench, curtain grouting would be executed. After completion of grout holes drilled by hydraulic boring machines, cement milk mixed by mortal mixer would be poured into the holes under the controlled pressure by grouting pump. For making sure the grouting condition, test hole would be drilled and grouted effect be checked by observation of the lifted core. If non-effective condition is observed, supplemental grouting around there is proposed.

(4) Embankment

According to the earth moving plan estimated in Table 10.1, embankment materials to be transported from the proposed areas would be spreaded by bull-dozer at the specified thickness and compacted by suitable compacting machines. The specified thickness of spreading, numbers of compaction runs and suitable compacting machines are proposed as follows:

Zone	Spreading (cm)	Compaction (runs)	Compacting Machine
Zone 1	20	6	Tamping Roller
Zone 2	40	4	Vibration Roller
Zone 3	60	4	Vibration Roller
Filter	30	4	Compactor
Riprap	30	4	Compactor

Impervious materials of Zone 1 would be strictly controlled by the D-value, and other materials be done by the relation between minimum and maximum dry density. The water contents would be checked throughout the construction period and in case of a low water contents ratio, some amounts of water would be added to the materials by tank lorry so as to approximate the optimum water content.

(5) Construction of Appurtenant Structures

As the appurtenant structures of the dam, the spillway, outlet structures and others would be constructed. Useful materials excavated at spillway would be embanked for the Zone 1 and Zone 2. The remaining or unusable materials would be hauled to the spoil area.

Concretes for these structures would be mixed by batching plant installed at the project site. Specifications of the batching plant are proposed as follows, taking into account the proposed quantity and placement plan of concretes for the relevant structures.

Batching Plant (Fully Automatic) (0.7 m^3 mixer x 2 sets)	1 set
Cement Silo (200 t)	1 set
Agitator Truck (3.2 m^3)	5 sets
Belt Conveyor (L = 80 m)	1 set
Screw Conveyor (L = 10 m)	1 set
Backet Elevator (L = 25 m)	1 set
Stock Bin for Aggregate	2 sets

1.4 Diversion Dam Construction

The construction works of upper Gumain diversion dam would be mainly executed during dry season in due consideration of magnitude of flooding in the river. A cofferdam would be mounded with riverbed materials to enclose the half of the diversion dam and divert river flow into opposite side of the river channel.

Excavation works of the site surrounded by the cofferdam would be mainly made by back-hoe shovel and excavated excess materials be hauled to a spoil area by dump-truck. Concretes would be produced by several numbers of portable concrete mixers and placed using concrete backet hanged by truck-crane.

1.5 Construction of Irrigation Facilities

The irrigation facilities consist of diversion canals, main canals, laterals, these related structures and on-farm development.

Most of canal excavation and embankment would be executed mainly by rather small class construction machineries. Earth works of Porac diversion canal with about 2 km in length running near northern boundary of the Basa Air Base will become big volumes due to the deep excavation, and big construction machineries are proposed for the works in order to make reduce the construction period. Concrete works such as canal linings, related structures and others would be mainly executed by manpower using portable concrete mixer. Major works of on-farm development are making farm ditches and small division boxes, and these works would be carried out by manpower.

1.6 Construction of Drainage Facilities

Excavation of drainage canals would be executed by back-hoe shovel and excavated materials be directly used for filling, and remain materials be hauled to spoil areas. Related structures of concrete or wet stone masonry would be constructed by manpower using portable concrete mixer. On-farm drains would be excavated by manpower. Concrete pipes for cross drains would be set up by chain-block.

1.7 Implementation Schedule

The project implementation schedule is shown in Fig. 10.1. First one year of 1986 would be necessary time for survey and mapping works, detailed design works, mobilization, and construction of offices and quarters. The actual construction works would be commenced in 1987. Gumain dam construction including diversion tunnel, foundation treatment, spillway and excavation and embankment of the dam will need six years in total. In this schedule, dam embankment would be started in 1989 and completed at the end of 1992. Improvement works of existing facilities such as diversion dams, canals, etc., are planned to be completed by the end of 1989, so as to enable to use irrigation water as fast as possible. New construction works of upper Gumain diversion dam and Caulaman and Porac diversion canals would be finished before completion of Gumain dam construction.

CHAPTER 2 COST ESTIMATE

2.1 General

The project cost comprises direct construction cost, compensation cost for land acquisition, cost of O&M facilities, administration cost, engineering services, physical contingency and price contingency.

The following considerations were made for the cost estimate of the Project.

1) The exchange rate used in the estimate is:

   US$1.0 = 14 pesos = 240 yen

2) The construction works are executed on the contract basis. The construction machinery and equipment required for the construction works are provided by the contractors themselves. Therefore, depreciation costs of machinery and equipment are considered in the estimate of the construction unit cost.

3) The construction cost comprises foreign currency and local currency portions. Local currency portion is estimated on the basis of the current prices in Manila in March 1984 and foreign currency portion is estimated on the CIF prices at Manila.

4) The physical contingency related to the construction quantities is set at 15% of the direct cost. The price contingency is assumed as follows:

(Unit: %)

Year	Foreign Currency	Local Currency
1985	8.0	45.6
1986	9.0	12.0
1987	9.0	12.0
1988	9.0	12.0
1989	7.5	12.0
1990	6.0	12.0
1991	6.0	12.0
1992	6.0	12.0

2.2 Estimation of Project Cost

The project cost was estimated at ₱2,768 million comprising ₱1,635 million of foreign currency and ₱1,133 million of local currency. The summary of the cost estimate is shown in Table 10.2.

2.3 Annual Disbursement Schedule

The annual disbursement schedule was worked out as shown in Table 10.3 based on the construction time schedule, and the summary is as follows:

(Unit: ₱10⁶)

Financial Years	Total	Foreign Currency	Local Currency
1986	60.6	47.4	13.2
1987	362.9	233.8	129.1
1988	395.0	247.5	147.5
1989	346.8	209.8	137.0
1990	586.2	324.2	262.0
1991	520.0	286.6	233.4
1992	496.5	285.3	211.2
Total	2,768.0	1,634.6	1,133.4

2.4 Breakdown of Project Cost

(1) Direct Construction Cost

Direct construction cost was estimated for the individual items by unit cost basis. The summary is shown in Table 10.4, and the breakdown is shown in Table 10.5.

(2) Land Acquisition

Cost of land acquisition for the project is summarized below:

Land	Acquisition (ha)	Amount (₱10⁶)
Farm Land	280	14.0
Non-Farm Land	100	0.4
Total	380	14.5

(3) O&M Equipment

All the construction equipment and materials necessary for the construction of the Project would be provided by the contractors. While, O & M equipment would be procured by the Government for the smooth operation and maintenance of the project facilities after completion of the construction works.

The number of O&M equipment and their procurement costs were estimated as listed in Table 10.6.

(4) Administration and Engineering Costs

Administration costs comprise staff salary, and direct costs such as office expenses, equipment running cost, labour wage and others.

Engineering services by foreign consultants would be required for the detailed design and construction supervision stages. Total required man-month of the engineers is 200 M/M for detailed design and 230 M/M for the construction supervision.

The breakdown of above costs are summarized in Table 10.7, and the required man-month of consultant engineers is shown in Table 10.8.

2.5 Unit Cost Analysis

Construction cost was calculated by use of detailed unit costs. Each unit cost is composed of the basic unit cost and working rate of labour and/or construction machinery. Basic cost of labour and materials were basically quotated from current unit cost investigated at the job site and Manila as shown in Table 10.9 and 10.10.

Unit cost was calculated by each, according to the proposed work items which were designed by construction method. Analyzed unit cost is summarized in Table 10.11 and 10.12.

2.6 Annual Operation and Maintenance Cost

Annual operation and maintenance cost comprises of the salaries for administrative and water control staffs, the materials and labour costs for repair and maintenance of project facilities, the costs for operation, repair and maintenance of O&M equipment.

The summary of the annual operation and maintenance cost is shown in Table 10.13 and the breakdown of staff salary at O&M stage is shown in Table 10.14.

2.7 Replacement Cost

Some of the facilities installed or constructed in the Project have some shorter useful life than the Project life and will require replacement at a certain time within the project useful life. The replacement costs and the useful lives of these facilities are listed in Table 10.15.

Table 10.1 EARTH MOVING PLAN OF GUMAIN DAM

Excavation			Embankment & Backfill						
			Dam					Spillway Backfill (129,000)	Spoil Area
			Zone 1 (847,000)	Zone 2 (2,536,000)	Zone 3 (1,331,000)	Filter (620,000)	Riprap (250,000)		
Dam	N/S	104,200	-	-	-	-	-	-	104,200
	W/R	208,400	-	104,200 (104,200)	-	-	-	-	104,200
	R	208,400	-	52,100 (62,500)	52,100 (62,500)	-	-	-	104,200
Spillway	N/S	173,400	43,400 (39,100)	-	-	-	-	-	130,000
	W/R	346,800	-	131,100 (131,100)	-	-	-	129,000 (129,000)	86,700
	R	346,800	-	346,800 (416,200)	-	-	-	-	-
Borrow Area I	T/S	89,800	-	-	-	-	-	-	89,800
	N/S	897,700	897,700 (807,900)	-	-	-	-	-	-
Quarry Site (Q-1)	T/S	281,000	-	-	-	-	-	-	281,000
	W/R	1,404,800	-	1,404,800 (1,404,800)	-	-	-	-	-
	R	1,404,800	-	347,700 (417,200)	1,057,100 (1,268,500)	-	-	-	-
River Deposit	Sand	652,600	-	-	-	652,600 (620,000)	-	-	-
	Gravel	250,000	-	-	-	-	250,000 (250,000)	-	-

Remarks: T/S; Top Soil, N/S; Normal Soil, W/R; Weathered Rock, R; Rock

Table 10.2 SUMMARY OF THE PROJECT COST

(Unit: ₱10⁶)

Item	Foreign Currency	Local Currency	Total
1. Direct Construction Cost	846.6	315.0	1,161.6
1.1 Gumain Dam	749.6	217.2	966.8
1.2 Diversion Dams	16.4	9.0	25.4
1.3 Irrigation Facilities	61.9	61.7	123.6
1.4 Drainage Facilities	17.8	12.8	30.6
1.5 On-farm Development	0.9	14.3	15.2
2. Compensation Cost for Land Acquisition	-	14.5	14.5
3. Cost of O&M Facilities	8.9	2.1	11.0
4. Administration and Engineering Costs	76.0	68.0	144.0
Sub-total	931.5	399.6	1,331.1
5. Physical Contingency	139.8	60.0	199.8
Total	1,071.3	459.6	1,530.9
6. Price Contingency	563.3	673.8	1,237.1
Grand Total	1,634.6	1,133.4	2,768.0
(US$10⁶)	116.76	80.96	197.72
(¥10⁶)	28,022	19,430	47,452

Conversion Rate: US$1.0 = ₱14.0 = ¥240

Table 10.3 DISBURSEMENT SCHEDULE OF THE PROJECT COST

(Unit: P10^6)

Item	Total			1986			1987			1988		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
1. Direct Construction Cost	846.6	315.0	1,161.6	-	-	-	151.4	46.5	197.9	145.8	45.7	191.5
1.1 Gumain Dam	749.6	217.2	966.8	-	-	-	148.5	38.1	186.6	137.2	33.8	171.0
1.2 Diversion Dam	16.4	9.0	25.4	-	-	-	0.4	0.5	0.9	2.8	0.9	3.7
1.3 Irrigation Facilities	61.9	61.7	123.6	-	-	-	2.5	7.9	10.4	5.8	11.0	16.8
1.4 Drainage Facilities	17.8	12.8	30.6	-	-	-	-	-	-	-	-	-
1.5 On-Farm Development	0.9	14.3	15.2	-	-	-	-	-	-	-	-	-
2. Compensation Cost for Land Acquisition	-	14.5	14.5	-	-	-	-	5.0	5.0	-	5.0	5.0
3. Cost for O&M Facilities	8.9	2.1	11.0	-	-	-	-	-	-	-	-	-
4. Administration and Engineering Costs	76.0	68.0	144.0	35.0	7.0	42.0	7.0	10.0	17.0	8.0	12.0	20.0
Sub-total	931.5	399.6	1,331.1	35.0	7.0	42.0	158.4	61.5	219.9	153.8	62.7	216.5
5. Physical Contingency	139.8	60.0	199.8	5.3	1.1	6.4	23.8	9.2	33.0	23.1	9.4	32.5
Total	1,071.3	459.6	1,530.9	40.3	8.1	48.4	182.2	70.7	252.9	176.9	72.1	249.0
6. Price Contingency	563.3	673.8	1,237.1	7.1	5.1	12.2	51.6	58.4	110.0	70.6	75.4	146.0
Grand Total	1,634.6	1,133.4	2,768.0	47.4	13.2	60.6	233.8	129.1	362.9	247.5	147.5	395.0

Item	1989			1990			1991			1992		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
1. Direct Construction Cost	113.3	35.5	148.8	163.8	76.9	240.7	141.6	61.6	203.2	130.7	48.8	179.5
1.1 Gumain Dam	98.2	22.2	120.4	131.5	42.5	174.0	117.1	40.3	157.4	117.1	40.3	157.4
1.2 Diversion Dam	-	-	-	6.6	3.8	10.4	6.6	3.8	10.4	-	-	-
1.3 Irrigation Facilities	12.0	11.0	23.0	19.0	18.0	37.0	11.3	6.9	18.2	11.3	6.9	18.2
1.4 Drainage Facilities	3.1	2.3	5.4	6.2	4.4	10.6	6.2	4.5	10.7	2.3	1.6	3.9
1.5 On-Farm Development	-	-	-	0.5	8.2	8.7	0.4	6.1	6.5	-	-	-
2. Compensation Cost for Land Acquisition	-	4.5	4.5	-	-	-	-	-	-	-	-	-
3. Cost for O&M Facilities	-	-	-	6.1	1.9	8.0	-	-	-	2.8	0.2	3.0
4. Administration and Engineering Costs	8.0	12.0	20.0	7.0	10.0	17.0	6.0	9.0	15.0	5.0	8.0	13.0
Sub-total	121.3	52.0	173.3	176.9	88.8	265.7	147.6	70.6	218.2	138.5	57.0	195.5
5. Physical Contingency	18.2	7.8	26.0	26.5	13.3	39.8	22.1	10.6	32.7	20.8	8.6	29.4
Total	139.5	59.8	199.3	203.4	102.1	305.5	169.7	81.2	250.9	159.3	65.6	224.9
6. Price Contingency	70.3	77.2	147.5	120.8	159.9	280.7	116.9	152.2	269.1	126.0	145.6	271.6
Grand Total	209.8	137.0	346.8	324.2	262.0	586.2	286.6	233.4	520.0	285.3	211.2	496.5

Remarks: F.C.: Foreign Currency, L.C.: Local Currency

Table 10.4 SUMMARY OF DIRECT CONSTRUCTION COST

(Unit: ₱10⁶)

Item	New Construction	Rehabilitation	Total
1. Gumain Dam	966.80	0	966.80
2. Diversion Dam	20.81	4.59	25.40
2.1 Upper Gumain D.D	20.81	0	20.81
2.2 Porac D.D	0	3.38	3.38
2.3 Caulaman D.D	0	0.30	0.30
2.4 Gumain D.D	0	0.91	0.91
3. Irrigation Facilities	73.41	50.19	123.60
3.1 PRIS/1			
(1) Extension Works	54.49	0	54.49
(2) Rehabilitation Works	0	16.59	16.59
3.2 CRIS/2			
(1) Extension Works	18.92	0	18.92
(2) Rehabilitation Works	0	12.87	12.87
3.3 GRIS/3			
(1) Extension Works	0	0	0
(2) Rehabilitation Works	0	20.73	20.73
4. Drainage Facilities	21.87	8.73	30.60
4.1 PRIS	11.43	4.03	15.46
4.2 CRIS	4.96	1.90	6.86
4.3 GRIS	5.48	2.80	8.28
5. On-Farm Development	15.20	0	15.20
5.1 PRIS	6.49	0	6.49
5.2 CRIS	5.04	0	5.04
5.3 GRIS	3.67	0	3.67
Total	1,098.09	63.51	1,161.60

Remarks: /1: Porac River Irrigation System
/2: Caulaman River Irrigation System
/3: Gumain River Irrigation System

Table 10.5(1) BREAKDOWN OF DIRECT CONSTRUCTION COST

(Unit: ₱103)

Work Item	Unit	Q'ty	Foreign Currency	Local Currency	Total
1. Gumain Dam					
1-1 Preparatory Works	L.S.		35,710	10,450	46,160
1-2 Dam					
1) Excavation of Dam Foundation					
a) Normal Soil	m3	104,200	2,870	730	3,600
b) Weathered Rock	m3	208,400	6,390	1,590	7,980
c) Rock Blasting	m3	208,400	22,780	10,690	33,470
2) Excavation at Borrow Area & Quarry Site					
a) Top Soil	m3	370,800	1,930	480	2,410
b) Normal Soil	m3	897,700	25,940	6,550	32,490
c) Weathered Rock	m3	1,404,800	46,640	11,660	58,300
d) Rock Blasting	m3	1,404,800	94,960	21,210	116,170
3) Embankment					
a) Spreading of Zone 1	m3	847,000	5,080	1,190	6,270
b) " Zone 2	m3	2,536,000	12,170	2,790	14,960
c) " Zone 3	m3	1,331,000	5,990	1,460	7,450
d) " Filter	m3	620,000	3,290	810	4,100
e) " Drain	m3	250,000	1,200	280	1,480
f) Compacting of Zone 1	m3	847,000	7,370	1,520	8,890
g) " Zone 2	m3	2,536,000	29,920	5,580	35,500
h) " Zone 3	m3	1,331,000	12,910	2,400	15,310
i) " Filter	m3	1,272,600	46,140	13,380	59,520
j) " Drain	m3	590,000	20,850	6,050	26,900
Sub-total			345,430	88,370	434,800
1-3 Spillway					
1) Excavation					
a) Normal Soil	m3	173,400	5,100	1,470	6,570
b) Weathered Rock	m3	345,800	11,440	3,270	14,710
c) Rock Blasting	m3	346,800	39,400	18,760	58,160
2) Concrete Works					
a) Concrete Lining	m3	92,000	62,160	22,160	84,320
b) Concrete Form	m2	55,200	260	12,250	12,510
c) Reinforced Iron Bar	ton	2,760	20,360	8,490	28,850
3) Back Filling	m3	129,000	4,630	1,340	5,970
Sub-total			143,350	67,740	211,090
1-4 Foundation Treatment					
a) Grout Hole Drilling	m	70,000	45,650	3,850	49,500
b) Grouting of Cement Milk	m	70,000	7,810	4,250	12,060
c) Test Hole Drilling	m	7,000	4,330	960	5,290
Sub-total			57,790	9,060	66,850
1-5 Diversion Tunnel					
Right Bank	m	660	165,320	41,580	207,900
Total (Item 1)			749,600	217,200	966,800

Table 10.5(2) BREAKDOWN OF DIRECT CONSTRUCTION COST

(Unit: P103)

Work Item	Unit	Q'ty	Foreign Currency	Local Currency	Total
2. Diversion Dam					
2-1 Upper Gumain Diversion Dam					
1) Preparatory Works	L.S.		1,169.4	757.0	1,926.4
2) Dam Portion					
a) Plain Concrete	m³	10,200	4,806.2	2,068.6	6,874.8
b) Reinforcement Concrete	m³	1,130	666.6	269.8	936.4
c) Reinforcement Bar	ton	90	664.1	276.7	940.8
d) Concrete Form	m²	3,320	15.9	737.0	752.9
e) Concrete Block	m²	600	1,417.9	1,443.9	2,861.8
f) Excavation A	m³	40,376	775.2	197.8	973.0
g) Excavation B	m³	911	9.2	1.7	10.9
h) Backfill	m³	820	8.0	2.3	10.3
i) Rock Riprap	m³	860	158.6	290.6	449.2
j) Wet Stone Masonry	m³	80	36.2	32.8	69.0
k) Roller Gate 4.0m x 4.0m	nos.	1	520.0	130.0	650.0
" 3.0m x 4.0m	nos.	1	432.0	108.0	540.0
Sub-total			9,509.9	5,559.2	15,069.1
3) Intake for Porac Diversion Canal					
a) Reinforcement Concrete	m³	570	336.2	136.1	472.3
b) Reinforcement Bar	ton	46	339.4	141.4	480.8
c) Concrete form	m²	1,051	5.0	233.3	238.3
d) Excavation A	m³	735	13.5	3.7	17.2
e) Excavation B	m³	1,405	12.9	2.8	15.7
f) Backfill	m³	1,265	13.4	3.8	17.2
g) Sluice Gate 2.0m x 2.0m	nos.	3	96.0	24.0	120.0
h) Trash Rack	m²	24	51.8	13.0	64.8
Sub-total			868.2	558.1	1,426.3
4) Intake for Caulaan Diversion Canal					
a) Reinforcement Concrete	m³	394	232.4	94.1	326.5
b) Reinforcement Bar	ton	32	236.1	98.4	334.5
c) Concrete Form	m²	900	4.3	199.8	204.1
d) Excavation A	m³	470	10.4	2.8	13.2
e) Excavation B	m³	1,607	16.2	3.1	19.3
f) Backfill	m³	1,446	14.0	4.0	18.0
g) Sluice Gate 2.0m x 2.0m	nos.	2	64.0	28.0	92.0
h) Trash Rack	m²	16	2.2	8.6	10.8
Sub-total			579.6	438.8	1,018.4
5) Dike Portion					
a) Excavation, Common	m³	6,120	117.5	30.0	147.5
b) Embankment A	m³	26,883	516.2	131.7	647.9
c) Embankment B	m³	24,195	399.2	82.3	481.5
d) Sod Facing	m²	5,311	-	92.9	92.9
Sub-total			1,032.9	336.9	1,369.8
Total			13,160	7,650	20,810

Table 10.5(3) BREAKDOWN OF DIRECT CONSTRUCTION COST

(Unit: ₱10³)

Work Item	Unit	Q'ty	Foreign Currency	Local Currency	Total
2-2 Improvement Works for Porac Diversion Dam					
1) Preparatory Works	L.S.		236.3	66.3	302.6
2) Replacement of Gates					
a) Flap Gates H = 1.4m Total width 43.3m	set	1	2,240.0	560.0	2,800.0
b) Sluice Gate 1.5m x 1.5m	nos.	4	43.2	10.8	54.0
c) Concrete Lining	m3	100	5.8	2.4	8.2
d) Rock Riprap	m3	250	46.1	84.5	130.6
e) Wet Stone Masonry	m3	80	36.2	32.8	69.0
f) Excavation for River Bed Clay	m3	600	12.4	3.2	15.6
Total			2,620	760	3,380
2-3 Improvement Works for Caulaman Diversion Dam					
1) Preparatory Works	L.S.		18.1	9.1	27.2
2) Replacement of Gates					
a) Sluice Gate 2.0m x 1.0m	nos.	2	19.2	4.8	24.0
b) Concrete Lining	m3	230	134.0	54.2	188.2
c) Wet Masonry	m3	40	18.1	16.4	34.5
d) Excavation for River Bed Sand	m3	1,200	20.6	5.5	26.1
Total			210	90	300
2-4 Improvement Works for Gumain Diversion Dam					
1) Preparatory Works	L.S.		40.2	42.7	82.9
2) Replacement of Gates					
a) Sluice Gate 1.4m x 1.3m	nos.	4	34.9	8.7	43.6
b) Concrete Lining	m3	160	93.2	37.7	130.9
c) Rock Riprap	m3	1,150	212.1	388.6	600.7
d) Wet Masonry	m3	50	22.7	20.5	43.2
e) Excavation for River Bed Sand	m3	400	6.9	1.8	8.7
Total			410	500	910
Total (Item 2)			16,400	9,000	25,400

Table 10.5(4) BREAKDOWN OF DIRECT CONSTRUCTION COST

(Unit: ₱10³)

Work Item	Unit	Q'ty	Foreign Currency	Local Currency	Total
3. Irrigation Facilities					
3-1 Porac Diversion Canal					
1) Preparatory Works	L.S.		3,067.0	1,660.4	4,727.4
2) Main Canal					
a) Excavation A	m³	1,016,000	18,796.0	4,775.2	23,571.2
b) Excavation B	m³	1,125,000	1,645.9	337.9	1,983.8
c) Embankment	m³	98,000	1,038.8	294.0	1,332.8
d) Sod Facing	m²	14,000	-	245.0	245.0
e) Lining Concrete	m³	6,530	3,961.8	8,786.8	12,748.6
Sub-total			25,442.5	14,438.9	39,881.4
3) Related Structures on Main Canal					
a) Concrete	m³	1,500	1,359.2	2,007.9	3,367.1
b) Foundation Concrete	m³	120	56.5	24.3	80.8
c) Lining Concrete	m³	100	60.7	134.6	195.3
d) Wet Masonry	m³	1,500	679.5	615.8	1,295.3
e) Excavation	m³	6,100	66.5	15.3	81.8
f) Backfill	m³	6,000	63.6	18.0	81.6
g) Gate 1.5m x 1.5m	nos.	16	172.8	43.2	216.0
" 1.0m x 1.0m	nos.	1	4.8	1.2	6.0
" 0.8m x 0.8m	nos.	2	6.2	1.6	7.8
" 1.8m x 1.8m	nos.	2	32.0	7.8	39.8
" ϕ600	nos.	4	12.8	3.2	16.0
h) Concrete Pipe ϕ600	m	16	1.8	1.3	3.1
i) Hand Rail	m	200	48.0	12.0	60.0
Sub-total			2,564.4	2,886.2	5,450.6
4) Lateral					
a) Excavation A	m³	26,700	494.0	125.5	619.5
b) Excavation B	m³	20,600	311.1	63.9	375.0
c) Embankment	m³	18,500	196.1	55.5	251.6
d) Sod Facing	m²	25,000	-	437.5	437.5
Sub-total			1,001.2	682.4	1,683.6
5) Related Structures on Lateral					
a) Concrete	m³	190	172.2	254.3	426.5
b) Foundation Concrete	m³	40	18.8	8.1	26.9
c) Lining Concrete	m³	250	151.7	336.4	488.1
d) Wet Masonry	m³	140	63.4	57.5	120.9
e) Excavation	m³	150	1.6	0.4	2.0
f) Backfill	m³	40	0.4	0.1	0.5
g) Gate 0.8m x 0.8m	nos.	10	31.0	8.0	39.0
" ϕ600	nos.	21	67.2	16.8	84.0
h) Concrete Pipe ϕ600	m	84	9.3	7.1	16.4
" ϕ1,000	m	114	47.2	31.9	79.1
Sub-total			562.8	720.6	1,283.4
6) Farm Road					
a) Embankment	m³	30,800	831.6	234.1	1,065.7
b) Pavement	m³	11,500	310.5	87.4	397.9
Sub-total			1,142.1	321.5	1,463.6
Total			33,780	20,710	54,490

Table 10.5(5) BREAKDOWN OF DIRECT CONSTRUCTION COST

(Unit: ₱10³)

Work Item	Unit	Q'ty	Foreign Currency	Local Currency	Total
3.2 Caulaman Diversion Canal					
1) Preparatory Works	L.S.		706.8	1,007.3	1,714.1
2) Main Canal					
a) Excavation A	m³	32,800	606.8	154.2	761.0
b) Excavation B	m³	25,200	380.5	78.1	458.6
c) Embankment	m³	22,700	240.6	68.1	308.7
d) Sod Facing	m²	13,000	-	227.5	227.5
e) Lining Concrete	m³	4,710	2,857.6	6,337.8	9,195.4
Sub-total			4,085.5	6,865.7	10,951.2
3) Related Structures on Main Canal					
a) Concrete	m³	1,800	1,631.0	2,409.5	4,040.5
b) Foundation Concrete	m³	150	70.7	30.4	101.1
c) Lining Concrete	m³	220	133.5	296.0	429.5
d) Wet Masonry	m³	840	380.5	344.8	725.3
e) Excavation	m³	650	7.1	1.6	8.7
f) Backfill	m³	180	1.9	0.5	2.4
g) Gate 1.2m x 1.2m	nos.	18	124.2	30.6	154.8
" ϕ600	nos.	11	35.2	3.8	44.0
h) Concrete Pipe ϕ600	m	44	4.9	3.7	8.6
i) Hand Rail	m	240	57.6	14.4	72.0
Sub-total			2,446.6	3,140.3	5,586.9
4) Farm Road					
a) Embankment	m³	15,300	413.1	116.3	529.4
b) Pavement	m³	4,000	108.0	30.4	138.4
Sub-total			521.1	146.7	667.8
Total			7,760	11,160	18,920
3.3 Porac River Irrigation System					
1) Preparatory Works	L.S.		809.8	700.4	1,510.2
2) Main Canal					
a) Excavation A	m³	34,700	666.2	170.0	836.2
b) Excavation B	m³	3,100	46.8	9.6	56.4
c) Embankment	m³	34,000	360.4	102.0	462.4
d) Sod Facing	m²	29,000	-	507.5	507.5
Sub-Total			1,073.4	789.1	1,862.5
3) Related Structures on Main Canal					
a) Concrete	m³	276	250.1	369.4	619.5
b) Foundation Concrete	m³	46	21.7	9.3	31.0
c) Lining Concrete	m³	105	63.7	141.3	205.0
d) Wet Masonry	m³	290	131.4	119.0	250.4
e) Excavation	m³	76	0.8	0.2	1.0
f) Backfill	m³	18	0.2	0.1	0.3
g) Gate 1.5m x 1.5m	nos.	5	54.0	13.5	67.5
" 1.2m x 1.2m	nos.	5	34.5	8.5	43.0
" 1.0m x 1.0m	nos.	6	28.8	7.2	36.0
" 0.8m x 0.8m	nos.	3	9.3	2.4	11.7
" ϕ600	nos.	8	25.6	6.4	32.0
h) Concrete Pipe ϕ600	m	32	3.6	2.7	6.3
i) Concrete Demolition	m³	20	4.8	1.2	6.0
Sub-total			628.5	681.2	1,309.7

Table 10.5(6) BREAKDOWN OF DIRECT CONSTRUCTION COST

(Unit: ₱10³)

Work Item	Unit	Q'ty	Foreign Currency	Local Currency	Total
4) Lateral					
a) Excavation A	m³	43,040	826.4	210.9	1,037.3
b) Excavation B	m³	34,700	524.0	107.6	631.6
c) Embankment	m³	70,000	742.0	210.0	952.0
d) Sod Facing	m²	312,100	-	1,961.8	1,961.8
Sub-total			2,092.4	2,490.3	4,582.7
5) Related Structures on Lateral					
a) Concrete	m³	810	733.9	1,084.3	1,818.2
b) Foundation Concrete	m³	152	71.6	30.8	102.4
c) Lining Concrete	m³	460	279.1	619.0	898.1
d) Wet Masonry	m³	470	212.9	192.9	405.8
e) Excavation	m³	600	6.5	1.5	8.0
f) Backfill	m³	110	1.2	0.3	1.5
g) Gate 1.5m x 1.5m	nos.	6	64.8	16.2	81.0
" 1.2m x 1.2m	nos.	12	82.8	20.4	103.2
" 1.0m x 1.0m	nos.	30	144.0	36.0	180.0
" 0.8m x 0.8m	nos.	16	49.6	12.8	62.4
" ϕ600	nos.	102	326.4	81.6	408.0
h) Concrete Pipe ϕ600	m	332	36.9	27.9	64.8
" ϕ1,000	m	36	13.3	10.1	23.4
" ϕ1,200	m	156	57.7	43.7	101.4
Sub-total			2,080.7	2,177.5	4,258.2
6) Farm Road					
a) Embankment	m³	38,600	1,042.2	293.4	1,335.6
b) Pavement	m³	15,500	418.5	117.8	536.3
Sub-total			1,460.7	411.2	1,871.9
7) Re-Use Structures					
a) Concrete	m³	280	253.7	374.8	628.5
b) Foundation Concrete	m³	90	42.4	18.3	60.7
c) Wet Masonry	m³	329	145.0	131.4	276.4
d) Excavation	m³	260	2.8	0.7	3.5
e) Backfill	m³	40	0.4	0.1	0.5
f) Gate 1.7m x 2.0m	nos.	2	54.4	13.6	68.0
" 2.0m x 2.0m	nos.	3	96.0	24.0	120.0
" 0.8m x 0.8m	nos.	5	15.4	3.8	19.2
" 1.5m x 1.0m	nos.	2	14.4	3.6	18.0
Sub-total			624.5	570.3	1,194.8
Total			8,770	7,820	16,590

Table 10.5(7) BREAKDOWN OF DIRECT CONSTRUCTION COST

(Unit: ₱10³)

Work Item	Unit	Q'ty	Foreign Currency	Local Currency	Total
3.4 Caulaman River Irrigation System					
1) Preparatory Works	L.S.		601.8	559.4	1,161.2
2) Main Canal					
a) Excavation A	m³	2,500	46.3	11.8	58.1
b) Excavation B	m³	5,700	86.1	17.7	103.8
c) Embankment	m³	5,100	54.1	15.3	69.4
d) Sod Facing	m²	25,600	-	448.0	448.0
Sub-total			186.5	492.8	679.3
3) Related Structures on Main Canal					
a) Concrete	m³	950	860.8	1,271.7	2,132.5
b) Foundation Concrete	m³	110	51.8	22.3	74.1
c) Lining Concrete	m³	200	121.3	269.1	390.4
d) Wet Masonry	m³	370	167.6	151.9	319.5
e) Excavation	m³	60	0.7	0.2	0.9
f) Backfill	m³	40	0.4	0.1	0.5
g) Gate 1.5m x 1.5m	nos.	2	21.6	5.4	27.0
" 1.2m x 1.2m	nos.	12	82.8	20.4	103.2
" 1.0m x 1.0m	nos.	7	33.6	8.4	42.0
" 0.8m x 0.8m	nos.	1	3.1	0.8	3.9
" ϕ600	nos.	20	64.0	16.0	80.0
h) Concrete Pipe ϕ600	m	40	4.4	3.4	7.8
Sub-total			1,412.1	1,769.7	3,181.8
4) Lateral					
a) Excavation A	m³	27,800	533.8	136.2	670.0
b) Excavation B	m³	20,800	314.1	64.5	378.6
c) Embankment	m³	43,700	463.2	131.1	594.3
d) Sod Facing	m²	60,600	-	1,060.5	1,060.5
Sub-total			1,311.1	1,392.3	2,703.4
5) Related Structures on Lateral					
a) Concrete	m³	410	371.5	548.8	920.3
b) Foundation Concrete	m³	90	42.4	18.3	60.7
c) Lining Concrete	m³	570	345.8	767.0	1,112.8
d) Wet Masonry	m³	280	126.8	114.9	241.7
e) Excavation	m³	330	3.6	0.8	4.4
f) Backfill	m³	100	1.1	0.3	1.4
g) Gate 1.5m x 1.5m	nos.	2	21.6	5.4	27.0
" 1.0m x 1.0m	nos.	20	96.0	24.0	120.0
" 0.8m x 0.8m	Nos.	18	55.8	14.4	70.2
" ϕ600	nos.	75	240.0	60.0	300.0
h) Concrete Pipe ϕ600	m	240	26.6	20.2	46.8
" ϕ1,200	m	144	53.3	40.3	93.6
Sub-total			1,384.5	1,614.4	2,998.9
6) Farm Road					
a) Embankment	m³	45,000	1,215.0	342.2	1,557.2
b) Pavement	m³	17,000	459.0	129.2	588.2
Sub-total			1,674.0	471.4	2,145.4
Total			6,570	6,300	12,870

Table 10.5(8) BREAKDOWN OF DIRECT CONSTRUCTION COST

(Unit: ₱103)

Work Item	Unit	Q'ty	Foreign Currency	Local Currency	Total
3.5 Gumain River Irrigation System					
1) Preparatory Works	L.S.		460.8	1,422.1	1,882.9
2) Main Canal					
a) Excavation A	m³	4,200	80.6	20.6	101.2
b) Excavation B	m³	1,700	25.7	5.3	31.0
c) Embankment	m³	5,300	56.2	15.9	72.1
d) Sod Facing	m²	8,000	-	140.0	140.0
Sub-total			162.5	181.8	344.3
3) Related Structures on Main Canal					
a) Concrete	m³	560	507.4	749.6	1,257.0
b) Foundation Concrete	m³	50	23.6	10.1	33.7
c) Lining Concrete	m³	100	60.7	134.6	195.3
d) Wet Masonry	m³	200	90.6	82.1	172.7
e) Excavation	m³	100	1.1	0.3	1.4
f) Backfill	m³	40	0.4	0.1	0.5
g) Gate 1.5m x 1.5m	nos.	2	21.6	5.4	27.0
" 1.2m x 1.2m	nos.	16	110.4	27.2	137.6
" 1.0m x 1.0m	nos.	4	19.2	4.8	24.0
" ϕ600	nos.	6	19.2	4.8	24.0
h) Concrete Pipe ϕ600	m	24	2.7	2.0	4.7
Sub-total			856.9	1,021.0	1,877.9
4) Lateral					
a) Excavation A	m³	19,600	376.3	96.0	472.3
b) Excavation B	m³	15,400	232.5	47.7	280.2
c) Embankment	m³	31,500	333.9	94.5	428.4
d) Sod Facing	m²	612,000	-	10,710.0	10,710.0
Sub-total			942.7	10,948.2	11,890.9
5) Related Structures on Lateral					
a) Concrete	m³	490	362.4	535.4	897.8
b) Foundation Concrete	m³	70	33.0	14.2	47.2
c) Lining Concrete	m³	670	406.5	901.6	1,308.1
d) Wet Masonry	m³	480	217.4	197.0	414.4
e) Excavation	m³	200	2.2	0.5	2.7
f) Backfill	m³	50	0.5	0.2	0.7
g) Gate 1.0m x 1.0m	nos.	10	48.0	12.0	60.0
" 0.8m x 0.8m	nos.	28	86.8	22.4	109.2
" ϕ600	nos.	64	204.8	51.2	256.0
h) Concrete Pipe ϕ600	m	188	20.9	15.8	36.7
" ϕ1,200	m	66	24.4	18.5	42.9
Sub-total			1,406.9	1,768.8	3,175.7
6) Farm Road					
a) Embankment	m³	30,000	810.0	228.0	1,038.0
b) Pavement	m³	11,000	297.0	83.6	380.6
Sub-total			1,107.0	311.6	1,418.6
7) Re-Use Structures					
a) Concrete	m³	13	11.8	17.4	29.2
b) Foundation Concrete	m³	6	2.8	1.2	4.0
c) Wet Masonry	m³	70	31.7	28.7	60.4
d) Excavation	m³	5	0.1	0.0	0.1
e) Gate 2.0m x 2.0m	nos.	1	32.0	8.0	40.0
" 1.0m x 1.0m	nos.	1	4.8	1.2	6.0
Sub-total			83.2	56.5	139.7
Total			5,020	15,710	20,730
Total (Item 3)			61,900	61,700	123,600

Table 10.5(9) BREAKDOWN OF DIRECT CONSTRUCTION COST

(Unit: ₱10³)

Work Item	Unit	Q'ty	Foreign Currency	Local Currency	Total
4. Drainage Facilities					
4.1 Porac River Irrigation System					
1) Preparatory Works	L.S.		660.0	386.8	1,046.8
2) Drainage Creek					
a) Excavation	m³	52,000	447.2	93.6	540.8
b) Filling	m³	19,000	201.4	57.0	258.4
c) Waste Soil	m³	31,000	282.1	93.0	375.1
Sub-total			930.7	243.6	1,174.3
3) Collector Drain					
a) Excavation	m³	138,000	1,186.8	248.4	1,435.2
b) Filling	m³	56,000	593.6	168.0	761.6
c) Waste Soil	m³	76,000	691.6	228.0	919.6
Sub-total			2,472.0	644.4	3,116.4
4) Related Structure					
a) Concrete	m³	1,880	1,703.5	2,516.6	4,220.1
b) Foundation Concrete	m³	160	75.4	32.4	107.8
c) Wet Masonry	m³	1,890	856.2	775.8	1,632.0
d) Hand Rail	m	280	112.0	56.0	168.0
e) Excavation	m³	1,620	-	32.2	32.2
f) Backfill	m³	520	0.8	4.4	5.2
g) Concrete Pipe ϕ1,200	m	66	31.7	23.8	55.5
h) Concrete Decolition	m³	70	7.7	4.0	11.7
Sub-total			2,787.3	3,445.2	6,232.5
Total			6,850	4,720	11,570
4.2 Caulasan River Irrigation System					
1) Preparatory Works	L.S.		301.6	165.4	467.0
2) Drainage Creek					
a) Excavation	m³	30,900	265.7	56.5	322.2
b) Filling	m³	11,600	123.0	34.8	157.8
c) Waste Soil	m³	18,000	163.8	54.0	217.8
Sub-total			552.5	145.3	697.8
3) Collector Drain					
a) Excavation	m³	65,000	559.0	117.0	676.0
b) Filling	m³	26,300	278.8	78.9	357.7
c) Waste Soil	m³	35,800	325.8	107.4	433.2
Sub-total			1,163.6	303.3	1,466.9
4) Related Structure					
a) Concrete	m³	730	661.5	977.2	1,638.7
b) Foundation Concrete	m³	80	37.7	16.2	53.9
c) Wet Masonry	m³	900	407.7	369.5	777.2
d) Hand Rail	m	80	32.0	16.0	48.0
e) Excavation	m³	870	-	17.3	17.3
f) Backfill	m³	290	0.4	2.5	2.9
g) Concrete Pipe ϕ1,200	m	48	23.0	17.3	40.3
Sub-total			1,162.3	1,416.0	2,578.3
Total			3,180	2,030	5,210

Table 10.5(10) BREAKDOWN OF DIRECT CONSTRUCTION COST

(Unit: P103)

Work Item	Unit	Q'ty	Foreign Currency	Local Currency	Total
4.3 Gumain River Irrigation System					
1) Preparatory Works	L.S.		445.4	300.6	746.0
2) Drainage Creek					
a) Excavation	m3	22,400	192.6	40.3	232.9
b) Filling	m3	8,400	89.0	25.2	114.2
c) Waste Soil	m3	13,100	119.2	39.3	158.5
Sub-total			400.8	104.8	505.6
3) Collector Drain					
a) Excavation	m3	85,400	734.4	153.7	888.1
b) Filling	m3	34,600	366.8	103.8	470.6
c) Waste Soil	m3	47,000	427.7	141.0	568.7
Sub-total			1,528.9	398.5	1,927.4
4) Related Structure					
a) Concrete	m3	1,580	1,431.6	2,115.0	3,546.6
b) Foundation Concrete	m3	120	56.5	24.3	80.8
c) Wet Masonry	m3	1,430	647.8	587.0	1,234.8
d) Hand Rail	m	260	104.0	52.0	156.0
e) Excavation	m3	1,120	-	22.3	22.3
f) Backfill	m3	350	0.5	3.0	3.5
g) Concrete Pipe ϕ1,200	m	42	20.2	15.1	35.3
h) Concrete Dezolition	m3	130	14.3	7.4	21.7
Sub-total			2,274.9	2,826.1	5,101.0
Total			4,650	3,630	8,280
4.4 Catch Drain					
1) Preparatory Works	L.S.		292.0	197.6	489.6
2) Earth Works					
a) Excavation	m3	74,400	639.8	133.9	773.7
b) Filling	m3	16,700	177.0	50.1	227.1
c) Waste Soil	m3	55,800	507.8	167.4	675.2
Sub-total			1,324.6	351.4	1,676.0
3) Related Structure					
a) Concrete	m3	1,070	969.5	1,432.3	2,401.8
b) Foundation Concrete	m3	80	37.7	16.2	53.9
c) Wet Masonry	m3	870	394.1	357.1	751.2
d) Hand Rail	m	240	96.0	48.0	144.0
e) Excavation	m3	590	-	11.7	11.7
f) Backfill	m3	170	0.3	1.4	1.7
g) Concrete Pipe ϕ1,200	m	12	5.8	4.3	10.1
Sub-total			1,503.4	1,871.0	3,374.4
Total			3,120	2,420	5,540
Total (Item 4)			17,800	12,800	30,600

Table 10.5(11) BREAKDOWN OF DIRECT CONSTRUCTION COST

(Unit: P10³)

Work Item	Unit	Q'ty	Foreign Currency	Local Currency	Total
5. On-Farm Development					
5.1 Porac River Irrigation System					
1) Preparatory Works	L.S.		54.9	591.9	646.8
2) On-Farm Canal					
a) Farm Ditch	m	101,920	-	835.7	835.7
b) Supplementary Farm Ditch	m	254,800	-	1,325.0	1,325.0
c) Division Box	nos.	642	319.7	472.5	792.2
Sub-total			319.7	2,633.2	2,952.9
3) On-Farm Drain					
a) Tertiary Drain	m	25,000	-	747.5	747.5
b) Drainage Ditch	m	142,000	-	2,130.0	2,130.0
c) Structure Works	nos.	50	5.4	7.4	12.8
Sub-total			5.4	2,884.9	2,890.3
Total			380	6,110	6,490
5.2 Caulaman River Irrigation System					
1) Preparatory Works	L.S.		33.7	446.4	480.1
2) On-Farm Canal					
a) Farm Ditch	m	84,400	-	692.1	692.1
b) Supplementary Farm Ditch	m	210,600	-	1,095.1	1,095.1
c) Division Box	nos.	527	262.4	387.9	650.3
Sub-total			262.4	2,175.1	2,437.5
3) On-Farm Drain					
a) Tertiary Drain	m	18,000	-	538.2	538.2
b) Drainage Ditch	m	105,000	-	1,575.0	1,575.0
c) Structure Works	nos.	36	3.9	5.3	9.2
Sub-total			3.9	2,118.5	2,122.4
Total			300	4,740	5,040
5.3 Gumain River Irrigation System					
1) Preparatory Works	L.S.		27.6	320.4	348.0
2) On-Farm Canal					
a) Farm Ditch	m	60,000	-	492.0	492.0
b) Supplementary Farm Ditch	m	150,000	-	780.0	780.0
c) Division Box	nos.	380	189.2	279.7	468.9
Sub-total			189.2	1,551.7	1,740.9
3) On-Farm Drainage					
a) Tertiary Drain	m	15,000	-	448.5	448.5
b) Drainage Ditch	m	75,000	-	1,125.0	1,125.0
c) Structure Works	nos.	30	3.2	4.4	7.6
Sub-total			3.2	1,577.9	1,581.1
Total			220	3,450	3,670
Total (Item 5)			900	14,300	15,200