TABLES

Table 1.1 Crop Coefficient for Each Crop

Crop	1st Month	2nd Month	3rd Month	4th Month	5th Month
Paddy	1.00	1.05	0.95	-	-
Maize	0.40	0.80	1.00	1.00	0.80
Cotton	0.35	0.70	0.90	0.95	-
Groundnut	0.50	0.95	0.90	0.50	-
Green gram	0.50	0.95	0.90	0.50	-

Table 1.2 Potential Evapotranspiration

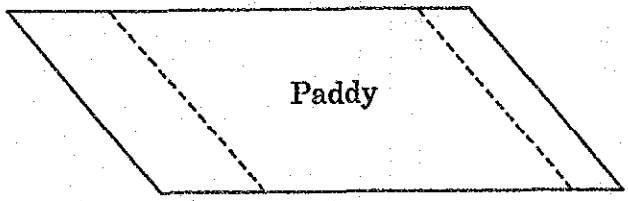
Unit: mm/day

Year	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1970	4.81	6.01	5.21	5.05	4.72	4.55	4.42	4.12	5.14	5.79	5.37	5.42
1971	5.08	6.48	6.20	4.98	4.28	4.10	4.27	4.63	5.38	6.07	5.76	5.15
1972	6.18	4.96	6.17	5.97	5.18	4.04	4.27	4.81	5.51	5.27	4.98	5.63
1973	5.63	5.76	6.33	5.73	4.61	4.43	4.35	4.92	5.60	6.07	5.71	6.12
1974	6.30	6.78	4.96	4.96	4.67	4.53	3.75	4.92	4.77	5.65	5.24	5.89
1975	6.68	6.80	6.12	5.16	4.83	4.22	4.24	3.85	4.47	4.99	5.67	5.74
1976	6.39	6.01	6.47	5.29	4.24	4.22	3.79	4.69	5.41	5.86	5.67	5.41
1977	5.02	5.60	6.03	4.45	4.78	4.36	4.61	4.94	5.83	6.21	4.50	5.34
1978	5.85	5.84	4.75	4.94	4.92	4.14	4.30	4.75	5.25	5.57	5.58	5.19
1979	5.44	5.28	6.32	5.27	4.94	4.27	4.71	5.16	5.80	6.15	5.40	5.86
1980	6.33	6.64	6.40	5.81	4.37	4.44	4.67	4.87	5.73	6.14	5.00	5.88
1981	6.58	6.93	5.16	5.16	5.06	4.87	3.98	4.73	5.02	5.86	5.45	5.69
1982	5.85	6.02	6.41	4.69	4.30	4.60	4.50	4.53	5.37	5.08	4.76	5.17
1983	6.27	6.41	6.53	5.57	5.22	4.64	4.41	4.55	5.18	4.97	5.45	4.97
Mean	5.89	6.11	5.93	5.22	4.72	4.39	4.31	4.68	5.32	5.69	5.32	5.53

Table 1.3 Average Monthly Effective Rainfall as Related to Mean Monthly Rainfall and Mean Monthly Use (USDA, SCS)

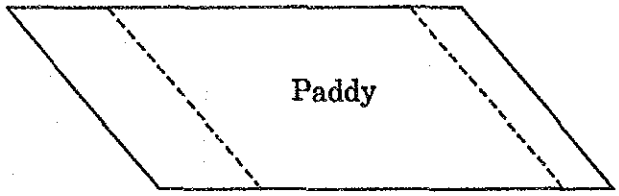
Monthly mean rainfall mm	Mean monthly consumptive use mm													
	25	50	75	100	125	150	175	200	225	250	275	300	325	350
	Mean monthly effective rainfall mm													
12.5	7.5	8.0	8.7	9.0	9.2	10.0	10.5	11.2	11.7	12.5	12.5	12.5	12.5	12.5
25.0	15.0	16.2	17.5	18.0	18.5	19.7	20.5	22.0	24.5	25.0	25.0	25.0	25.0	25.0
37.5	22.5	24.0	26.2	27.5	28.2	29.2	30.5	33.0	36.2	37.5	37.5	37.5	37.5	37.5
50.0	25	32.2	34.5	35.7	36.7	39.0	40.5	43.7	47.0	50.0	50.0	50.0	50.0	50.0
62.5	at 41.7	39.7	42.5	44.5	46.0	48.5	50.5	53.7	57.5	62.5	62.5	62.5	62.5	62.5
75.0		46.2	49.7	52.7	55.0	57.5	60.2	63.7	67.5	73.7	75.0	75.0	75.0	75.0
87.5		50.0	56.7	60.2	63.7	66.0	69.7	73.7	77.7	84.5	87.5	87.5	87.5	87.5
100.0		at 80.7	63.7	67.7	72.0	74.2	78.7	83.0	87.7	95.0	100	100	100	100
112.5			70.5	75.0	80.2	82.5	87.2	92.7	98.0	105	111	112	112	112
125.0			75.0	81.5	87.7	90.5	95.7	102	108	115	121	125	125	125
137.5		at 122		88.7	95.2	98.7	104	111	118	126	132	137	137	137
150.0				95.2	102	106	112	120	127	136	143	150	150	150
162.5				100	109	113	120	128	135	145	153	160	162	162
175.0			at 160		115	120	127	135	143	154	164	170	175	175
187.5					121	126	134	142	151	161	170	179	185	187
200.0					125	133	140	148	158	168	178	188	196	200
225					at 197	144	151	160	171	182				
250						150	161	170	183	194				
275						at 240	171	181	194	205				
300							175	190	203	215				
325							at 287	198	213	224				
350								200	220	232				
375								at 331	225	240				
400									at 372	247				
425										250				
										at 412				
450	25	50	75	100	125	150	175	200	225	250				

Table 1.4 (1/8) Crop Water Requirement (LR Paddy)

Description	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Cropping Pattern							
a) Land Preparation	2.7	2.7 2.7	2.7 2.7				
b) Topping Up		1.5 1.5	1.5 1.5				
c) Re-Flooding		2.5	2.5 2.5	2.5			
d) Sub-Total	2.7	4.2 6.7	6.7 6.7	2.5			
e) Effective Rainfall	1.1	1.8	2.4	2.3	1.1	1.0	
f) Water Requirement d) - e)	0.80	3.65	4.30	0.10			
Crop Factor Kc		1.00	1.00 1.05	1.05 0.95	0.95		
			1.00 1.00	1.05 1.05	0.95 0.95		
			1.00	1.00 1.05	1.05 0.95	0.95	
				1.00 1.00	1.05 1.05	0.95 0.95	
g) Average Kc		1.00	1.01	1.02	0.99	0.95	
h) Eto		5.93	5.22	4.72	4.39	4.31	
i) Consuptive Use g) x h)		5.93	5.27	4.81	4.35	4.09	
j) Water Requirement i) - e)		4.13	2.87	2.51	3.25	3.09	
k) Crop Area		1/12	2/3	1	11/12	1/3	
l) Net Water Requirement j) x k)		0.34	1.91	2.51	2.98	1.03	
m) Total Water Requirement f) + l)	0.80	3.99	6.21	2.61	2.98	1.03	
n) GrossWater Requirement m)/0.4	0.23	1.16	1.80	0.76	0.86	0.30	

Note: All unit are mm/day excepy item n)
g) Crop Factor: Ref. to AIRS General Report (ILACO, 1974)
h) Eto: Modified Penman Method
n) Irrigation Efficiency : 40%

Table 1.4 (2/8) Crop Water Requirement (SR Paddy)

Description	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Cropping Pattern							
a) Land Preparation	2.7	2.7 2.7	2.7 2.7				
b) Topping Up		1.5 1.5	1.5 1.5				
c) Re-Flooding		2.5	2.5 2.5	2.5			
d) Sub-Total	2.7	4.2 6.7	6.7 6.7	2.5			
e) Effective Rainfall	1.6	1.0	1.0	1.4	1.4	1.0	
f) Water Requirement d) - e)	0.55	4.45	5.70	0.55			
Crop Factor Kc		1.00	1.00 1.05	1.05 0.95	0.95		
			1.00 1.00	1.05 1.05	0.95 0.95		
			1.00	1.00 1.05	1.05 0.95	0.95	
				1.00 1.00	1.05 1.05	0.95 0.95	
g) Average Kc		1.00	1.01	1.02	0.99	0.95	
h) Eto		5.32	5.69	5.32	5.53	5.89	
i) Consuptive Use g) x h)		5.32	5.75	5.43	5.47	5.60	
j) Water Requirement i) - e)		4.32	4.75	4.03	4.07	4.60	
k) Crop Area		1/12	2/3	1	11/12	1/3	
l) Net Water Requirement j) x k)		0.36	3.16	4.03	3.74	1.53	
m) Total Water Requirement f) + l)	0.55	4.81	8.86	4.58	3.74	1.53	
n) GrossWater Requirement m)/0.4	0.16	1.39	2.56	1.32	1.08	0.44	

Note: All unit are mm/day excepy item n)
g) Crop Factor: Ref. to AIRS General Report (ILACO, 1974)
h) Eto: Modified Penman Method
n) Irrigation Efficiency : 40%

Table 1.4 (3/8) Crop Water Requirement (LR Maize)

Description	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Cropping Pattern							
a) Land Preparation	1.7 1.7	1.7 1.7					
b) Topping Up							
c) Re-Flooding							
d) Sub-Total	1.7 1.7	1.7 1.7					
e) Effective Rainfall	1.2	1.7	2.4	2.1	1.3	1.2	1.5
f) Water Requirement d) - e)	0.5	0					
Crop Factor Kc	0.4	0.4 0.8	0.8 1.0	1.0 1.0	1.0 0.8		
		0.4 0.4	0.8 0.8	1.0 1.0	1.0 1.0	0.8	
		0.4	0.4 0.8	0.8 1.0	1.0 1.0	1.0 0.8	
			0.4 0.4	0.8 0.8	1.0 1.0	1.0 1.0	0.8
g) Average Kc	0.40	0.48	0.68	0.93	0.98	0.92	0.80
h) Eto	6.11	5.93	5.22	4.72	4.39	4.31	4.68
i) Consuptive Use g) x h)	2.44	2.85	3.55	4.39	4.30	3.97	3.74
j) Water Requirement i) - e)	1.24	1.15	1.15	2.29	3.00	2.77	2.24
k) Crop Area	1/12	2/3	1	1	1	2/3	11/12
l) Net Water Requirement j) x k)	0.10	0.76	1.15	2.29	3.00	1.84	0.19
m) Total Water Requirement f) + l)	0.60	0.76	1.15	2.29	3.00	1.84	0.19
n) GrossWater Requirement m)/0.4	0.17	0.22	0.33	0.66	0.87	0.53	0.05

Note: All unit are mm/day excepy item n)
g) Crop Factor: Ref. to AIRS General Report (ILACO, 1974)
h) Eto: Modified Penman Method
n) Irrigation Efficiency : 40%

Table 1.4 (4/8) Crop Water Requirement (SR Maize)

Description	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Cropping Pattern			Maize				
a) Land Preparation	1.7 1.7	1.7 1.7					
b) Topping Up							
c) Re-Flooding							
d) Sub-Total	1.7 1.7	1.7 1.7					
e) Effective Rainfall	1.4	0.9	0.9	1.6	1.7	1.0	1.4
f) Water Requirement d) - e)	0.3	0.8					
Crop Factor Kc	0.4	0.4 0.8	0.8 1.0	1.0 1.0	1.0 0.8		
		0.4 0.4	0.8 0.8	1.0 1.0	1.0 1.0	0.8	
		0.4	0.4 0.8	0.8 1.0	1.0 1.0	1.0 0.8	
			0.4 0.4	0.8 0.8	1.0 1.0	1.0 1.0	0.8
g) Average Kc	0.4	0.48	0.68	0.93	0.98	0.92	0.80
h) Eto	4.68	5.32	5.69	5.32	5.53	5.89	6.11
i) Consuptive Use g) x h)	1.87	2.55	3.87	4.95	5.42	5.42	4.89
j) Water Requirement i) - e)	0.47	1.65	2.97	3.35	3.72	4.42	3.49
k) Crop Area	1/12	2/3	1	1	1	2/3	1/12
l) Net Water Requirement j) x k)	0.04	1.10	2.97	3.35	3.72	2.95	0.29
m) Total Water Requirement f) + l)	0.34	1.90	2.97	3.35	3.72	2.95	0.29
n) GrossWater Requirement m)/0.4	0.10	0.55	0.86	0.97	1.08	0.85	0.08

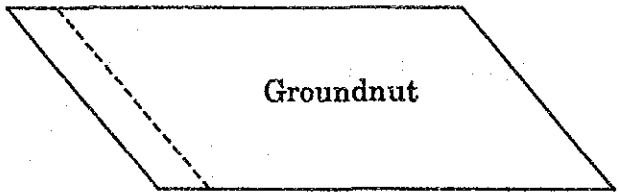
Note: All unit are mm/day excepy item n)
g) Crop Factor: Ref. to AIRS General Report (ILACO, 1974)
h) Eto: Modified Penman Method
n) Irrigation Efficiency : 40%

Table 1.4 (5/8) Crop water Requirement (Cotton)

Description	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Cropping Pattern			Cotton				
a) Land Preparation	1.3 1.3	1.3 1.3					
b) Topping Up							
c) Re-Flooding							
d) Sub-Total	1.3 1.3	1.3 1.3					
e) Effective Rainfall	1.2	1.7	2.3	2.1	1.2	1.3	
f) Water Requirement d) - e)	0.1	0					
Crop Factor Kc	0.85	0.35 0.70	0.70 0.90	0.90 0.95	0.95		
		0.35 0.35	0.70 0.70	0.90 0.90	0.95 0.95		
		0.85	0.35 0.70	0.70 0.90	0.90 0.95	0.95	
			0.35 0.35	0.70 0.70	0.90 0.90	0.95 0.95	
g) Average Kc	0.35	0.42	0.59	0.83	0.93	0.95	
h) Eto	6.11	5.93	5.22	4.72	4.39	4.31	
i) Consuptive Use g) x h)	2.14	2.49	3.08	3.92	4.08	4.09	
j) Water Requirement i) - e)	0.94	0.79	0.78	1.82	2.88	2.79	
k) Crop Area	1/12	2/3	1	1	11/12	1/3	
l) Net Water Requirement j) x k)	0.08	0.53	0.78	1.82	2.64	0.93	
m) Total Water Requirement f) + l)	0.18	0.53	0.78	1.82	2.64	0.93	
n) GrossWater Requirement m)/0.4	0.05	0.15	0.23	0.53	0.76	0.27	

Note: All unit are mm/day excepy item n)
g) Crop Factor: Ref. to AIRS General Report (ILACO, 1974)
h) Eto: Modified Penman Method
n) Irrigation Efficiency : 40%

Table 1.4 (6/8) Crop Water Requirement (Groundnut)

Description	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Cropping Pattern		 Groundnut					
a) Land Preparation	1.3	1.3 1.3	1.3				
b) Topping Up							
c) Re-Flooding							
d) Sub-Total	1.3	1.3 1.3	1.3				
e) Effective Rainfall	1.3	0.9	0.9	1.6	1.6	0.9	1.3
f) Water Requirement d) - e)	0	0.4	0.2				
Crop Factor Kc		0.50 0.50	0.95 0.95	0.90 0.90	0.50 0.50		
		0.50	0.50 0.95	0.95 0.90	0.90 0.50	0.50	
			0.50 0.50	0.95 0.95	0.90 0.90	0.50 0.50	
			0.50	0.50 0.95	0.95 0.90	0.90 0.50	0.50
g) Average Kc		0.50	0.69	0.88	0.77	0.67	0.50
h) Eto		5.32	5.69	5.32	5.53	5.89	6.11
i) Consuptive Use g) x h)		2.66	3.93	4.68	4.26	3.95	3.06
j) Water Requirement i) - e)		1.76	3.03	3.08	2.66	3.05	1.76
k) Crop Area		1/3	11/12	1	1	2/3	1/12
l) Net Water Requirement j) x k)		0.59	2.77	3.08	2.66	2.03	0.15
m) Total Water Requirement f) + l)		0.99	2.97	3.08	2.66	2.03	0.15
n) GrossWater Requirement m)/0.4		0.29	0.86	0.89	0.77	0.59	0.04

Note: All unit are mm/day excepy item n)
g) Crop Factor: Ref. to AIRS General Report (ILACO, 1974)
h) Eto: Modified Penman Method
n) Irrigation Efficiency : 40%

Table 1.4 (7/8) Crop Water Requirement (Green Gram)

Description	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	
Cropping Pattern		Green Gram					
a) Land Preparation	1.7 1.7	1.7 1.7					
b) Topping Up							
c) Re-Flooding							
d) Sub-Total	1.7 1.7	1.7 1.7					
e) Effective Rainfall	1.4	0,9	0.9	1.6	1.5	0.9	
f) Water Requirement d) - e)	0.3	0.8					
Crop Factor Kc	0.50	0.50 0.95	0.95 0.90	0.90 0.50	0.50		
		0.50 0.50	0.95 0.95	0.90 0.90	0.50 0.50		
		0.50	0.50 0.95	0.95 0.90	0.90 0.50	0.50	
			0.50 0.50	0.95 0.95	0.90 0.90	0.50 0.50	
g) Average Kc	0.50	0.59	0.78	0.87	0.70	0.50	
h) Eto	4.68	5.32	5.69	5.32	5.53	5.89	
i) Consuptive Use g) x h)	2.34	3.14	4.44	4.63	3.87	2.95	
j) Water Requirement i) - e)	0.94	2.24	3.54	3.03	2.37	2.05	
k) Crop Area	1/12	2/3	1	1	11/12	1/3	
l) Net Water Requirement j) x k)	0.08	1.49	3.54	3.03	2.17	0.68	
m) Total Water Requirement f)+l)	0.38	2.29	3.54	3.03	2.17	0.68	
n) GrossWater Requirement m)/0.4	0.11	0.66	1.02	0.88	0.63	0.20	

Note: All unit are mm/day excepy item n)

g) Crop Factor: Ref. to AIRS General Report (ILACO, 1974)

h) Eto: Modified Penman Method

n) Irrigation Efficiency : 40%

Table 1.4 (8/8) Crop Water Requirement (Fodder)

Description	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Kc	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Eto (mm/day)	5.89	6.11	5.93	5.22	4.72	4.39	4.31	4.68	5.32	5.69	5.32	5.53
CU (mm/day)	2.95	3.06	2.97	2.61	2.36	2.20	2.16	2.34	2.66	2.85	2.66	2.77
ER (mm/day)	0.9	1.3	1.7	2.3	1.8	1.2	1.2	1.4	0.9	0.9	1.5	1.5
NWR (mm/day)	2.05	1.76	1.27	0.31	0.56	1.00	0.96	0.94	1.76	1.95	1.16	1.27
GWR (l/sec/ha)	0.59	0.51	0.37	0.09	0.16	0.29	0.28	0.27	0.51	0.56	0.34	0.37

Note:
Kc : Crop Coefficient (=0.50)
Eto : Potential Evapotranspiration
CU : Consumptive Use of Water
ER : Effective Rainfall
NWR : Net Water Requirement (NWR = CU-ER)
GWR : Gross Water Requirement (GWR = NWR/0.40)

Table 1.5 Water Requirement for Each Cropping Pattern

Cropping Pattern A

Crop	Area	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
LR Paddy	0.8 ha		0.18	0.93	1.44	0.61	0.69	0.24					
Green gram	0.8 ha	0.16							0.09	0.53	0.82	0.70	0.50
LR Maize	0.8 ha		0.14	0.18	0.26	0.53	0.70	0.42	0.04				
SR Maize	0.8 ha	0.68	0.06						0.08	0.44	0.69	0.78	0.86
Fodder	0.4 ha	0.24	0.20	0.15	0.04	0.06	0.12	0.11	0.11	0.20	0.22	0.14	0.15
TOTAL	(l/sec/2 ha)	1.08	0.58	1.26	1.74	1.20	1.51	0.77	0.32	1.17	1.73	1.62	1.51
	(l/sec/ha)	0.54	0.29	0.63	0.87	0.60	0.76	0.39	0.16	0.59	0.87	0.81	0.76

Cropping Pattern B

Crop	Area	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
LR Paddy	0.8 ha		0.18	0.93	1.44	0.61	0.69	0.24					
Green gam	0.8 ha	0.16							0.09	0.53	0.82	0.70	0.50
LR Maize	0.8 ha		0.14	0.18	0.26	0.53	0.70	0.42	0.04				
SR Paddy	0.8 ha	0.35							0.13	1.11	2.05	1.06	0.86
Fodder	0.4 ha	0.24	0.20	0.15	0.04	0.06	0.12	0.11	0.11	0.20	0.22	0.14	0.15
TOTAL	(l/sec/2 ha)	0.75	0.52	1.26	1.74	1.20	1.51	0.77	0.37	1.84	3.09	1.90	1.51
	(l/sec/ha)	0.38	0.26	0.63	0.87	0.60	0.76	0.39	0.19	0.92	1.55	0.95	0.76

Cropping Pattern C

Crop	Area	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Cotton	0.8 ha		0.04	0.12	0.18	0.42	0.61	0.22					
Groundnut	1.6 ha	0.94	0.06							0.46	1.38	1.42	1.23
LR Maize	0.8 ha		0.14	0.18	0.26	0.53	0.70	0.42	0.04				
Fodder	0.4 ha	0.24	0.20	0.15	0.04	0.06	0.12	0.11	0.11	0.20	0.22	0.14	0.15
TOTAL	(l/sec/2 ha)	1.18	0.44	0.45	0.48	1.01	1.43	0.75	0.15	0.66	1.60	1.56	1.38
	(l/sec/ha)	0.59	0.22	0.23	0.24	0.51	0.72	0.38	0.08	0.33	0.80	0.78	0.69

Table 1.6 Diversion Water Requirement

Unit: m3/sec

		JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Sub-area I													
Pattern A	(0 ha)	-	-	-	-	-	-	-	-	-	-	-	-
Pattern B	(0 ha)	-	-	-	-	-	-	-	-	-	-	-	-
Pattern C	(950 ha)	0.56	0.21	0.22	0.23	0.48	0.68	0.36	0.08	0.31	0.76	0.74	0.66
Sub-total	(950 ha)	0.56	0.21	0.22	0.23	0.48	0.68	0.36	0.08	0.31	0.76	0.74	0.66
Sub-area II													
Pattern A	(290 ha)	0.16	0.08	0.18	0.25	0.17	0.22	0.11	0.05	0.17	0.25	0.23	0.22
Pattern B	(70 ha)	0.03	0.02	0.04	0.06	0.04	0.05	0.03	0.01	0.06	0.11	0.07	0.05
Pattern C	(3,720 ha)	2.19	0.82	0.86	0.89	1.90	2.68	1.41	0.30	1.23	2.98	2.90	2.57
Sub-total	(4,080 ha)	2.38	0.92	1.08	1.20	2.11	2.95	1.55	0.36	1.46	3.34	3.20	2.84
Sub-area III													
Pattern A	(1,700 ha)	0.92	0.49	1.07	1.48	1.02	1.29	0.66	0.27	1.00	1.48	1.38	1.29
Pattern B	(430 ha)	0.16	0.11	0.27	0.37	0.26	0.33	0.17	0.08	0.40	0.67	0.41	0.33
Pattern C	(1,380 ha)	0.81	0.30	0.32	0.33	0.70	0.99	0.52	0.11	0.46	1.10	1.08	0.95
Sub-total	(3,510 ha)	1.89	0.90	1.66	2.18	1.98	2.61	1.35	0.46	1.86	3.25	2.87	2.57
Total-area													
Pattern A	(1,990 ha)	1.08	0.57	1.25	1.73	1.19	1.51	0.77	0.32	1.17	17.3	1.61	1.51
Pattern B	(500 ha)	0.19	0.13	0.31	0.43	0.30	0.38	0.20	0.09	0.46	0.78	0.48	0.38
Pattern C	(6,050 ha)	3.56	1.33	1.40	1.45	3.08	4.35	2.29	0.49	2.00	4.84	4.72	4.18
Total	(8,540 ha)	4.83	2.03	2.96	3.61	4.57	6.24	3.26	0.90	3.63	7.35	6.81	6.07

Table 2.1 Monthly Mean Discharge at 1JG1

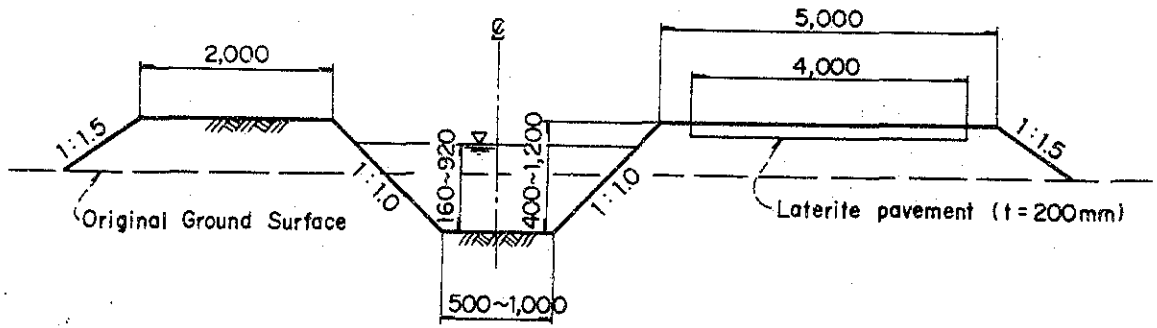
Unit : m^3/sec

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
1946			2.36	3.69	14.12	48.26	37.46	83.08	82.50	33.22	16.95	10.04	39.71
1947	13.16	11.83	15.58	99.60	264.97	79.78	52.07	56.27	59.93	53.99	13.44	8.50	61.13
1948	5.30	3.46	2.79	5.17	9.61	25.33	26.59	57.29	64.40	19.03	10.30	2.78	19.35
1949	3.49	2.78	1.74	4.15	5.53	13.46	15.77	36.09	57.62	23.48	10.85	9.31	15.39
1950	6.58	3.89	5.72	14.07	20.89	22.62	35.44	44.78	57.90	24.23	10.47	6.96	21.21
1951	4.50	4.67	4.23	110.48	92.02	87.55	35.21	45.12	28.54	31.42	45.78	123.48	51.28
1952	60.32	14.73	8.72	44.83	201.45	65.52	29.04	52.92	46.56	25.71	15.73	10.62	48.33
1953	5.49	3.17	2.31	6.16	9.86	10.75	9.85	11.96	9.73	7.05	6.65	6.45	7.48
1954	3.32	1.72	1.58	5.89	45.75	75.33	39.00	34.10	56.07	26.91	13.32	11.00	26.16
1955	5.92	5.55	3.10	6.81	16.26	10.25	16.51	45.16	86.04	63.39	25.04	19.21	25.36
1956	41.62	31.56	14.51	36.77	104.10	75.25	48.16	54.04	86.63	40.64	27.72	16.73	48.14
1957	8.58	6.95	6.57	47.67	113.96	149.81	63.26	53.37	45.54	15.27	10.62	9.40	44.35
1958	6.47	9.71	9.70	9.76	66.99	33.78	34.66	32.82	45.29	27.77	13.87	11.52	25.32
1959	8.64	6.64	11.68	37.04	69.75	35.22	16.09	18.29	28.56	22.84	23.27	14.49	24.44
1960	9.74	6.20	17.90	70.06	62.60	55.34	36.56	40.10	78.78	43.50	23.21	13.08	38.06
1961	6.76	4.54	4.32	9.72	24.06	15.55	12.92	33.03	46.28	56.62	258.81	227.19	58.49
1962	85.56	26.66	12.65	32.71	182.56	111.75	88.55	45.75	86.22	73.18	31.11	18.04	66.56
1963	31.95	24.98	21.17	74.05	264.96	118.43	34.96	51.32	37.63	10.98	12.69	88.08	64.63
1964	33.83	13.38	25.37	183.64	108.52	49.04	69.10	71.89	60.73	75.29	22.12	11.40	60.41
1965	10.03	6.37	4.01	32.45	72.74	23.59	15.38	16.38	17.01	11.81	31.57	22.14	22.04
1966	11.02	11.29	32.36	89.45	80.88	33.29	26.36	24.60	71.05	24.10	22.88	11.86	36.61
1967	6.55	4.35	3.64	19.93	99.09	64.22	75.48	40.09	30.81	17.02	21.22	57.12	36.92
1968	15.32	17.18	51.35	122.92	160.99	92.59	57.35	93.56	46.83	17.75	29.27	93.28	66.73
1969	22.83	48.94	39.46	29.85	37.70	23.70	14.16	16.94	34.87	14.15	9.58	6.89	24.71
1970	14.33	22.60	66.73	126.23	115.65	82.58	42.54	79.93	79.54	59.12	27.14	11.90	60.80
1971	10.54	6.86	4.61	11.21	41.77	66.50	64.14	100.38	93.93	46.17	16.84	10.38	39.63
1972	10.25	9.19	7.44	7.66	32.37	41.38	45.88	44.40	26.74	19.83	74.83	47.23	30.62
1973	43.61	32.63	20.06	12.45	33.23	80.71	31.40	48.67	62.91	36.59	30.01	13.36	37.07
1974	7.11	4.50	5.71	71.24	51.20	56.58	130.91	67.00	55.03	42.84	24.24	11.02	44.27
1975	6.21	4.42	5.50	28.79	33.33	50.50	42.40	94.43	136.64	81.90	36.79	14.41	44.74
1976	8.89	6.17	5.39	8.42	22.84	41.59	58.00	50.89	73.24	21.65	11.29	9.07	26.49
1977	11.65	24.01	13.92	89.55	163.96	81.02	109.92	78.33	53.35	26.12	109.91	78.31	70.40
1978	31.26	28.15	168.06	198.19	153.49	46.46	58.52	55.92	70.46	73.79	40.71	28.57	79.78
1979	21.22	69.63	48.07	69.45	92.72	75.23	56.32	63.41	35.35	15.33	10.08	7.65	46.85
1980	5.87	5.22	7.70	14.76	39.42	55.90	64.56	33.42	32.28	14.00	13.23	10.36	24.79
1981	5.69	6.26	12.53	142.07	93.51	33.41	40.33	79.29	62.33	56.68	22.00	13.11	47.41
1982	7.57	4.48	2.66	4.82	44.02	72.24	36.89	65.10	50.18	35.82	122.30	163.90	51.09
1983	26.80	11.74	7.50	16.96	48.94	50.50	42.83	55.15	107.71	80.22	51.82	24.52	43.84
Mean	16.70	13.69	17.86	49.99	81.46	56.74	45.12	51.98	58.09	36.01	34.14	32.98	41.59

Table 3.1 List of Secondary Canal

Sub-area	Canal Name	Irrigation Block	Commanding Area	Design Discharge	Canal Length	Related Structure (Nos.)							
						Turnout	Check	Culvert	Drop	Cross Drain	Siphon	Spillway	Wasteway
			(ha)	(m^3/sec)	(m)								
Sub-area I	LSC-3	L6	950	0.82	17,900	16	4	38	-	19	1	6	1
Sub-area II	LSC-1	L4	200	0.17	1,200	3	3	4	58	-	-	-	1
	LSC-2	L5	110	0.10	700	2	2	3	28	-	-	-	1
	LSC-4	L7	250	0.21	1,300	3	3	4	3	-	-	-	1
	RSC-1	R1	130	0.11	2,000	5	5	6	43	-	-	-	1
	RSC-2	R5	400	0.34	2,400	5	5	5	44	-	-	-	1
	RSC-3	R6	410	0.35	2,000	5	5	5	37	-	-	-	1
	RSC-4	R7	300	0.26	2,700	6	6	7	37	-	-	-	1
	RSC-5	R11	610	0.53	2,500	6	6	6	43	-	-	-	1
	RSC-6	R13	180	0.15	2,500	6	6	6	38	-	-	-	1
	RSC-7	R14	150	0.13	2,400	5	5	6	40	-	-	-	1
	RSC-8	R15	220	0.19	3,000	7	7	6	48	-	-	-	1
	RSC-9	R16	420	0.36	1,900	4	4	4	41	-	-	-	1
	RSC-10	R20	310	0.27	3,800	8	8	9	35	-	-	-	1
Sub-total					28,400	65	65	71	495	0	0	0	13
Sub-area III	RSC-11	R21	760	0.65	5,300	11	11	12	47	-	-	-	1
	RSC-12	R22	1,700	1.46	8,500	18	18	18	54	-	-	-	1
	RSC-13	R23	1,050	0.91	5,800	12	12	13	54	-	-	-	1
Sub-total					19,600	41	41	43	155	0	0	0	3
TOTAL					65,900	122	110	152	650	19	1	6	17

TYPICAL CROSS SECTION



FIGURES

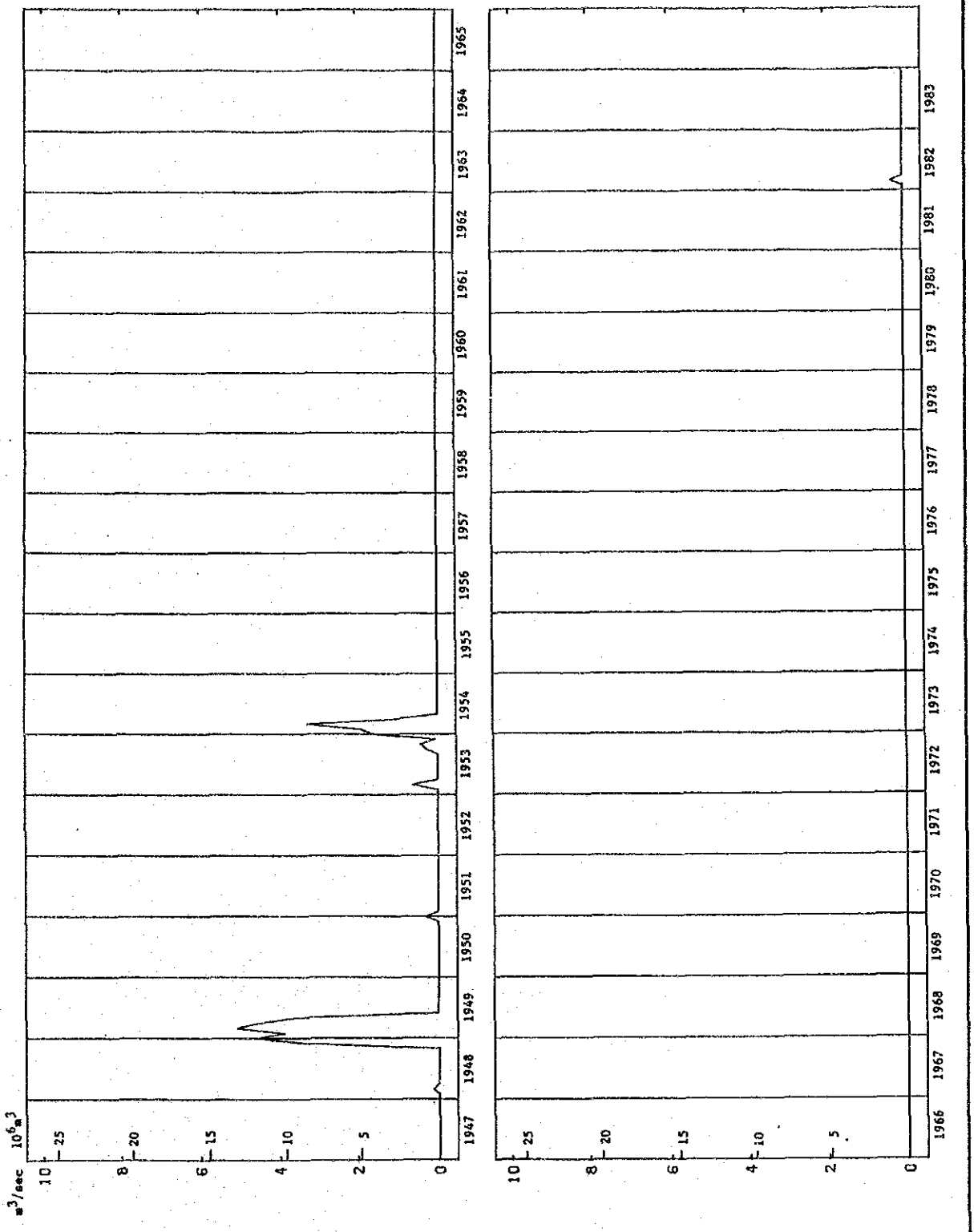


Figure 2.1 Monthly Irrigation Water Deficit Curve

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LEGEND

- Main Irrigation Canal
- Secondary Irrigation Canal
- Turnout
- Existing Road
- Natural Drainage
- Project Area
- Boundary of SUBAREA

Figure 3.1
Irrigation and Drainage Canal Layout

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SONDU RIVER
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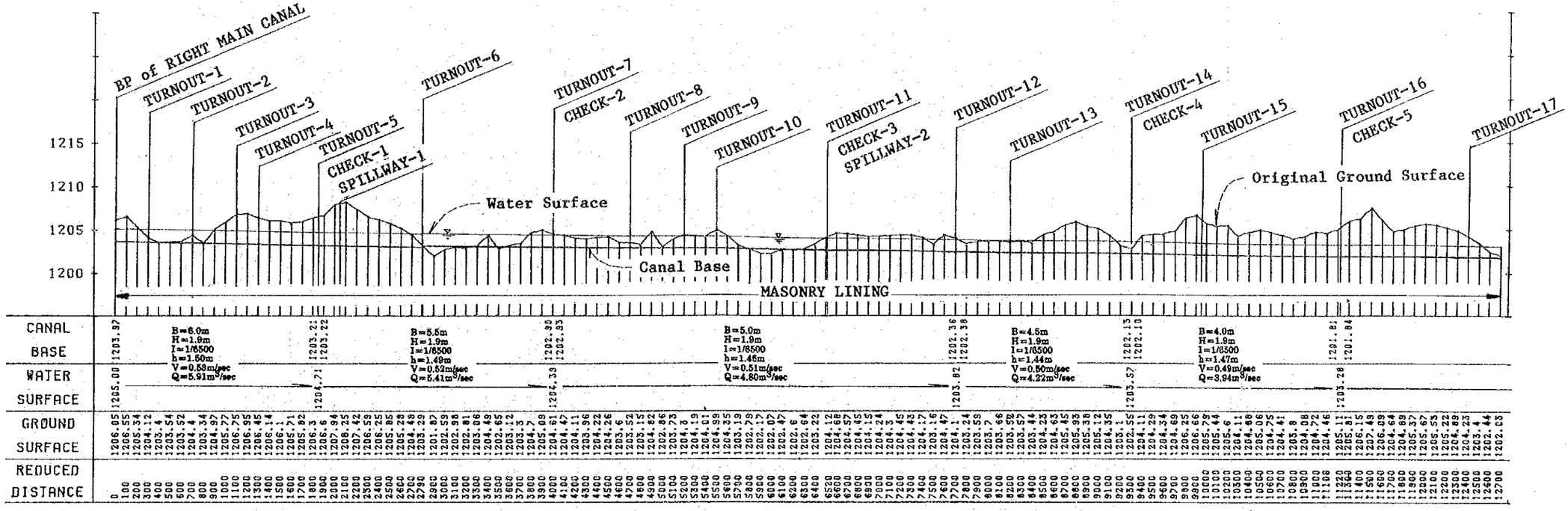
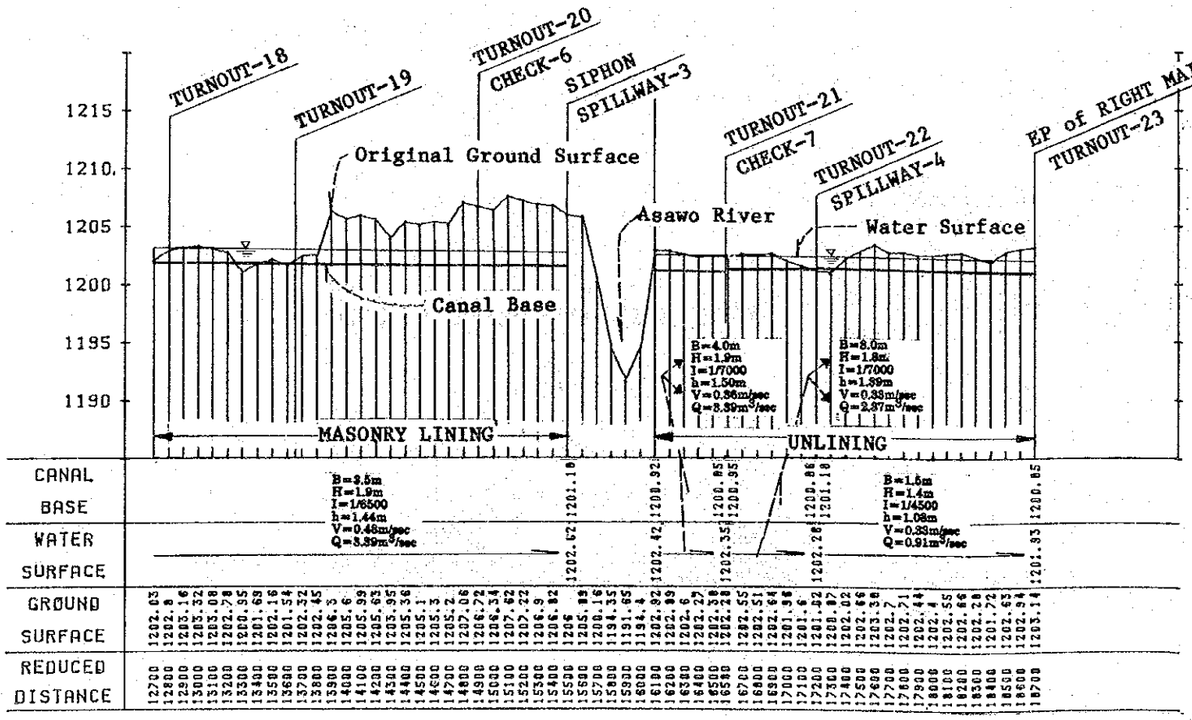
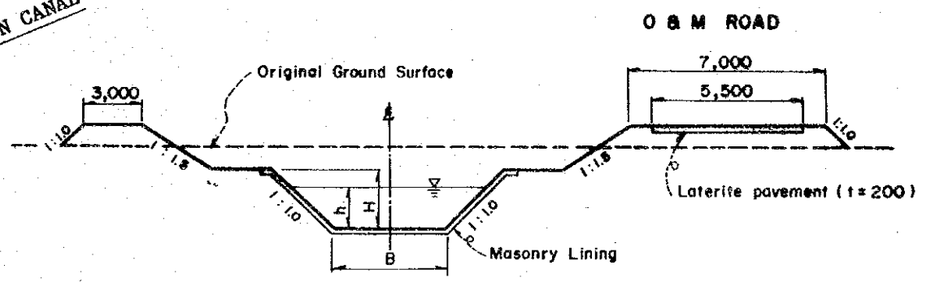




TYPICAL CROSS SECTION

MASONRY LINING



UNLINING

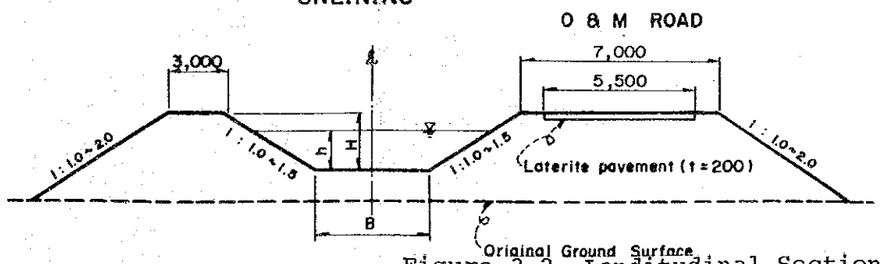


Figure 3.2 Londitudinal Section of Right Main Canal

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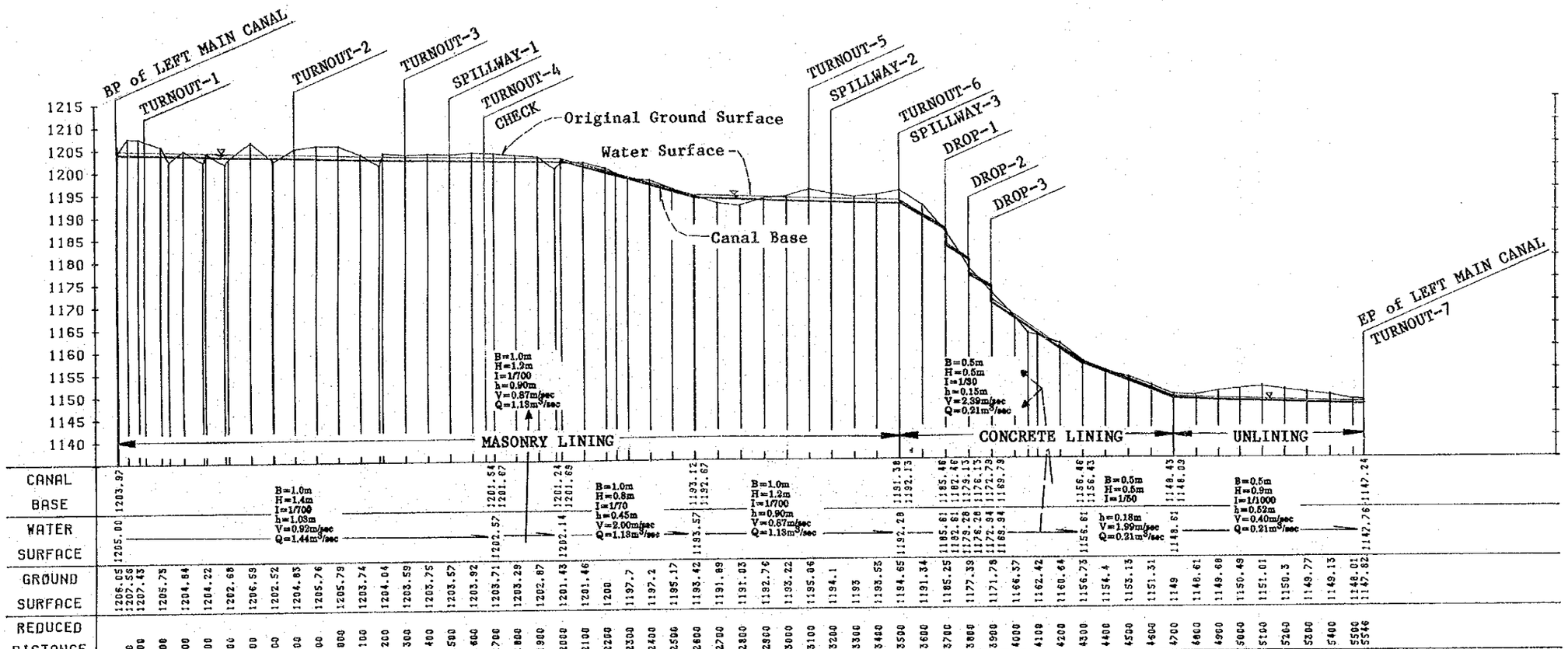
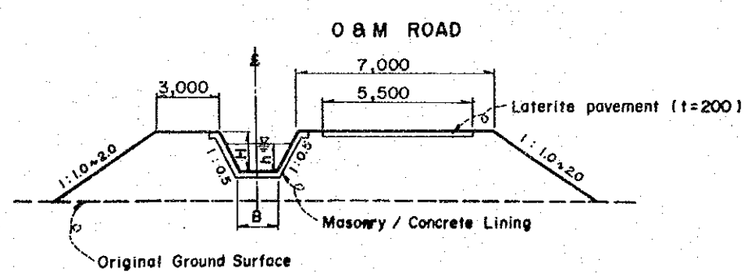
SONDU RIVER
MULTIPURPOSE DEVELOPMENT PROJECT
JAPAN INTERNATIONAL COOPERATION AGENCY



TYPICAL CROSS SECTION

MASONRY LINING / CONCRETE LINING



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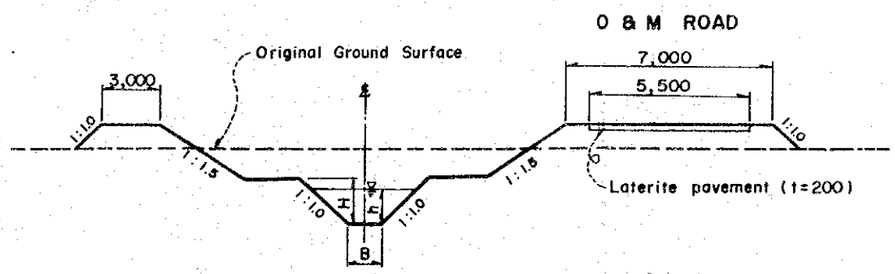

Figure 3.3 Londitudinal Section of Left Main Canal

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JAPAN INTERNATIONAL COOPERATION AGENCY

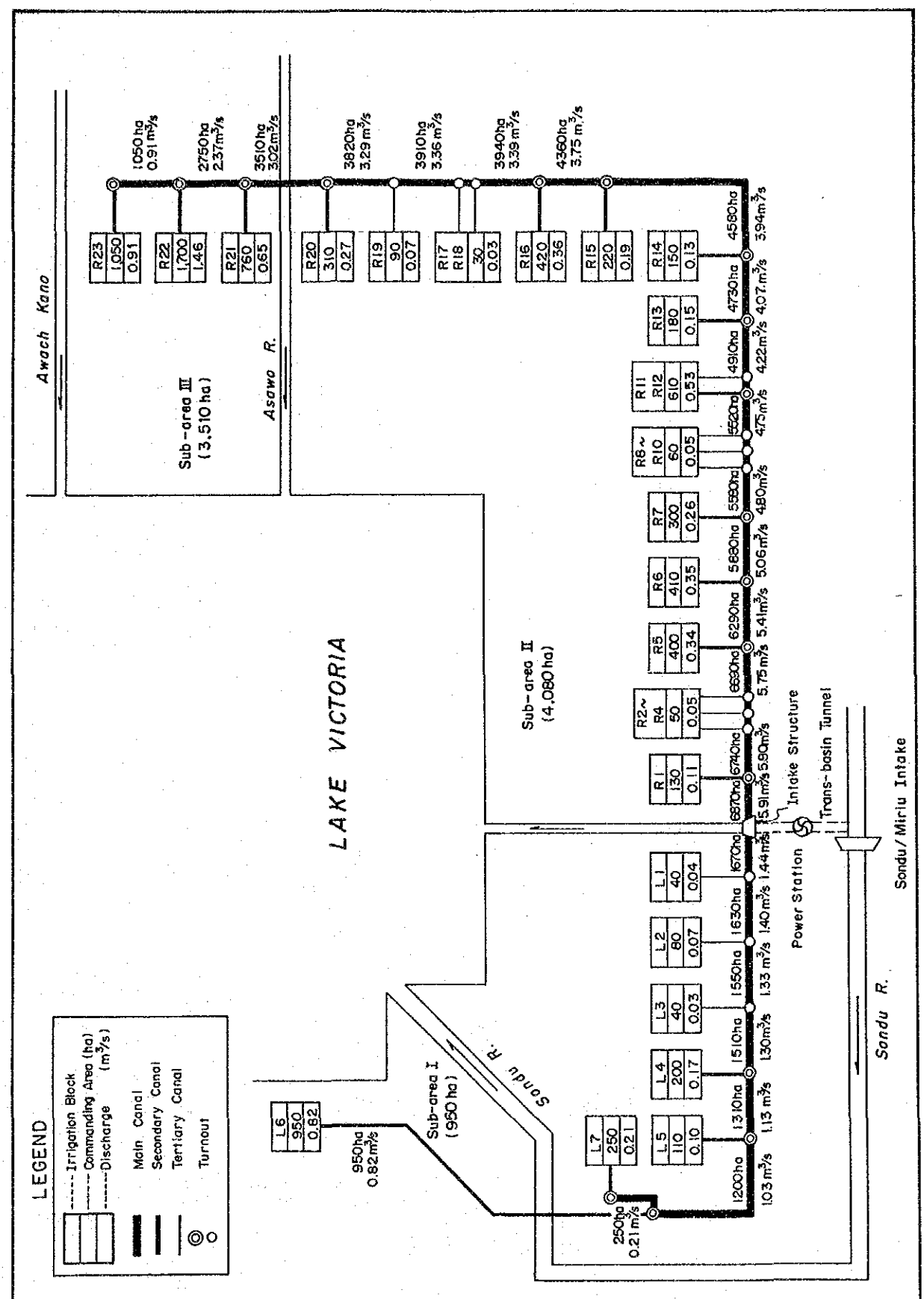

Figure 3.4 Irrigation Diagram

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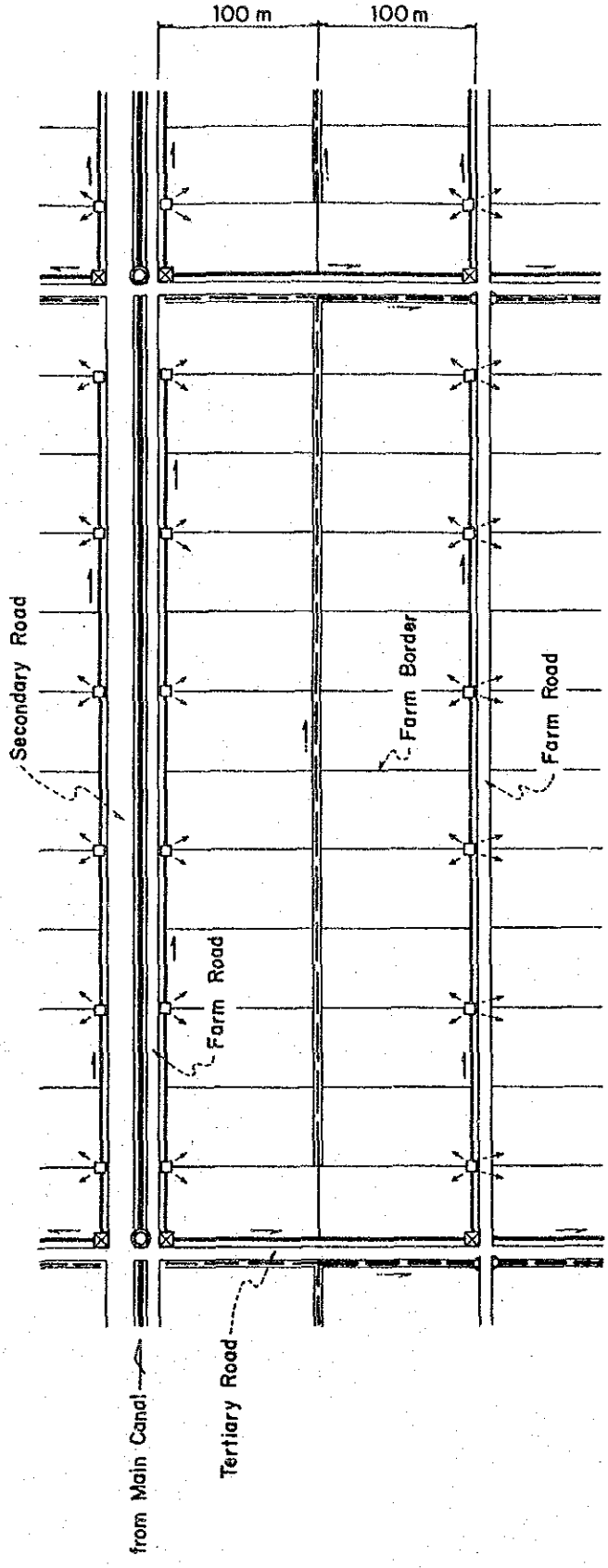

L E G E N D

- Secondary Canal
- Tertiary Canal
- Distribution Canal
- Tertiary Drain
- Field Drain

- Turnout on Secondary Canal
- Division Box on Tertiary Canal
- Division Box on Distribution Canal
- Drainage Culvert

Figure 3.5 Typical Farm Layout

REPUBLIC OF KENYA
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APPENDIX VI. COST ESTIMATE

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LIST OF TABLES

Chapter 1. CONSTRUCTION COST

1.1 Conditions of Cost Estimate

The construction cost is estimated under the following conditions:

(1) The exchange rate used in the estimate is US$1.0 = KShs 15.00 = Yen 240,

(2) Construction works are to be executed on contract basis using contractor's own construction machinery and equipment,

(3) Taxes on the construction materials, machinery and equipment to be imported from abroad are included in the estimate of construction cost,

(4) The construction cost is estimated based on the price level of December 1984,

(5) Costs for diversion intake works, tunnel and tailrace are excluded in this cost estimate,

(6) O&M equipment cost is estimated to be 5% of direct construction cost,

(7) Cost for land levelling is estimated only for proposed paddy field,

(8) The administration expenses and the engineering services are assumed to be 7 % and 20 % of the direct construction cost respectively,

(9) The annual price escalation is estimated to be 3 % on foreign currency and 9 % on local currency, respectively, and

(10) The physical contingency is assumed to be 10 % of the total construction cost.

1.2 Estimate of Constructin Cost

The construction cost for the irrigation component comprises of direct construction cost, compensation cost for land acquisition, cost for O&M equipment, administration expenses, engineering costs, price escalation and physical contingency.

The summary and breakdown of the cost estimate are shown in Table 1.1 to 1.5.

A list of unit rates for estimating construction costs is given in Table 1.6.

1.3 Annual Operation and Maintenance Costs

The annual operation and maintenance costs include the salaries of project 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, and running costs of project facilities.

Annual O&M costs are estimated to be 2 % of the direct construction cost.

TABLES

Table 1.1 Total Construction Cost

Description	F/C	L/C	TOTAL
	(1,000 US$)	(1,000 Kshs)	(1,000 Kshs)
1. Preparatory Works	2,035	10,222	40,747
2. Main Irrigation System	5,331	34,461	114,426
3. Secondary Irrigation System	3,906	19,652	78,242
4. Tertiary and On-farm Development	8,044	35,761	156,421
5. Land Levelling	1,942	6,718	35,848
6. Office and Quarters	1,125	5,625	22,500
Sub-total(item 1 to 6)	22,383	112,439	448,184
7. Land Acquisition	-	8,494	8,494
8. O&M Equipment	852	666	13,446
9. Administration Expenses	-	31,373	31,373
10. Engineering Services	5,976	-	89,640
11. Price Escalation	8,507	164,171	291,776
Sub-total(item 1 to 11)	37,718	317,143	882,913
12.Physical Contingency	3,772	31,714	88,294
TOTAL	41,490	348,857	971,207

Table 1.2 Summary of Direct Construction Cost

Description	TOTAL		SUBAREA I		SUBAREA II		SUBAREA III	
	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C
1. Preparatory Works	2,035	10,222	314	1,540	1,073	5,780	648	2,902
2. Main irrigation System	5,331	34,461	-	-	4,898	31,010	433	3,451
3. Secondary irrigation System	3,906	19,652	2,096	10,666	1,127	5,645	683	3,341
4. Tertiary and On-farm Development	8,044	35,761	895	3,978	3,843	17,085	3,306	14,698
5. Land Levelling	1,942	6,718	-	-	281	972	1,661	5,746
6. Office and Quarters	1,125	5,625	151	753	575	3,088	399	1,784
TOTAL	22,383	112,439	3,456	16,937	11,797	63,580	7,130	31,922

F/C : Foreign Currency (1,000 US$)
L/C : Local Currency (1,000 Kshs)

Table 1.3 Construction Cost of Sub-area I

	WORK ITEM	UNIT	Q'ty	AMOUNT F/C	AMOUNT L/C
II	SECONDARY IRRIGATION SYSTEM				
1	SECONDARY IRRIGATION CANAL		(17.9 km)		
	-Excavation	m3	125,000	140	606
	-Embankment	m3	336,000	588	2,355
	-Stripping of Topsoil	m3	55,800	34	123
	-Sod Facing	m2	114,000	119	114
	-Laterite Pavement	m3	14,400	75	262
	-Wet Stone Masonry	m3	23,400	711	3,795
	-miscellaneous	L.S.		50	218
2	RELATED STRUCTURE				
	-Turnout	nos.	16	36	186
	-Check Gate	nos.	4	5	47
	-Culvert	nos.	38	63	335
	-Spillway	nos.	6	23	178
	-Drop	nos.	-	-	-
	-Cross Drain	nos.	19	115	1,138
	-Siphon	nos.	1	124	1,204
	-Wasteway	nos.	1	2	12
	-miscellaneous	L.S.		11	93
	Sub-total			2,096	10,666
III	TERTIARY AND ON-FARM DEVELOPMENT	ha	950	895	3,978
IV	LAND LEVELLING	ha	-	-	-
	TOTAL			2,991	14,644

F/C : Foreign Currency (1,000 US$)
L/C : Local Currency (1,000 Kshs)

Table 1.4 Construction Cost of Sub-area II (1/2)

WORK ITEM	UNIT	Q'ty	AMOUNT F/C	AMOUNT L/C
I MAIN IRRIGATION SYSTEM				
1 MAIN IRRIGATION CANAL		(LMC 5.6 km ,RMC 15.5 km)		
-Excavation	m3	417,000	467	2,022
-Embankment	m3	357,000	625	2,503
-Stripping of Topsoil	m3	106,000	65	233
-Sod Facing	m2	136,000	141	136
-Laterite Pavement	m3	23,200	121	422
-Wet Stone Masonry	m3	54,000	1,642	8,759
-Concrete Lining	m3	800	39	369
-miscellaneous	L.S.		93	433
2 RELATED STRUCTURE				
-Turnout	nos.	27	83	413
-Check Gate	nos.	7	16	158
-Culvert	nos.	12	45	328
-Spillway	nos.	6	47	376
-Drop	nos.	3	6	32
-Cross Drain	nos.	20	231	2,289
-Aquiduct	nos.	9	1,226	12,055
-Siphon	nos.	-	-	-
-Wasteway	nos.	1	1	12
-miscellaneous	L.S.		50	470
Sub-total			4,898	31,010
II SECONDARY IRRIGATION SYSTEM				
1 SECONDARY IRRIGATION CANAL		(28.4 km)		
-Excavation	m3	26,000	29	126
-Embankment	m3	81,800	143	573
-Stripping of Topsoil	m3	36,200	22	80
-Sod Facing	m2	51,200	54	52

(to be continued)

Table 1.4 Construction Cost of Sub-area II (2/2)

	WORK ITEM	UNIT	Q'ty	AMOUNT	
				F/C	L/C
	-Laterite Pavement	m3	22,800	119	415
	-Wet Stone Masonry	m3	-	-	-
	-miscellaneous	L.S.		11	37
2	RELATED STRUCTURE				
	-Turnout	nos.	65	146	754
	-Check Gate	nos.	65	77	761
	-Culvert	nos.	71	88	437
	-Spillway	nos.	-	-	-
	-Drop	nos.	495	401	2,131
	-Cross Drain	nos.	-	-	-
	-Siphon	nos.	-	-	-
	-Wasteway	nos.	13	15	152
	-miscellaneous	L.S.		22	124
	Sub-total			1,127	5,645
III	TERTIARY AND ON-FARM DEVELOPMENT	ha	4,080	3,843	17,085
IV	LAND LEVELLING	ha	360	281	972
	TOTAL			10,149	54,712

F/C : Foreign Currency (1,000 US$)
L/C : Local Currency (1,000 Kshs)

Table 1.5 Construction Cost of Sub-area III(1/2)

WORK ITEM	UNIT	Q'ty	AMOUNT F/C	AMOUNT L/C
I MAIN IRRIGATION SYSTEM				
1 MAIN IRRIGATION CANAL		(RMC 2.6 km)		
-Excavation	m3	17,000	19	82
-Embankment	m3	35,000	61	245
-Stripping of Topsoil	m3	11,000	7	24
-Sod Facing	m2	9,000	9	9
-Laterite Pavement	m3	3,000	16	55
-Wet Stone Masonry	m3	-	-	-
-Concrete Lining	m3	-	-	-
-miscellaneous	L.S.		3	12
2 RELATED STRUCTURE				
-Turnout	nos.	3	15	123
-Check Gate	nos.	1	2	21
-Culvert	nos.	2	10	80
-Spillway	nos.	1	8	65
-Drop	nos.	-	-	-
-Cross Drain	nos.	-	-	-
-Aquiduct	nos.	-	-	-
-Siphon	nos.	1	273	2,635
-Wasteway	nos.	1	1	12
-miscellaneous	L.S.		9	88
Sub-total			433	3,451
II SECONDARY IRRIGATION SYSTEM				
1 SECONDARY IRRIGATION CANAL		(19.6 km)		
-Excavation	m3	55,800	62	271
-Embankment	m3	56,500	99	396
-Stripping of Topsoil	m3	29,100	18	64
-Sod Facing	m2	35,300	37	35

(to be continued)

Table 1.5 Construction Cost of Sub-area III(2/2)

	WORK ITEM	UNIT	Q'ty	AMOUNT	
				F/C	L/C
	-Laterite Pavement	m3	15,700	82	286
	-Wet Stone Masonry	m3	-	-	-
	-miscellaneous	L.S.		9	32
2	RELATED STRUCTURE				
	-Turnout	nos.	41	92	476
	-Check Gate	nos.	41	49	480
	-Culvert	nos.	43	71	417
	-Spillway	nos.	-	-	-
	-Drop	nos.	155	149	783
	-Cross Drain	nos.	-	-	-
	-Siphon	nos.	-	-	-
	-Wasteway	nos.	3	4	35
	-miscellaneous	L.S.		11	63
	Sub-total			683	3,341
III	TERTIARY AND ON-FARM DEVELOPMENT	ha	3,510	3,306	14,698
IV	LAND LEVELLING	ha	2,130	1,661	5,746
	TOTAL			6,083	27,236

F/C : Foreign Currency (1,000 US$)
L/C : Local Currency (1,000 Kshs)

Table 1.6 Unit Rates for Civil Works

Work Item	Unit	Unit Rate	
		F/C	L/C
		(US$)	(Ksh)
1 Land levelling	ha	780.00	2697.50
2 Excavation (common)	m3	1.12	4.85
3 Embankment	m3	1.75	7.01
4 Stripping of Topsoil	m3	0.61	2.20
5 Sod Facing	m2	1.04	1.00
6 Laterite Pavement	m3	5.20	18.20
7 Reinforced Concrete	m3	50.40	402.00
8 Plain Concrete	m3	42.50	342.00
9 Reinforcement Bar	ton	504.00	4190.00
10 Form	m2	2.50	55.50
11 Wet Stone Masonry	m3	30.40	162.20
12 Concrete Lining	m3	49.22	461.08