5.6 Benthara Ganga Right Bank Scheme

5.6.1 Irrigation and Drainage System

(1) General

The Benthara Ganga has a catchment area of 622 km² with an average annual runoff of 1,250 million m³ (39.6 m³/sec in average). The river flow of Benthara Ganga is strongly affected by change of sea levels. The Benthara Ganga functions as the main canal of the scheme. Sand bar formation at the estuary of the Ganga is not problematic at present according to the observation during the phase-I field survey. Originally, this scheme was constructed as a drainage scheme in 1953 facilitated with SWE (Salt Water Exclusion) structures; anicuts, flood protection bunds and drainage canals. The scheme is divided into two sections, i.e., Meegama section on the right bank of the Welipenne Ganga with a catchment area of 230 km² as the main tributary of the Benthara Ganga, and Ittapana section on the left bank of the Welipenne Ganga.

(2) Command Area and Presently Irrigated Area

As a result of survey conducted during phase-I field survey, the command area and presently irrigated area under Benthara Ganga Right Bank Scheme were identified as follows.

Meegama Section

		Command Area(ha)	Presently Irrigated Area(ha)
(1)	Devagoda Meegama Tract	81	30
(2)	Ladduwa Tract	243	80
(3)	Meegama Tract	182	65
	Sub-total	506	175

Ittapana Section

		Command Area(ha)	Presently Irrigated Area(ha)
(1)	Ittapana Tract	162	60
(2)	Badugoda-Lulbanduwa Tract	196	70
(3)	Munamaiwatte Tract	101	35
	Sub-total	459	165
	Total	965	340 (35 % of the command area)

As is seen from the above figures, only 35 % of the total command areas of the scheme are presently irrigated and the remaining has been abandoned due mainly to poor drainage and salt water intrusion to the farmlands. The dominant elevations of the farmlands under the scheme

located along the lower part of the Welipenne Ganga range from 1.0 to 2.0 ft above sea which is near or lower than MSL. Due to this, it seems that about 60 % of the total farmlands under the scheme could not be drained by present gravity drainage systems. The majority of the farmers in the scheme cultivate paddy and occasionally grow vegetables, rubber and coconut in the upland farms. The almost all the farmers in the scheme seem to have strong interest for cultivating paddy if conditions permit.

(3) Major Facilities in the Scheme

The major facilities in the scheme are salt water exclusion (SWE) structures with wooden lifting gates and steel -made flap gates. These facilities are summarized in Tables 5.6.1-1 to 5.6.1-3. Also there are 22 earthen canals with a top width of 2 to 4 m in average. These canals function as drainage canals and occasionally they function as irrigation canals. The length of these canals totals about 23 km. There exist flood protection bunds with a top width of 3 to 4 m along the Bentahara Ganga and Welipenne Ganga , however, these earthen bunds are not continuously provided along the said Gangas.

(4) Schematic Diagram of the System

The schematic diagram of the system is given in Figure 5.6.1-1. The diagram was prepared based on the field observation during the phase-I field survey and further study at home office.

(5) Survey Results for Degree of Deterioration of the Facilities

During the phase-I field survey, the study team conducted a survey to grasp the degree of deterioration of the major facilities under the scheme. The results of the survey are given in Table 5.6.1-4. The degree of deterioration was evaluated as the following criteria.

Marks	Judgement
A:	Can be used without rehabilitation.
B:	Needs rehabilitation.
C:	Needs replacement with new ones.

The survey results show that 68 % of the major reinforced concrete structures (SWE) need rehabilitation and 22 % of the major reinforced concrete structures need replacement with new ones.

And 31 % of the gates need rehabilitation, also 67 % of the gates need replacement with new ones.

(6) Major Problems Identified in the Scheme

Major problems with the scheme identified during the phase-I field survey can be summarized below.

(i) As stated earlier, most of the existing gates, which are either steel-made flap gates or wooden gates do not function well due to aging, rusts and deformation, resulting in

difficulty in operation of the gates, thus allowing free intrusion of saline water to the farmlands of the scheme, which makes crop cultivation in the scheme very difficult. Interview to the several representative farmers in the scheme and hearing from the irrigation engineers in charge of the scheme have revealed that almost of the farmlands under the scheme are inundated 3 to 4 times every Maha season with an average inundation depth of about 60 cm. The said inundation usually continues for 3 to 4 days. Also it may be mentioned here that in the floods of 1969 inundation of about 5.0 ft was observed. However, interview to the farmers also have revealed that the said inundation had not been observed until early 1970. This suggests that the drainage facilities of the scheme had been functioning well until early 1970. Accordingly, if those drainage facilities are improved or replaced with new ones, it is expected that present inundating condition of the scheme will be broadly improved.

(ii) Insufficient height and section of the existing bunds along the Benthara Ganga and Welipenne Ganga, which ranges from 3.0 to 4.0 ft, resulting in yearly overflowing of flood water and developing leakage through the bunds.

(iii) Sedimentation in the drainage canals has been one of the main factors for hindrance of free passage of designed drainage flow.

(iv) Present operation activities by the farmer's organizations do not at all cope with the required standard for operation and maintenance. It has been observed that present function of the existing SWE structures under the scheme needs much more attention, i.e., much frequent operation and maintenance of the facilities by the farmers' organizations, otherwise, the flood water in the farmlands of the scheme cannot be drained as designed and at the same time intrusion of saline water to the farmlands can not be protected by these existing SWE structures.

(v) Insufficient budget allocation and manpower arrangement for operation and maintenance of the major facilities in the scheme, causing insufficient maintenance of the facilities as well as difficulty in timely operation of the gates.

(7) Reasons for Need of Rehabilitation and Replacement

The main reasons for need of rehabilitation and replacement of the existing facilities under the scheme are that most of the existing gates in the existing facilities, which are either steel-made flap gates or wooden gates do not function well due to deterioration. Also the designed dimensions of the existing major facilities do not satisfy the drainage capacity required. Accordingly, it may be suggested that option of the gates in need of replacement should be adopted rust-proof steel made.

Table 5.6.1-1 Benthara Ganga RB Scheme <Meegama Section>

No.	Name of Canal	Structure						Benifit area		Length of canal			Year of Const-ruction	No. of Farm Families
		Name	Number of Bays	Dimension (feet-inch)	Dimension (m)		Type	(Acs)	(ha)	Miles	Chains	(m)		
M-1	Wadigawela Ela	S.W.E. Structure	2	2'-6"x4'-0"	0.76 x	1.22	Lifting Wooden Gates	40	16.2		20	610	1936-1947	80
M-2	Kaduruwatta Ela	- do -	8	3'-0"x4'-0"	0.91 x	1.22	- do -	70	28.3	1	26	2,402	- do -	130
M-3	Mahawanguwa Ela	- do -	1	2'-0"x3'-0"	0.61 x	0.91	- do -	12	4.9		26	792	- do -	25
M-4	Geriatabokka Ela	- do -	2	3'-0"x3'-0"	0.91 x	0.91	- do -	30	12.1		18	549	- do -	50
M-5	Kapuge Ela	- do -	1	2'-0"x3'-0"	0.61 x	0.91	- do -	25	10.1		19	579	- do -	40
M-6	Sooriya Ela	- do -	2	2'-5"x3'-6"	0.76 x	1.07	- do -	120	48.6	1	13	2,006	- do -	200
M-7	Guruge Ela	- do -	2	3'-6"x4'-6"	1.07 x	1.37	Wooden Planks	50	20.2		50	1,524	- do -	80
M-8	Bubule Ela	- do -	2	3'-0"x3'-6"	0.91 x	1.07	- do -	45	18.2	1		1,609	- do -	60
M-9	Ado Ayyage Ela	- do -	2	2'-5"x3'-6"	0.76 x	1.07	- do -	30	12.1		26	792	- do -	35
M-10	Totupola	- do -	2	3'-6"	1.07 x		Lifting Wooden G.							
M-11	Malmedilla Ela	- do -	1	3'-0"x4'-0"	0.91 x	1.22	- do -	26	10.5		19	579	- do -	40
M-12	Malpandura Ela	- do -	2	4'-3"x4'-6"	1.3 x	1.37	Lifting Wooden G. & Steel Flap Gate	17	6.9	1		1,609	- do -	20
M-13	Mahapiyadda Ela	- do -	2	8'-6"x6'-0"	2.59 x	1.83	- do -	60	24.3		49	1,493	- do -	100
M-14	Kadolthuduwa Ela	- do -	2	3'-3"x4'-0"	0.99 x	1.22	Lifting Wooden G.	40	16.2		19	579	- do -	80
M-15	Kandana Ela	- do -	2	4'-3"x4'-6"	1.3 x	1.37	- do -	70	28.3		26	792	- do -	120
M-16	Kimbul Ela	- do -	4	5'-0"x5'-0"	1.52 x	1.52	- do -	350	141.6	2	13	3,615	- do -	450
M-17	New Structure	- do -	1	3'0 H.P.		0.91	Wooden Planks	10	4.0			0	- do -	20
M-18	Aththa Hedura Ela	- do -	2	3'-6"x4'-6"	1.07 x	1.37	Lifting Wooden G.	40	16.2		20	610	- do -	70
-	Ladduwa Ela	Not existing	-				-	50	20.2		43	1,311	- do -	100
M-19	Andawela Structure	S.W.E. Struc.	2	3'-6"-x4'-6"	1.07 x	1.37	Lifting Wooden G.	-		No Canal			- do -	-
M-20	Parapaththotuwa Ela	- do -	4	4'-0"x5'-6"	1.22 x	1.68	- do -	-		-			- do -	-
-	Bondupitiya Ela	Not existing	-				-	75	30.4	1		1,609	- do -	120
M-21	Polkatuwa Structure	S.W.E. Struc.	2	3'-6"x4'-9"	1.07 x	1.45	Lifting Wooden G.	-		No Canal			- do -	-
M-22	Yakadayawella Structure (Kotapitiya Ela)	- do -	2	3'-3"x4'-6"	0.99 x	1.37	- do -	40	16.2	1	20	2,219	- do -	80
								50	20.2	2	37	4,346	- do -	120
M-23	Parappuwa Ela	- do -	4	4'-0"x4'-6"	1.22 x	1.37	- do -	Included above		10		16,093	- do -	Incl. above
Total for Meegama Section								1250	505.9					

Table 5.6.1-2 Parameter of Benthara Ganga RB Scheme <Ittapana Section - 1/2>

No.	Name of Canal	Structure					Benifit area		Length of canal			Year of Const-ruction	No. of Farm Families
		Name	Number of Bays	Dimension (feet-inch)	Dimension (m)	Type	(Acs)	(ha)	Miles	Chains	(m)		
I-1	Lewwanduwa Ela	S.W.E.Struc.	3	5'-0"x4'-6"	1.52 x 1.37	Steel Flap Gate & Lifting Wooden G.	65	26.3		35	1,067	- do -	200
I-2	Bokkewela Ela (Bangala Moda Ela)	- do -	2	3'-6"x4'-6"	1.07 x 1.37	Steel Flap Gate	20	8.1		21	640	- do - - do -	62
I-3	Letheri Ela	- do -	2	3'-6"x4'-6"	1.07 x 1.37	- do -	48	19.4		47	1,433	- do -	149
I-4	Kanana Ela	- do -	2	5'-0"x4'-6"	1.52 x 1.37	- do -	45	18.2		19	579	- do -	140
I-5	Puwakgaha Ela	- do -	1	3'-6"x4'-6"	1.07 x 1.37	- do -	25	10.1		8	244	- do -	77
I-6	Pothukumbure Ela	- do -	3	4'-6"x5'-0"	1.37 x 1.52	- do -	42	17.0		37	1,128	- do -	130
I-7	Dehiduwa Ela	- do -	2	3'-6"x4'-6"	1.07 x 1.37	- do -	43	17.4		39	1,189	- do -	133
I-8	Kumbure Ela	- do -	1	4'-0"x4'-6"	1.22 x 1.37	- do -	56	22.7		26	792	- do -	173
I-9	Pallewela Ela	- do -	1	3'-6"x4'-6"	1.07 x 1.37	- do -	40	16.2		19	579	- do -	124
I-10	Indu Ela (Kepu Ela)	- do -	2	4'-6"x5'-0"	1.37 x 1.52	- do -	58	23.5		18	549	- do -	180
I-11	Madarita Ela	- do -	2	3'-6"x4'-6"	1.07 x 1.37	- do -	58	23.5		17	518	- do -	178
I-12	Dombagaha Ela	- do -	2	3'-6"x4'-6"	1.07 x 1.37	- do -	42	17.0		14	427	- do -	130
I-13	Thummodara Ela	- do -	2	3'-6"x4'-6"	1.07 x 1.37	- do -	37	15.0		7	213	- do -	115
I-14	Yakgaha Ela	- do -	1	4'-6"x5'-0"	1.37 x 1.52	- do -	20	8.1		4	122	- do -	62
I-15	Malgaha Ela	- do -	2	3-6"x4'-6"	1.07 x 1.37	- do -	49	19.8		9	274	- do -	150
I-16	Kuruthune Ela	- do -	3	3'-6"x4'-6"	1.07 x 1.37	- do -	55	22.3		19	579	- do -	170
I-17	Horawala Wella Ela	- do -	1	4'-6"x5'-0"	1.37 x 1.52	- do -	42	17.0		15	457	- do -	130
I-18	Kiriamma Watta Ela	- do -	1	3'-6"x4'-6"	1.07 x 1.37	Steel Flap Gate & Lifting Wooden G.	53	21.4		18	549	- do -	164

Table 5.6.1-3 Parameter of Benthara Ganga RB Scheme <Ittapana Section - 2/2>

No.	Name of Canal	Structure					Benifit area		Length of canal			Year of Const-ruction	No. of Farm Families
		Name	Number of Bays	Dimension (feet-inch)	Dimension (m)	Type	(Acs)	(ha)	Miles	Chains	(m)		
	Pareigama Bund												
I-19	Tikirawa Gammaim Ela	S.W.E.Struc.	2	5'-0"x5'-6"	1.52 x 1.68	Steel Flap Gate	32	12.9		30	914	- do -	99
I-20	Puwakgaha Ela	- do -	2	4'-0"x4'-6"	1.22 x 1.37	- do -	10	4.0		10	305	- do -	31
I-21	Badugoda Ela	- do -	2	4'-0"x4'-6"	1.22 x 1.37	- do -	21	8.5		53	1,615	- do -	65
I-22	Hiriyana Ela	- do -	2	4'-0"x4'-6"	1.22 x 1.37	- do -	23	9.3		17	518	- do -	70
I-23	Lulbadduwa Ela	- do -	2	3'-6"x4'-6"	1.07 x 1.37	- do -	55	22.3		40	1,219	- do -	170
I-24	Thotupala Ela	- do -	2	4'-6"x5'-0"	1.37 x 1.52	Lifting Wooden G.	10	4.0		8	244	- do -	31
I-25	Duwe Ela	- do -	2	4'-0"x4'-6"	1.22 x 1.37	Steel Flap Gate & Lifing Wooden G.	28	11.3		20	610	- do -	87
	Gammana Bund											- do -	
I-26	Dehiduwa Ela	S.W.E.Struc.	2	3'-6"x4'-6"	1.07 x 1.37	Steel Flap Gate & Lifing Wooden G.	20	8.1		15	457	- do -	62
I-27	Cirumulla Ela	- do -	2	3'-6"x4'-6"	1.07 x 1.37	- do -	14	5.7		8	244	- do -	44
I-28	Bubula Ela	- do -	2	3'-6"x4'-6"	1.07 x 1.37	- do -	56	22.7		40	1,219	- do -	172
I-29	Dangaha Ela	- do -	2	3'-6"x4'-6"	1.07 x 1.37	- do -	18	7.3		20	610	- do -	56
-	Eluvila Ela	Not existing	-			-	5	2.0		15	457	- do -	15
I-30	Thotupola Ela (Oliyawalla Ela)	S.W.E.Struc.	2	3'-6"x4'-6"	1.07 x 1.37	Steel Flap Gate & Lifing Wooden G.	12	4.9		11	335	- do -	37
I-31	Duwe Ela	- do -	2	3'-6"x4'-6"	1.07 x 1.37	- do -	20	8.1		15	457	- do -	62
-	Kimbulkotuwa Ela	Not existing	-			-	13	5.3		26	792	- do -	40
	Total for Ittapana section						1135	459.3					

Table 5.6.1-4 Degree of Deterioration of Main Structures in Benthara Ganga RB Scheme

A: Can be used without rehabilitation
B: Needs rehabilitation
C: Needs replacement

No.	Name of canal or structure	Degree of deterioration		No.	Name of canal or structure	Degree of deterioration	
		Gate	Structure			Gate	Structure
	Meegama Section				**Ittapana Section**		
M-1	Wadigawela	C	C	I-1	Lewwanduwa	C	B
M-2	Kaduruwatta	C	B	I-2	Bokkewa	C	B
M-3	Mahawanguwa	C	C	I-3	Lentheri	C	B
M-4	Geriatta Bokka	C	C	I-4	Kanana	C	B
M-5	Kapuge	C	C	I-5	Puwakgaha	C	A
M-6	Sooriya	C	C	I-6	Pothukumbure	C	B
M-7	Guruge	C	B	I-7	Dehiduwa	C	B
M-8	Bubule	C	B	I-8	Kumbure	C	B
M-9	Ado Ayyage	C	B	I-9	Pallewela	C	B
M-10	Totupola	B	B	I-10	Indu	C	B
M-11	Malmedilla	B	B	I-11	Madarila	C	B
M-12	Malpandura	B	B	I-12	Dombagaha	C	B
M-13	Mahapiyadda	B	B	I-13	Thummodara	C	B
M-14	Kadothuduwa	C	B	I-14	Yakgaha	B	A
M-15	Kandana	B	B	I-15	Malgaha	B	B
M-16	Kimbul	B	B	I-16	Kuruthune	B	B
M-17	New Structure	C	A	I-17	Harawara wella	B	B
M-18	Nadura	C	B	I-18	Kiriamma watta	B	B
M-19	Andawela	C	B	I-19	Tikirawa Gammain	C	B
M-20	Parapathotuwa	C	B	I-20	Badugoda	C	C
M-21	Polkatuwa	C	C	I-21	Hiriyana	C	C
M-22	Yakadawella	C	C	I-22	Luldadduwa	C	C
M-23	Parappuwa	A	B	I-23	Puwakgaha	C	C
				I-24	Thotupola	C	C
				I-25	Duwe	B	B
				I-26	Dehiduwa	B	A
				I-27	Urumulla	B	B
				I-28	Bubule	B	B
				I-29	Dangaha	B	A
				I-30	Thotupola	C	B
				I-31	Duwe	B	B

Degree of deterioration

	Gate	Structure
A	1 no. (1.9%)	5 nos. (9.3%)
B	17 nos. (31.5%)	37 nos. (68.5%)
C	36 nos. (66.6%)	12 nos. (22.2%)

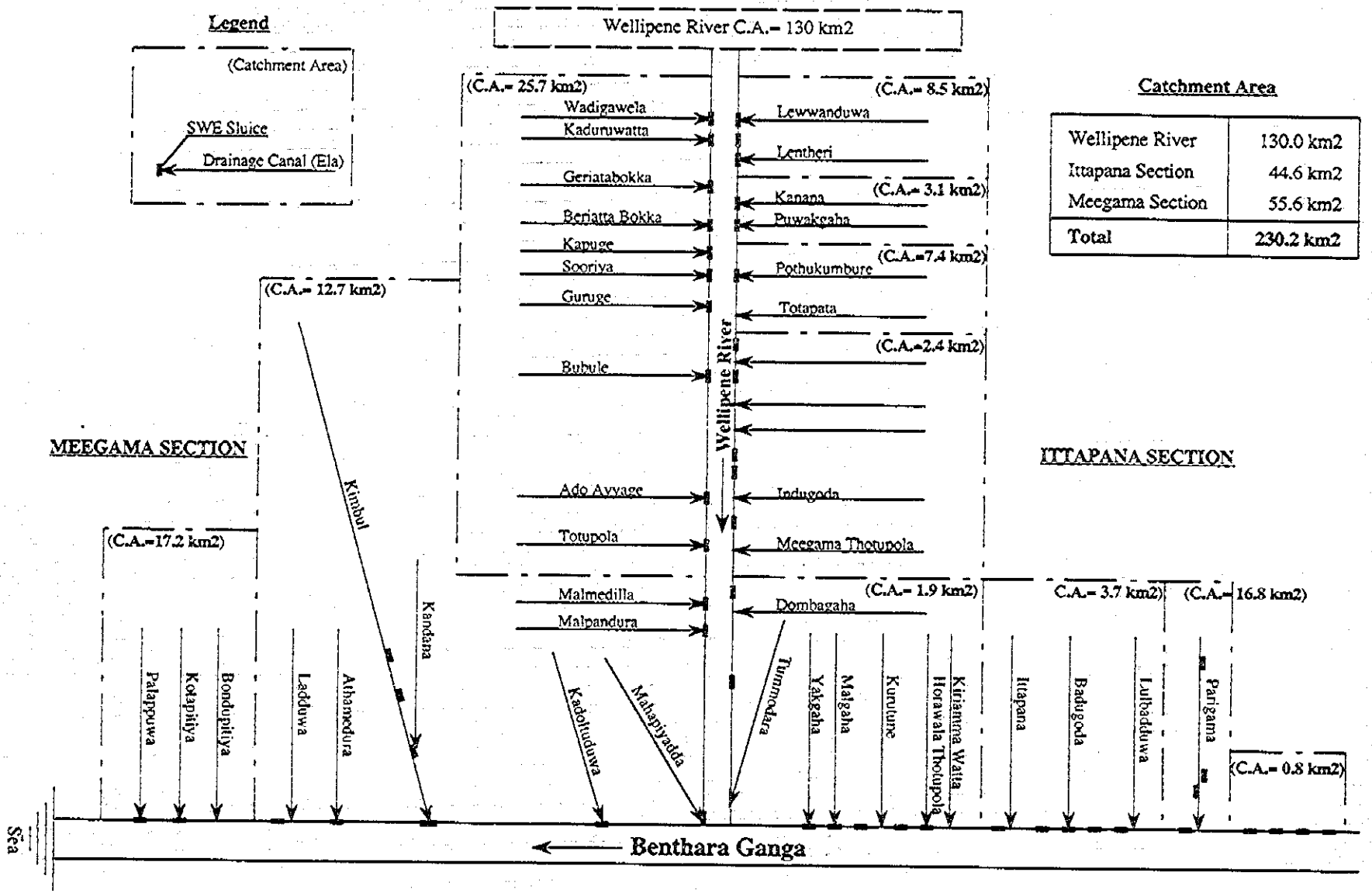

Fig. 5.6.1-1 Schematic Diagram of Benthara Ganga Right Bank Scheme

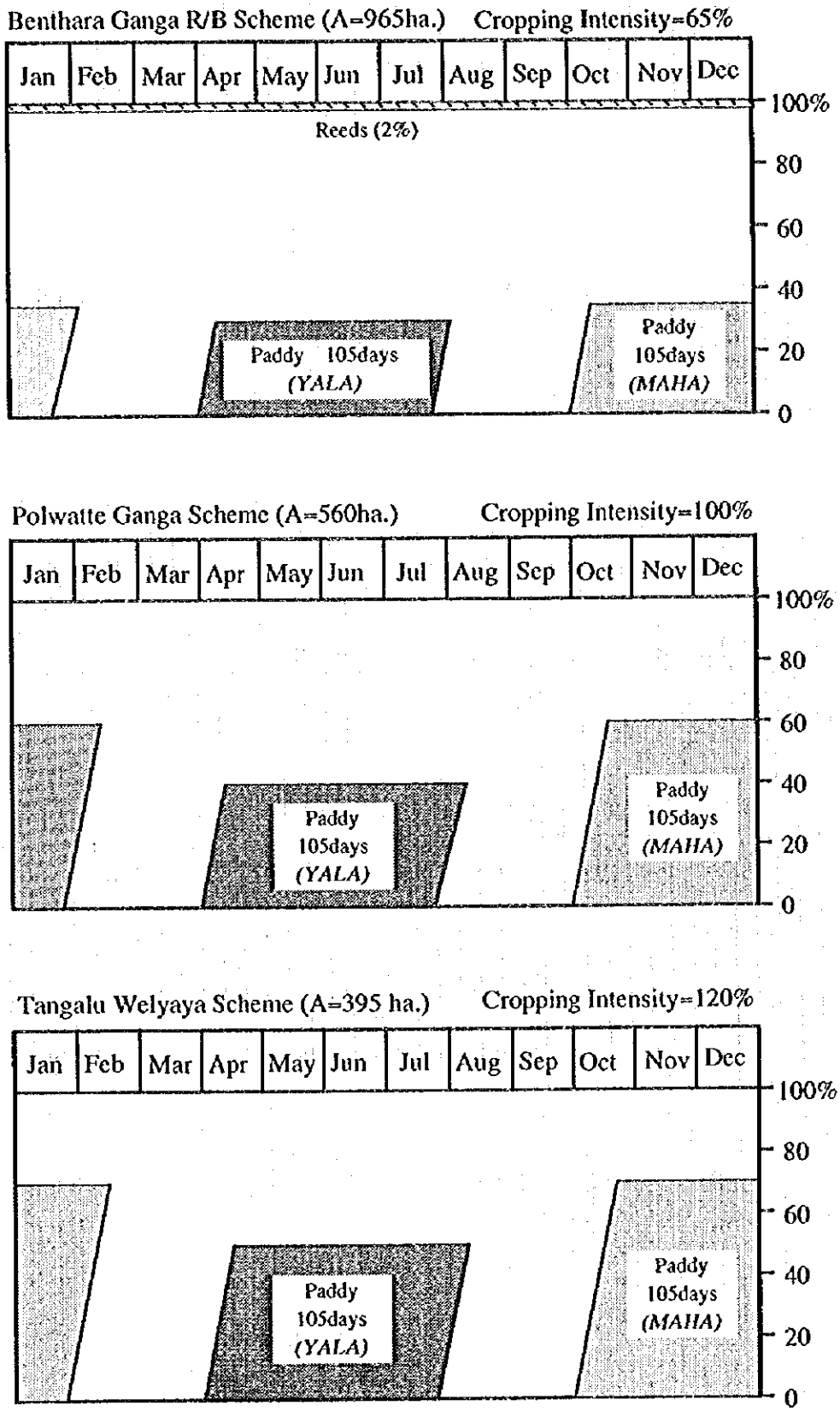

Fig. 5.6.1-2 Present Cropping Pattern for Benthara Ganga R/B, Polwatte Ganga and Tangalu Welyaya Scheme

5.6.2 Agriculture

(1) Land Use and Farm Family

Land Use

According to ID officers, present paddy cultivation area in irrigable land is now estimated at 290 ha in Yala and 340 ha in Maha indicating 67% crop intensity.

There is no OFC cropping, but 20 ha of Reed cultivation is supported by Agricultural Office (DOA) in Kalutara District.

Farm Family

Numbers of farm families are estimated at 1,380, holding 0.7 ha each paddy land with 0.4ha/ year of paddy cropping on the average.

According to the report by Dep. of Census & Statistics, 55% of paddy land is cultivated by owner farmers and 45% by tenant farmers in Kalutara district in 1989(Agricultural Statistics of Sri Lanka 1992).

(2) Crop cultivation and Cropping pattern

Paddy Cultivation

Land preparation by tractors shows only 14% in Kalutara, while, manual and/or buffaloes operation shows 82% due to small size of paddy cultivation. For threshing and transportation of production are also made by manual and buffaloes in small size operation. The application of fertilizer is supposed ineffective due to stagration of water and poor drainage condition.

Paddy yield is estimated at 2.5 t/ ha on the average.

OFC Cultivation

There is no OFC cultivation in paddy land in this scheme, but 20 ha of Reed is cultivated under support by District DOA.

Cropping Pattern

The present cropping pattern in Benthara scheme is as follows.

Name of Season	Present		
	Crops	CI(%)	Benefited Area (ha)
Yala	Paddy	30	290
	Reeds	2	20
Maha	Paddy	35	340
	Reeds	2	20
Total		67	650

(3) Livestock and Tree Crops

Livestock

Livestock in Kalutara district is not so popular as that in Hambantota due to little grassland. 356 heads of cattle, 273 heads of buffaloes and 108 heads of goats are estimated for the scheme area according to the district data of animal heads in 1991.

Tree Crops

Matugama, which is a neighbouring large town holding over 70,000 of population, is famous for its rubber production. Land use map in 1983 shows the area of Rubber, Coconuts and Cinnamon trees around the scheme area.

Besides those trees, there are fruit crops such as banana, papaya, jack-fruits, bread-tree, etc. mainly in the homestead.

(4) Agricultural Support Service

District Agricultural office(Assistant Director's office) helps Reeds cultivation in cooperation with women's society of which members are eager for Reeds cultivation and development of their wearing industry.

5.6.3 Farmer Organizations

There are 21 FOs representing different sections of the scheme. They are organized by the Agrarian Services Department according to Grama Niladari division areas and are independent of each other. Since farmers in this area are engaged in a variety of agricultural pursuits, their interest is not limited to water management. In fact there is hardly any water management in this scheme because their major problem is excess water and flooding. Nevertheless the farmers are organized and articulate.

There is a Project Management Committee under the MANIS program, chaired by the Irrigation Engineer Kalutare, which meets monthly. Farmers do participate in "Shramadama" activities for maintenance of the scheme.

It is rather difficult to correlate the present FOs to hydrological areas. Once the area for rehabilitation is determined, the farmers with an interest in that area have to be organized into FOs or informal groups. A list of FOs as reported by IE is annexed.

Bentara Ganga Right Bank Scheme
Farmer Organizations:

	Meegama Sectio		Ittepana Section
1.	Laddowa	1.	Samagi
2.	Parakrama	2.	Bokewayaya Eksath
3.	Indigastuduwa Nava Pethuma	3.	Thotapatha
4.	Devagoda	4.	Duwegoda
5.	Walagedara South No. 1	5.	Ittepana West
6.	Walagedara South No. 2	6.	Ittepana South No. 1
7.	Meegama	7.	Ittepana West No. 2
8.	Kurudippita	8.	Deniduwa-Garindawa Duwegoda
		9.	Poldugoda-Tikirawa
		10.	Galathara
		11.	Uronulla
		12.	Ganmana-Eluwila
		13.	Galhire Nedungahawela

5.6.4 Management of System

The extent identified by ID as command area of the scheme is 965 ha. However, about 65% of this area is not regularly cultivated at present owing to difficulties in regulating the supply of irrigation water. The area irrigated at present is identified by the Study Team as 340 ha; if properly rehabilitated and maintained the system has potential for irrigating the full extent.

The system is in two parts: Meegama section with a potential of 506 ha and 175 ha identified, and Ittapana section with a potential of 459 ha and 165 ha identified.

Farmers from the different parts, face difficult types of problems, e.g. in Meegama section part of the land is below sea level. During high tide the river heads up and if it rains upstream, paddy fields get inundated. Often this occurs in May when the paddy is in seedling stage and the crop is damaged. Farmers' main problem is to get over this period. In Ittapana section, salt water intrusion is the major problem. This is largely due to the fact that steel flap gates are either not functioning or are damaged by fishermen.

Several canals have got silted up due to poor maintenance; as a result some sections of paddy lands are abandoned. Insufficient height of bunds along the Bentara Ganga and Welipeena Ganga results in overtopping of bunds and leakages.

Gates are operated by ID field staff. Repairs and maintenances are supervised by ID staff. Funds provided for operation and maintenance are not adequate. The Project Management Committee chaired by the IE, Kalutara has been able to get the cooperation of FOs to contribute their labour for the maintenance of canals. In the absence of a controled irrigation system and a cultivation program, FOs are not able to play an active role in system management.

Operation and Maintenance Costs

O/M costs for the scheme are allocated by ID as follows:

Year	Allocation (Rs)	Area (ha)	Rs/ha
1995	260,000	965	265

5.6.5 Environmental Issues

(1) Soil and Water Quality

Soil Sampling

For checking sea water intrusion, 5 soil samples were collected and analyzed. Location of sampling sites and results of analysis are given in Fig.5.2.5-1 (1/6) and Table 5.2.5-1.

As a result of the analysis, the influence of sea water intrusion was observed in the scheme. Especially, sample No.BT-5 which is a non-cultivated area showed high value in EC and saline contents.

Water Sampling

For checking sea water intrusion into the rivers, 3 samples were collected and examined. Location of sampling sites and results of analysis are given in Fig.5.2.5-1 (1/6) and Table 5.2.5-2.

As a result of the analysis, sea water intrusion was confirmed at the point of 21 km from the estuary.

(2) Poor Drainage and Flood Damage

This scheme's area is particularly subject to flooding due to the fact that (i) scheme area is low wetland roughly at the same elevation as average tide, (ii) the Benthara Ganga basin lies in Wet Zone with annual rainfall over 4,000 mm, (iii) runoff is a large 70%, and (iv) discharge is 5~10 times greater than that of a basin of comparable size in Dry Zone.

During the rainy season, a 2 hour downpour at the headwaters of the basin will result in inundation of the scheme area with 2~4 ft of water. Flooding occurs a number of times throughout the year. Draining of inundated areas is done gradually by flap gate, which requires several days during which tilling is not possible.

Nevertheless, topographical conditions at the river mouth are favorable, and blockage does not occur.

(3) Wildlife

Although a high degree of biodiversity is not observed at Bentota estuary, a number of rare species are seen as well as continuous mangrove forest along the river embankment. Visually, this area appears as natural jungle.

Under the Wetland Conservation Project and other studies, species identified include 45 species of plant (including 14 rare species), 6 species of mammal (including 1 endemic specie), 49 species of bird (including 3 endemic species), 24 species of reptile (including 5 endemic species) which is identified relatively so many, 1 specie of amphibian, and 37 species of fish (including 3 endemic species).

(4) Fishery

i) Fishery in the Estuary

In the Benthara Ganga estuary near the scheme area, out of a total fishermen population around 260, 60 work the fresh~brackish waters of the river itself. The remainder fish along the coast. Of the 60 fishermen working the river, about 40 are estimated to fish along the Benthara Ganga and another 20 fish Dedduwa lake. Fishing in the river is by rod and line from dug out, outriggered canoes, and fishing in the lake is by fish kraals and cast net. Species caught are shrimp and brackish water fish.

ii) Fishery in Canals

Within the canals of the subject scheme as well, fishermen in the area fish with nets in groups of several to 20~30 persons. During the period February~March each year, large scale fishing operations are carried out 2~3 times in which (i) the canal gates are partially opened and netting drawn across the opening, and then (ii) buffalo are driven through the canals to in turn drive fish in the direction of the gates and into the nets. Catches are around 100 kg per time. Brackish water fish and shrimp are the species caught which serve to supplement the diet of themselves including area farmers and laborers. After fishing operations are completed, the flap gate is left partially open to allow fish stocks to be replenished. Water pressure at high tide, however, subsequently deforms the gates. According to farmer organizations, this practice deteriorates the water tightness of flap gates allowing salt intrusion into canals and thereby increase salt concentration in the soil, as well as allowing traffic into canals by both humans and buffalo resulting in damage to canals.

(5) Water Use

i) Tourism

The entire area around the river mouth is jungle, and motorboat cruises are available to tourists back and forth between the river mouth and Loolbadduwa, around 15 km upper point from the mouth on the Benthara Ganga for viewing the scenery and river wildlife including various species of reptiles such as crocodiles and bird, etc. Boat docks are located at the river mouth, etc. accommodating around 35 boats. According to interview survey, around 250 customers are expeted to come every day.

Factors promoting this tourist trade are the good guest capacity at the area hotels as well as the natural beauty and ample wildlife presence in the Benthara estuary.

ii) Water Use for Domestic Purposes

Diversion from the river for domestic purposes is not done.

(5) Others

i) ADB-funded Project

ADB-funded Salt Water Exclusion Drainage Scheme Project Plan is examined in the left bank

of Benthara Ganga due to poor drainage and frequent flood damage.

ii) Sedge Cultivation

Small scale sedge cultivation in poor drainage low land is proceeded, and farmer's women are producing mats, bags and some crafts goods made by sedge. The training center has been already establidhed around 15 years ago, and set several sewing machimes. Areal women can accept instruction of mat making, etc. in there with subsidy available.

5.7 Polwatte Ganga Scheme

5.7.1 Irrigation and Drainage System

(1) General

The scheme was constructed in 1957 and it consists of 5 sub-schemes. The Polwatte Ganga has a catchment area of 233 km² with an average runoff of 300 million m³/year (9.5 m³/sec in average). It functions as a main drainage channel of the scheme. The river flow of the Ganga is strongly affected by the change of the sea level. And the majority part of the scheme lie in Matara district and partially in Galle district.

(2) Command Area and Presently Irrigated Area

Through the phase-I field survey and home office work, the command area and presently irrigated area were identified as follows.

Name of sub-schemes		Command Area Informed by ID (ha)	Presently Irrigated Area Identified by JICA Study Team (ha)	Remarks
(i)	Ilwatta Anicut Scheme	560	220	
(ii)	Borala Tank Scheme	72.5	50	Under NIRP
(iii)	Ittawela Anicut Scheme	50.5	32	Under NIRP
(iv)	Deegoda Tank Scheme	81	60	To be taken up independently.
(v)	Other Small Irrigation Schemes	857	(350)	Estimated figure due to difficulty in identification.
Total		1,621	(712)	

Note * Rehabilitation for Borala Tank Scheme and Ittawela Anicut Scheme is in progress under National Irrigation Rehabilitation Project, accordingly these two schemes should be dropped from the study for rehabilitation of the scheme.

Note** " Other Small Irrigation Schemes " in the above table were not clearly identified by JICA Study Team as well as by Department of Irrigation during the phase-I field survey, accordingly it was decided between the both parties that these small irrigation schemes should be dropped from the study in the meeting held on April 7, 1995 at the Department of Irrigation. Accordingly, it may be mentioned here that only the Ilwatta Anicut Scheme with a command area of 560 ha can be taken up for the study of rehabilitation of the scheme.

Above figures show that only 44 % (712/1,621) of the command area under the total scheme is presently irrigated. This may be attributed to the following.

(i) Lack of proper drainage and irrigation networks,
(ii) Water shortage in Yala and floods during Maha season,
(iii) Water logging due to insufficient function of the existing drainage facilities, and
(iv) Intrusion of saline water to the farmlands, resulting in decrease of acreage of cropping farmlands etc.

(3) Major Facilities in the Scheme

The scheme consists of five sub-schemes i.e, (i) Ilwatta Anicut Scheme, (ii) Ittawela Anicut Scheme, (iii) Borala Tank Scheme, (iv) Deegoda Tank Scheme and (v) Other Small Irrigation Schemes. The major facilities of the scheme are summarized in Table 5.7.1-1 below.

Table 5.7.1-1 Summary of Major Facilities in the Scheme

Name of Sub-Schemes	Facilities and Main Dimensions	Remarks
(i) Ilwatta Anicut Scheme	3 nos. of steel-made lifting roller gates Full supply level: 2 feet above the MSL Sill level: 10 feet below the MSL Gates: 6 m wide, 2.6 m in height	Manually operated.
	Approach bund: Top elevation, 1.07 m above the MSL	
(ii) Ittawela Anicut Scheme NIRP.	5 nos. of wooden gates	Under rehabilitation by
	Gates: 1.52 m wide, 1.52 m in height.	Manually operated.
(iii) Borala Tank Scheme	Earthen tank (net capacity of 470,000 m^3) Catchment area of the tank: 1.54 km^2	
	3 nos.of wooden sluice gates and 1 nos of steel-made gates.	Under rehabilitation by NIRP
	Size of opening, 0.3 to 1.2 m. 5 earthen canals with a total length of 5.47 km.	Manually operated.
(iv) Deegoda Tank NIRP.	Earthen tank (net capacity 73,000 m^3)	Under rehabilitation by Manually operated.
	Catchment area of the tank: 0.77 km^2	
	Number of gate: 1 Nos.	
(v) Other Small Irrigation Schemes		
As mentioned earlier, these schemes were not identified by JICA Study Team as well as by Department of Irrigation. Accordingly, information on major facilities in these schemes cannot be supplied. However, according to the information provided by Irrigation Engineer's Office in Matara, each of these schemes consists of very small irrigation scheme under which vegetables are cultivated.		

(4) Schematic Diagram of the Scheme

The schematic diagram of the scheme is given in Figure 5.7.1-1. The diagram was prepared based on the field observation during phase-I field survey and further study at home office.

(5) Survey Results for Degree of Deterioration of the Facilities

Survey for degree of deterioration of the facilities was conducted by JICA study team during the phase-I field survey in collaboration with the counterpart from the Irrigation Engineer's Office in Matara applying the same criteria stated earlier. The results are summarized in Table 5.7.1-2 below.

Table 5.7.1-2 Survey Results for Degree of Deterioration of the Major Facilities

Name of Major Facilities		Judgement	Remarks
(i)	Ilwatta Anicut	"B"	
(ii)	Borala Tank and its irrigation canal systems		Being rehabilitated under NIRP
(iii)	Ittwela Anicut and its irrigation canal systems		Being rehabilitated under NIRP
(iv)	Deegoda Tank and its irrigation canal systems		
(v)	Other Small Irrigation Schemes		Not identified by JICA study team as well as by Department of Irrigation.

(6) Major Problems Identified in the Scheme

(i) Ilwatta Anicut Scheme

The dominant elevations of the farmlands under the scheme range from 1 to 2 ft, which is near or lower than MSL. And flood irrigation is being practiced under the scheme. The existing three steel-made gates in Ilwatta Anicut are originally by manual control, but difficult in operation, accordingly, the operation of the gates cannot timely respond to the changes of water levels. This allows free intrusion of saline water to the farmlands under the scheme. Another problem with the scheme is drainage. At the lowest end of the Polwatta Ganga, there exist two short-cut channels (each of which has a length of about 1.1 km and 0.4 km, completed in 1973) with the purpose of flushing excessive flood water down to the sea. However, since the Polwatta Ganga is meandering at several places and the existing railway bridges and road bridges cross the Ganga narrow the passage of the river flow, it is difficult to fully drain the excessive water from the farmlands by the existing drainage facilities. Due to these, about 70 % of the farmlands under the scheme are inundated 3 to 4 times in every Maha with an average inundation depth of 60 cm. The said inundation usually continues for 3 to 4 days.

(ii) Deegoda Tank Scheme

This scheme is presently maintained by the Irrigation Office of Southern Provincial Council in Galle district. The main problems with this scheme is not to satisfy water requirements in the tank by damaged irrigation canal systems and siltation in the irrigation canals.

(iii) Other Small Irrigation Schemes

The command areas and even locations of these irrigation schemes were not identified by the study team as well as by Department of Irrigation. Accordingly, it was decided in the meeting held on April 7, 1995 that these small irrigation schemes should be exclude from the study.

(iv) Present Condition of the Estuary of the Polwatte Ganga Scheme

Observation during the phase-I field survey has revealed that there exists sand bar formation along the lowest end of the right bank of the Ganga. It covers an area of about 100 m long and 7 m wide (with a depth of 1.5 to 2.0 m). Sand bars have been developing at the estuary of the Ganga, which is considered as one of the hazards for drainage. However, at present, it is

judged that the estuary still has enough capacity to flush the flood water down to the sea without dredging.

(v) Other Information

A drinking water supply scheme located 7 km upstream of Ilwatta Anicut is under construction funded by ADB will be completed soon. The scheme will supply drinking water to Weligama town at the rate of 130 m^3/hour with a maximum daily supply volume of 1,900 m^3. Accordingly, attention on water balance must be paid to this drinking scheme in formulation of rehabilitation plan of the scheme. In addition to the above, there exists the same problem in operation and maintenance of the scheme as mentioned in section 5.7.1.

(7) Reasons for Need of Rehabilitation

The main reasons for need of rehabilitation of Ilwatta anicut scheme are summarized below.

(i) As stated earlier, the gates in Ilwatta anicut are originally by manual control, however, since gates are deteriorated, this makes it difficult to fix the gates at the required position as a result of allowing free intrusion of saline water to the farmlands. Also, the existing anicut is not equipped with proper approach to the gate operation during floods in which timely operation is definitely required. And water leakage through the gates has also been observed. This situation calls for rehabilitation with improvement of the anicut.

(ii) Flood irrigation is common in the scheme. Accordingly, present irrigation canal systems under the scheme are not well developed. This situation calls for strengthening of the existing irrigation and drainage canal systems, especially improvement of drainage canals.

(iii) Present flood protection bunds are not fully provided along the Ganga to protect the scheme (Ilwatta anicut scheme) and their heights and sections are insufficient to protect the minor floods which occur several times a year. In this sense, the existing flood protection bunds need to be rehabilitated and improved. However, improvement of such bunds along the Ganga should be limited within reasonable extent.

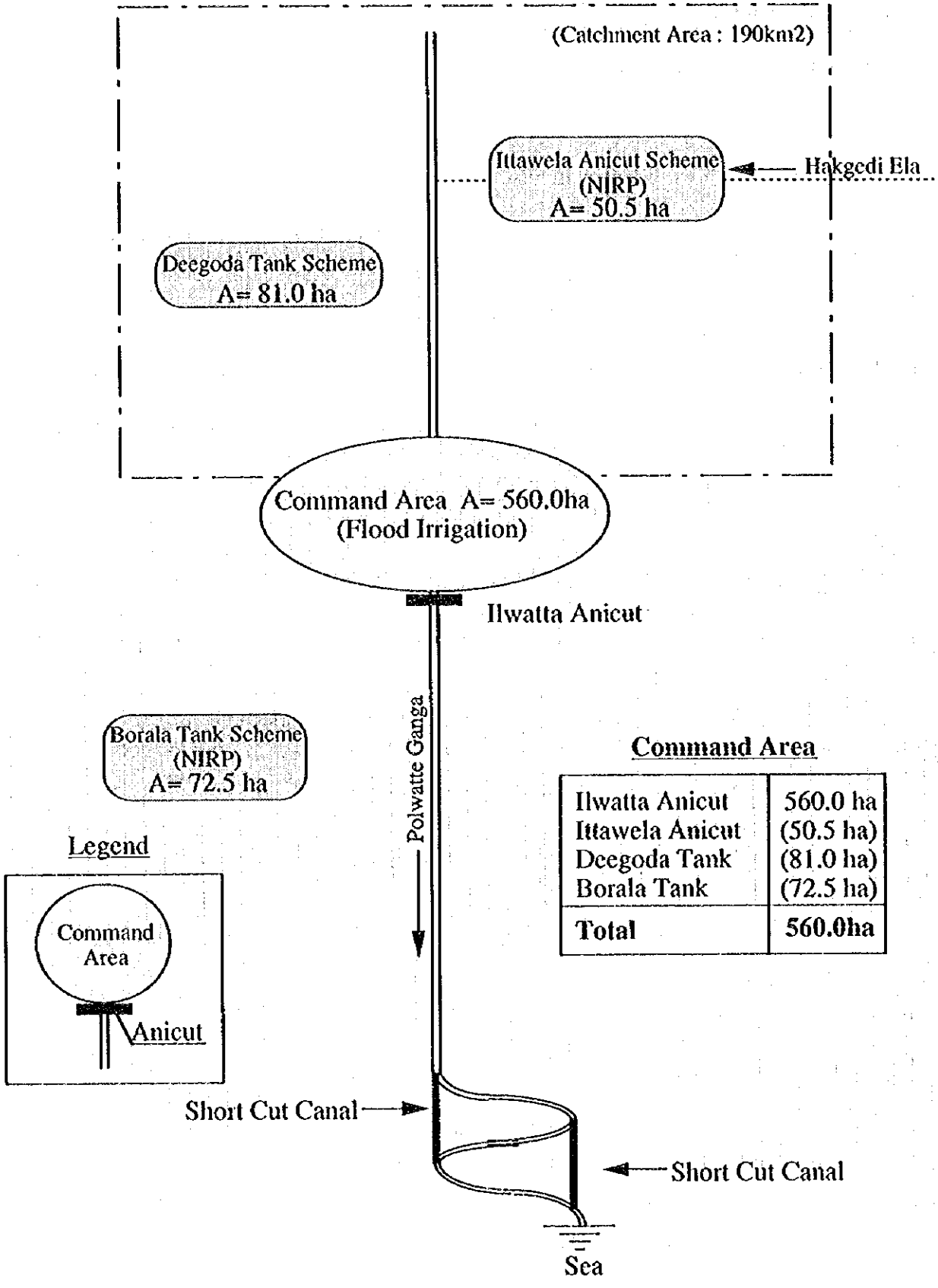

Fig. 5.7.1-1 Schematic Diagram of Polwatte Ganga Scheme

5.7.2 Agriculture

(1) Land Use and Farm Family

Land use

The irrigable area identified is 560 ha in total.

Upland area including homestead counts 290 ha in total, which is used for tree crops such as coconuts, fruits and OFC of chili, onion, vegetable, etc.

Farm Family

Numbers of farm families are estimated at 933, cultivating 0.6 ha of paddy land on the average.

According to the report by Dep. of Census & Statistics, tenancy in paddy land occupies 59% in Matara district (Agricultural Statistics of Sri Lanka 1992).

(2) Crop cultivation and Cropping pattern

Paddy Cultivation

Land preparation by tractors shows only 53% in Matara, while, manual and/or buffaloes operation shows 43% due to small size of paddy cultivation. For threshing and transportation of produce are also made by manual and buffaloes in small size operation. According to the questionnaire survey, the machinery cost occupies 29% of production cost in cash outlay. The most expensive cost is fertilizer showing 31% of the cost. They use 400kg/ ha for 3.0 t/ ha of the yield. This ineffective application of fertilizer is caused by the excess flow and poor drainage system.

Yield is estimated at 3.0 t/ ha on the average.

OFC Cultivation

DO(Divisional Officer) in DAS says there is no OFC cultivation in paddy land in this scheme due to the drainage problem. OFC can be seen in upland rainfed area.

Cropping Pattern

The present cropping pattern in Polwatte scheme is identified as follows.

Name of Season	Present		
	Crop	CI (%)	Benefited Area (ha)
Yala	Paddy	40	224
Maha	Paddy	60	336
Total		100	560

(3) Livestock and Tree Crops

Livestock

Livestock in Matara district is not so popular as that in Hambantota due to little grassland. 224 heads of cattle, 112 heads of buffaloes and 36 heads of goats are roughly estimated for the scheme area according to the district data of animal heads in 1991.

Tree Crops

Coconuts Cultivation Board is attached in DO office, and Coconuts Seed Farm is situated within the scheme area. Land use map in 1983 shows the area of Coconuts, Rubber and Cinnamon trees neighboring to the scheme area.

Besides those trees, there are fruit crops such as banana, papaya, jack-fruits, bread-tree, etc. mainly in the homestead.

(4) Agricultural Support Service

Agricultural extension services in this area (Weligama) is mainly carried out by DO office (DAS).

5.7.3 Farmer Organizations

In the area originally proposed by ID for rehabilitation there are over 30 FOs organized by the agrarian Services Department on a Grama Niladhari division basis. They do not necessarily coincide with the hydrological boundaries of the scheme. Hence it has not been possible to clearly identify the number of FOs in the irrigation-drainage area. The area now identified by the Study Team is 560 ha as against 1,619 ha originally identified by ID. The specific area and the number of FOs in this area have yet to be identified.

The existing FOs are registered under the Agrarian Services Act and operate independent of each other. Since farmers in this area are engaged in a variety of agricultural pursuits water management currently is not an organized function of the FOs. However, the FOs are very familiar with the operation and behavior of the existing irrigation-drainage system. The ability of the farmers in this scheme for organized group activity being quite high, they have the potential to be effective FOs.

5.7.4 Management of System

Polwatte Ganga is made up of Ilwatta anicut 560 ha (flood irrigation), Ittawela anicut 50.5 ha, Borala tank 72.5 ha (gravity irrigation) and Deegoda tank 81 ha (gravity irrigation).

Under Phase I of the Study, only Ilwatta anicut is identified as available for rehabilitation. Ilwatta anicut is employed to present the inflow of salt water from downstream and to head up water from upstream for flood irrigation. The scheme does not have an irrigation canal system. Since the irrigation supply cannot be regulated, this often results in inundation of both paddy lands and garden plots. Farmers do not have a major role to play in the regulation of water.

Furthermore, due to the deteriorated condition of anicut gates proper operation of gates and regulation of water is not possible. In the circumstances it is not possible to expect much participation from FOs in water management. The system is currently operated by staff of the Provincial Director of Irrigation.

There is no Project Management Committee to coordinate or manage the activities of the scheme.

Operation and Maintenance Costs

O/M costs for the scheme are allocated by ID as follows:

Year	Allocation (Rs)	Area (ha)	Rs/ha
1991	286,800	560	268
1992	259,875	560	242

5.7.5 Environmental Issues

(1) Soil and Water Quality

Soil Sampling
For checking sea water intrusion, 11 soil samples were collected and analyzed. Location of sampling sites and results of analysis are given in Fig.5.2.5-1 (2/6) and Table 5.2.5-1.

As a result of the analysis, the influence of sea water intrusion was observed in the scheme. Especially, sample No.P-1 which is poorly drained area showed higher value in EC and saline contents.

Water Sampling
For checking sea water intrusion into the river, 4 samples were collected and examined. Location of sampling sites and results of analysis are given in Fig.5.2.5-1 (2/6) and Table 5.2.5-2.
As a result of the analysis, sea water intrusion was confirmed at the point of 10 km from the estuary.

(2) Poor Drainage and Flood Damage

Annual rainfall at the headwaters of the Polwatte Ganga is over 3,000 mm making it an intermediate zone between Wet and Dry Zone. Runoff rate is 40% with discharge 2~4 times that for a basin of comparable size in the Dry Zone. Flood scale is estimated as about one half that for Benthara Ganga with discharge 5 to 10 times similarly.

Since Ilwatte anicut is a facility originally intended for flood irrigation, the scheme are is inundated during flooding and subsequent drainage is poor. Also, operational status of the Ilwatte anicut is poor resulting in inundation of the site during flooding which cuts off access to the structure. This further hinders effective drainage. At the river mouth, the widely meandering Polwatte Ganga is shortcutted by canal to improve drainage; however, this has increased susceptibility to sea water intrusion.

Topographical conditions at the river mouth are favorable with only minor siltation on the river bed. River mouth blockage does not occur.

(3) Wildlife

At the widely meandering river mouth does not form a significant lagoon, and biodiversity is relatively limited. No significant mangrove forest is observed.

(4) Fishery

At Garanduwa Kalapuwa, 30 fishermen (20 families) are engaged in fishing, taking in 1,400 kg of fish per month and generating a monthly income per person of 3,600 Rs. Although 64% of the catch weight is fresh and brackish water fish, shrimp account for 48~53% of actual income from fishing.

In the case of Polwatta Ganga estuary, 25 fishermen (10 families) work the waters with a monthly catch of 1,700 kg worth a per person income of 4,900 Rs. Shrimp account for 48~53% of actual income from fishing. Size of catches have not change significantly over the past 10 years.

Only a few fishermen are seen at Borala tank.

(5) Water Use

Water supply was commenced under the Weligama water supply scheme in February 1995, with a design diversion of 3,000 m³/day directly from the Polwatte Ganga. During February~ March in the dry season, salt intrusion occurs at the water source with levels as high as 150~200 ppm observed. The intake consists of an upper and lower inlets, with the lower inlet at an elevation roughly 1 m below the average tidal water level. As a result, the lower inlet cannot be utilized when sea water intrusion occurs during periods of low river discharge.

(6) Interview Survey

Farmers expressed concern about the potential for slope failure at the quarry immediately downstream of the scheme.

5.8 Tangalu Welyaya Scheme

5.8.1 Irrigation and Drainage System

(1) General

This scheme is located at the lower end of Kirama Oya basin of which catchment area is 223 km². The dominant elevations of the farmlands under the scheme are 1.0 to 1.5 ft above sea level which is lower than MSL. This condition makes it very difficult to drain the excessive water in the scheme by gravity. Accordingly, the scheme gets inundated during Maha seasons. The excessive water in Kirama tank, located upstream of Kirama Oya is sometimes released into Kirama Oya, which causes inundation of paddy land in lower section of Kirama Oya. Kirama Oya has a outfall near the Tangalu fishery harbor. In addition, there are two natural outfalls at Medilla and at Kapuhena and they function as supplemental outfalls of Kirama Oya. These three outfalls are presently blocked due to development of sand bars, making the drainage condition of the scheme worse. During the high tides, intrusion of saline water to the farmlands of the scheme through the damaged SWE structures is also commonly observed.

(2) Command Area

During the phase-I field survey, the study team identified the command area of the scheme in collaboration with the officials and with the topo-map of 1 to 50,000 scale. The results of survey are given below.

Results of Survey

Name of sub-schemes		Command Area Informed by ID (ha)	Command Area Identified by JICA Study Team (ha)	Remarks
(i)	Left Bank Area of D/S of Maha Amuna Anicut		71	
(ii)	Danketiya Anicut Command Area	607 (in total)	202	
(iii)	U/S Area of Karijja SWE Anicut		122	
Total		607	395*	

(3) Major Facilities in the Scheme

The major facilities in the scheme are anicuts for irrigation as well as for salt water exclusion, regulators, flood protection bunds and irrigation/drainage canals. They are summarized as follows.

List of Major Structures in the Scheme

Name of Structures	Nos. of Gates	Size of Gates (m) (Width x Height)	Remarks
Danketiya Anicut	5	1.5 x 2.0	Constructed in 1940
Waladora Anicut	6	2.0 x 2.4	-do-
Keelpathu Anicut	4		Broken
Weejjetota	4	1.8 x 2.0	Constructed in 1940
Karijja Anicut (West)**	8	1.6 x 1.4	-do-
Karijja Anicut (East)**	5	1.6 x 1.4	-do-
Regulator-1	4	1.4 x 1.2	-do-
Regulator-2	1	2.0 x 0.8	-do-
Regulator-3	1	1.4 x 1.0	-do-
Regulator-4	1	1.5 x 1.8	-do-
Regulator-5	1	1.5 x 0.9	Abandoned
Regulator-6	3	H = 1.5	Abandoned

Note**: Karijja Anicuts are salt exclusion (SWE) structures.

(4) Schematic Diagram of the Scheme

The schematic diagram of the scheme is given in Figure 5.8.1-1. The diagram is based on the field observation.

(5) Survey Results for the Degree of Deterioration of the Facilities

Survey for degree of deterioration of the facilities was conducted by applying the same criteria stated earlier. The results are summarized in Table 5.8.1-1 below.

Table 5.8.1-1 Survey Results for Degree of Deterioration of the Facilities

Name of Structures	Nos. of Gates	Size of Gates (m) (Width x Height)	Judgement	
			For Gates	For structures
Danketiya Anicut	5	1.5 x 2.0	C	B
Waladora Anicut	6	2.0 x 2.4	C	C
Keelpathu Anicut	4		C	C
Weejjetota	4	1.8 x 2.0	C	B
Karijja Anicut (West)**	8	1.6 x 1.4	C	C
Karijja Anicut (East)**	5	1.6 x 1.4	C	C
Regulator-1	4	1.4 x 1.2	C	C
Regulator-2	1	2.0 x 0.8	B	B
Regulator-3	1	1.4 x 1.0	B	B
Regulator-4	1	1.5 x 1.8	B	B
Regulator-5	1	1.5 x 0.9	C	C
Regulator-6	3	H = 1.5	C	C

Note**: Karijja Anicuts are salt exclusion structures (SWE).

The above survey results show that most of the major facilities of the scheme need replacement.and rehabilitation.

Additional Information (1)

The data on sill levels and others collected during the phase-I field survey are summarized below.

Location	Name of Structures	Sill Level (ft. MSL)
1. Kirama Oya	Danketiya Anicut	0.00 ft MSL (0.00 m MSL)
2. Main Road	199/2 Bridge Bed	0.27 ft MSL (+0.08 m MSL)
(Tangalu-Hambantota)	199/3 Bridge Bed	0.87 ft MSL (+0.26 m MSL)
	199/4 Bridge Bed	0.00 ft MSL (0.00 m.MSL)
	200/1 Bridge Bed	-0.20 ft MSL(-0.06 m MSL)
	200/2 Bridge Bed	-0.67 ft MSL(-0.20 m MSL)
3. Danketiya Paddy	Drainage Regulator	-0.06 to 0.31 ft MSL(-0.02 to 0.09 m MSL)
	Weejjetota Anicut	-0.15 ft MSL(-0.05 m MSL)
	Keeypathu Anicut	Data not available (Damaged)
	Paddy Field	0.9 to 1.3 ft MSL(+0.27 to +0.39 m MSL)
4. Karijja Area	No.1 Karijja Amuna (SWE Structure)	-0.05 ft MSL(-0.17 m MSL)
	No.2 Karijja Amuna (SWE Structure)	-1.00 ft MSL(-0.30 m MSL)
	Paddy Field	1.10 to 1.40 ft MSL(+0.33 to +0.42 m MSL)

Additional Information (2)

The following were proposed by the representative farmers in the first WLAC meeting held on February 24, 1995 at Agrarian Service Office in Netolopitiya in the presence of the ID officials, Representatives of F.O and the study team.

a) Raising and repair of flank bunds from Maha anicut to Walsdora anicut LB to protect Ratupitiya area;

b) Raising of existing flank bunds from Waladora anicut to Kuttardora anicut;

c) Reconstruction of Weejetota anicut and Kakkama anicut;

d) Embankment of flank bunds from Udapallamayaya to Pathapallamayaya upto Karijja SWE anicuts;

e) Repair of broken section of Weejjatota flank bund and provide causeway structure;

f) Dredging of Kirama Oya, from Danketiya anicut to the estuary at the Fishery Harbor; and

g) Replacing existing all damaged gates at Karijja anicuts and at the other regulators.

(6) Major Problems Identified in the Scheme

Major problems in the scheme identified during the phase-I field survey can be summarized below.

(i) Dominant elevations of the farmlands under the scheme are below MSL. Therefore these farmlands cannot be drained by gravity only. The major facilities such as anicuts, regulators and flood protection bunds which were constructed in early 1940's have lost their original functions designed and they need urgent rehabilitation.

(ii) Existing flood protection bunds need repair and embankment. For example, to protect Ratupitiya area, the existing flood protection bunds from Maha anicut to Waladora anicut need to be raised.

(iii) Sedimentation in Kirama Oya has been increasing.

(iv) Since the sand bar formation observed at lower end of Kirama Oya and at the outfalls of Medilla and Kapuhena has accelerated inferiority in drainage condition.

(v) Due to intrusion of saline water through the damaged or broken gates in the existing SWE anicuts, the cultivable areas under the scheme are decreasing year by year. This also calls for improvement of present function of gates.

(7) Reasons for Need of Improvement and Rehabilitation

The above-mentioned conditions of the major facilities in the scheme justify the need of rehabilitation and improvement of the facilities in the scheme including replacement of the facilities with new ones.

Parameters of Structure

Anicut / Reg	Nos. of Gate	Size of Gate(m) (B x H)	Remarks
Danketiya	5	1.5 x 2.0	Constructed in 1940
Waladora	6	2.0 x 2.4	-do-
Keelpathu	4	NA	Broken
Weejjetota	4	1.8 x 2.0	Constructed in 1940
Karijja (W)	8	1.6 x 1.4	-do-
Karijja (E)	5	1.6 x 1.4	-do-
Reg.-1	4	1.4 x 1.2	-do-
Reg.-2	1	2.0 x 0.8	-do-
Reg.-3	1	1.4 x 1.0	-do-
Reg.-4	1	1.5 x 1.8	-do-
Reg.-5	1	1.5 x 0.9	Abandoned
Reg.-6	3	H=1.5m	Abandoned

Command Area

Block - I	70 ha	175 Acs
Block - II	200 ha	500 Acs
Block - III	120 ha	300 Acs
Total	390 ha	975 Acs

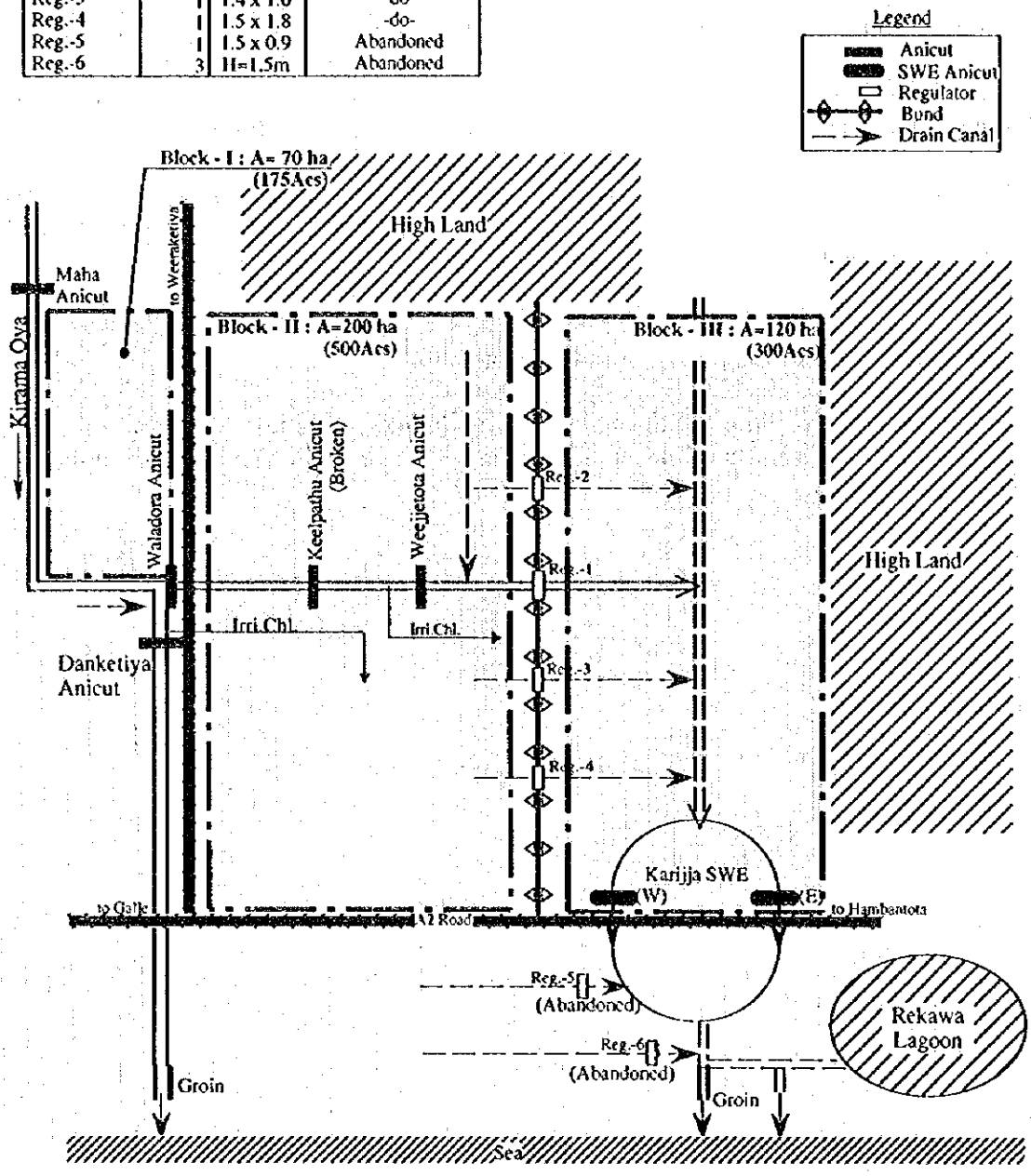

Fig. 5.8.1-1 Parameters and Schematic Diagram of Thangalu Welyaya Scheme

5.8.2 Agriculture

(1) Land Use and Farm Family

Land Use

Total paddy cropped area in recent years is estimated by ID at 474 ha with 120% of cropping intensity for the project irrigable area (395 ha).

Upland or non-paddy crop area including homestead counts 200 ha in total, which is used for tree crops such as coco-nuts or fruits and OFC of chili, onion, vegetable, etc.

Farm Family

Numbers of farm families are estimated at 360, with 1.1 ha each in paddy land holding on the average.

According to the report by Dep. of Census & Statistics, 52% of paddy land is cultivated by owner farmers and 48% by tenant farmers in Hambantota district in 1989(Agricultural Statistics of Sri Lanka 1992).

(2) Crop cultivation and Cropping pattern

Paddy Cultivation

Land preparation and threshing are generally used by machinery, however, wet muddy land can not be ploughed by tractor. Therefore, labour requirments are much more than those in the other irrigation schemes in hired labours as well as family labours. The fertilizer cost, showing 31% of total cash expediture, seems to be over-used.

Yield is estimated at 3.0 t/ ha on the average.

OFC Cultivation

There are no OFC cultivation in paddy land. The OFC is cropped in rainfed upland or homestead.

Cropping Pattern

The present cropping pattern in Thangalu Welyaya scheme is identified as follows.

Name of Season	Present		
	Crop	CI(%)	Benefited Area (ha)
Yala	Paddy	70	276
Maha	Paddy	50	198
Total		120	474

(3) Livestock and Tree Crops

Livestock

Hambantota Veterinary Service Center reported 10,890 heads of cattle and 16,900 heads of buffaloes at Thangalle AGA division in 1993.

Tree Crops

According to Coconuts Cultivation Board, numbers of coconuts trees are estimated at 40-50 trees in every farm house. Besides coconuts trees, there are fruit crops such as banana, papaya, jack-fruits, bread-tree, etc. mainly in the homestead.

(4) Agricultural Support Service

Agricultural extension in this scheme is carried out by the provincial Assistant Director under provincial DOA.

5.8.3 Farmer Organizations

According to information gathered there is only one FO registered with the Agrarian Service Department with a membership of 66 farmers out of a total of about 300 farmers in the area. In the absence of an organized irrigation cultivation program there is no active role that the FO can play. However they co-operate with the Irrigation Department in water distribution under Maha Amuna and Dauketiya anicuts. In addition, currently they function as an interest group to articulate their views about the need for a proper drainage system for the area and the rehabilitation of the existing facilities.

The FO members are quite knowledgeable about all the issues in the area including environmental problems; they seem to have the potential and interest to participate activity in development program.

5.8.4 Management of System

The command area of Thangalu Welyaya was estimated by ID as 607 ha, of this the study Team has identified 395 ha in Blocks I, II and III. Of this extent Maha Amuna anicut irrigates 70 ha and Danketiya anicut irrigates 200 ha. These anicuts are at the lower reach of Kirama Oya and therefore are influenced by the management of the Kirama Oya scheme. The operation of the two anicuts therefore should be synchronized with the operation of Kirama Oya scheme. Under the two anicuts water allocation is handled by the ID field staff while internal distribution is handled by FOs.

The SWB anicuts are in a deteriorated state; therefore no proper water management is possible. Further the formation of the sand bar at the sea outfall causes salt water intrusion, inundation and flooding due to poor drainage. Several alternative proposals to ease the drainage problem have been made and are under consideration.

An effective system management proposal for the whole scheme can be proposed only after the technical aspects of drainage problems have been fully evaluated.

Operation and Maintenance Costs
O/M costs for the scheme are allocated by ID as follows:

Year	Allocation (Rs)	Area (ha)	Rs/ha
1990	242,780	395	615
1991	127,095	395	322
1992	205,090	395	519
1993	202,863	395	514
1994	207,845	395	526

5.8.5 Environmental Issue

(1) Soil and Water Quality

Soil Sampling
For checking sea water intrusion, 5 soil samples were collected and analyzed. Location of sampling sites and results of analysis are given in Fig.5.2.5-1 (3/6) and Table 5.2.5-1.

As a result of the analysis, the influence of sea water intrusion was observed in the downstream part of scheme. Especially, sample No.T-5 at Karijja SWE structure showed higher value in saline contents. The other samples No.T-3 and T-4 were taken in the neighboring sites.No.T-3 in a cultivated area (paddy), and another in an abandoned area due to being flooded.

Water Sampling
For checking sea water intrusion into the scheme area, 4 samples were collected and examined. Location of sampling sites and results of analysis are given in Fig.5.2.5-1 (3/6) and Table 5.2.5-2.

As a result of the analysis, sea water intrusion was confirmed at the point of Danketiya Anicut.

(2) Poor Drainage and Flood Damage

Kirama Oya is located in the Intermediate Zone between Dry and Wet Zones, and has relatively small basin runoff rate and discharge per basin area. Discharge from Maha anicut and Danketiya anicut into Rekawa lagoon creates an area of poor drainage due to blockage of the lagoon estuary.

During flooding, the mouth of Rekawa lagoon opens and gradual outflow through the estuary occurs, the estuary closes up again before sufficient drainage has occurred. It is assumed that trapped water drains by backflow through the anicut. Discharge also moves upstream and downstream through the anicut as a result of tidal changes.

In the of case of the mouth of the Kirama Oya on the other hand, which is favorably located at an area where embankment protection works for Tangalle harbor have been carried out, does not experience blockage despite some silt build up in the estuary bed. Rekawa lagoon has two openings to the sea, with that on the east side being excavated by fishermen to promote the inflow of sea water. The west side opening was excavated by ID and an induction weir constructed. The opening has been widened by local farmers to release flood discharge, and this mouth opens natural in the rain season when water level is high allowing the entry into the lagoon of young fish and crustaceans.

(3) Wildlife

Mangrove forests (both pure and mixed) exist in around 100 m swath along the edges of Rekawa lagoon and along Kalepattu drain. Area covered by this type of forest totals over 200 ha around the lagoon. Seventeen species of mangrove and scrub are identified.

A survey in 1986 identified 18 species of fish in the lagoon, an a survey in 1994 identified 32 fish species and 9 species of crustaceans. Nesting of several types of sea turtles has also been observed on the beach of the area.

(4) Fishery

In Rekawa lagoon, 285 fishermen (255 families) work the waters, with monthly catch for the entire lagoon at 9,000 kg. worth income of Rs 1,206,000. This comes to a per fisherman income of Rs 4,230 per month. Species caught are shrimp and brackish water fish. Shrimp accounts for 67% of catch weight and 99% of the income from catches. The fishing season in the lagoon extends from December to May and although their has been a general decline in the size of catches over the past 10 years, catches have stabilized during the past two years.

According to the report of Coastal Environmental Profile of Rekawa Lagoon, balance of freshwater discharge from rivers (Kirama and Rekawa) and inflow of sea water (depending on tidal water level) determines the saline concentration of lagoon water. Saline concentration rises in the rainy season and drops in the dry season. In 1984, the Kapuhenwala causeway bas constructed across the channel leading into the lagoon, which impedes the inflow and outflow of salt water impacting on the fresh water / sea water balance in the lagoon. This promotes a drop in saline content during flooding.

(5) Water Use

Under the Tangalle water supply scheme inaugurated in 1953, water is diverted directly from Kirama Oya and from shallow wells for water supply to Tangalle town. Design supply is 2,800 m3/day.

(6) Others

i) Coastal Conservation Zone

A portion of the area along Danketiya and Maha Amuna channels from the mean low water line at normal flow to a point 2 km to the interior away from the channel is designated as a coast conservation zone and as such is subject to the Coast Conservation Act.

ii) Special Area Management (SAM) Project

The objective of the SAM project is to formulate planning for optimal and sustainably effective use of natural resources, and to foster consensus among concerned individual and relevant agencies in this regard. Under assistance from USAID, the Coast Conservation Department and the National Aquatic Resources Agency execute the project. The SAM project site centers on Rekawa lagoon and encompasses 7 G.N. divisions including a portion of the subject scheme area. The Rekawa lagoon SAM Coordinating Committee has been established to achieve agreement among the various concerned agencies and groups regarding the actions to be carried out under the project. In addition to holding regular monthly meetings, it publishes the Coastal Environmental Profile of Rekawa Lagoon as well as formulating proposals on future land use. The objective area of SAM project is including a part of area of the subject scheme near Karijja amuna SWE.

According to the said Environmental Profile, the following environmental issues exist:

- Inflow of freshwater into the lagoon in the dry season has decreased due to diversion for irrigation from 18 weirs on the Kirama Oya, and thereby increasing the saline content of lagoon waters. (Saline content drops during the rainy season due to flooding with fresh water.)
- Concern for contamination of lagoon waters with discharge contaminated by agro-chemicals and chemical fertilizers.
- Reduction of lagoon water surface area and depth due to siltation (also due to mangrove growth).

The following proposals have been put forth by the SAM Coordinating Committee for the management of the lagoon:

- Aquaculture development is proposed on that abandoned farmland (due to excessive salt buildup in the soil) south of highway A2.
- Shift to salt resistant crops in farm land around the lagoon, and development of a market for such crops.
- Modification of Kauhenwala and Medilla causeways to improve better fresh water flow into the lagoon.
- Monitoring of inflow into the lagoon and saline content of lagoon water.
- Interaction with farmer organizations on problem issues.

CHAPTER SIX :
FORMULATION OF REHABILITATION PLAN

CHAPTER SIX : FORMULATION OF REHABILITATION PLAN

6.1 Basic Approach

Formulation of the rehabilitation plan was carried out with focus on the following points identified as a result of experience and lessons learned from past irrigation rehabilitation projects carried out in Sri Lanka, and information gleaned from the field survey to date under the subject Study. These key points are dynamically inter-related and formulation of an effective rehabilitation plan must be fully cognizant of the need for the closest possible integration of all project components.

(1) Participatory Approach

A participatory approach to field survey was adopted at the outset of Phase I, upon which a study implementation plan was drawn up and the Phase I studies carried out. Under this approach, the views and aspirations of concerned Government officials and directly affected farmers in target benefit areas were carefully sounded. In particular, the know-how and experience of farmers in each scheme area were explored through WLAC meetings held on three occasions for each scheme. The findings of these efforts are to be reflected in the project formulation, and this participatory approach will be further pursued for the remainder of the Study.

(2) Strengthening of Farmer Organizations and Active Utilization of Local Resources

Active participation of farmers, primarily through farmer organizations, is essential in implementing an effective project. The role of the farmer organizations will be the foundation for realizing a cost-effective project as well as effective and sustainable operation and maintenance following construction. Accordingly, project formulation will be pursued with full awareness of the crucial need to strengthen farmer organizations to the extent possible.

3) Improvement of System Management

In order to carry out the rehabilitation project and achieve project goals, efficient system management is essential. In order to achieve this, both of the following are necessary:

i) Upgrading of physical facilities through rehabilitation

ii) Upgrading of system management capabilities of farmer organizations

Care will given in project formulation to the optimum balance between the above two "hard" and "soft" aspects. Such formulation will be premised on eventual handing over of system management entirely to the relevant farmer organizations, and an approach will be pursued for step-wise development of the FOs to be fully capable of managing the schemes at some point in the future.

(4) Selection of Cost-effective Option for Rehabilitation Project.

Project formulation will strive for a low cost rehabilitation project through maximized participation of farmer organizations (construction contracting) and use of local resources during the pragmatic project planning and implementation stages.

Under pragmatic planning, capital cost required for project implementation will be minimized within the range which still allows for equitable distribution of water, and sustainable and effective system O/M in the future.

In this regard it is necessary to carefully bear in mind (i) output accompanying rehabilitation under each scheme will most likely be marginal, and (ii) in the case of many similar projects, high capital intensity has threatened economic viability.

6.2 Rehabilitation of Irrigation Systems

6.2.1 Design Area under the Plan

The design area of each rehabilitation plan is determined as follows:

Scheme	Design Area (ha)
(1) Liyangastota Scheme	6,121
(WLB Scheme)	(2,767)
(WRB Scheme)	(3,354)
(2) Muruthawela Reservoir Scheme	6,149
(LB Main Tract I II III)	(1,698)
(Urubokka Oya)	(2,175)
(Kirama Oya)	(2,276)
(3) Badagiriya Scheme	703
(4) Kachigala Ara Scheme	516
Total Σ (1) - (4)	13,489

6.2.2 Estimate of Irrigation Water Requirement

(1) Design Criteria

Procedures for estimate of irrigation water requirement apply to the Irrigation Dept. Design Criteria.

Adopted data for computation of Field Water Requirement (FWR) are as follows:

i. Target Crops and Staggered Cropping Pattern

In this Study, following typical crops are adopted as estimate of irrigation water requirement.

Paddy: Low land 105 days type
OFC: Soya Beans crop factors

A staggered cropping pattern is adopted consist of 4 steps as tillage power both draft and machine is limited. Thus conditions were seen in the field during Phase I site survey.

ii. Crop Factor (CF) and Growth Stage

The growth of the crop to maturity in 4 growth stage is as follows:

	Crop Factor	Initial	Development	Mid	Late	Total Days
Lowland Paddy	Days	20	30	30	25	105
(105 days)	CF	1.00	1.15	1.20	0.90	
Soya Beans	Days	15	20	50	20	105
	CF	0.65	0.85	1.05	0.75	

Source: ID Design Criteria

iii. Evapo transpiration of Crop (ET)

For the selected crop, ET is calculated following relation and gives the water requirement of the crop:

$ET = CF \times ET_0$

CF : Crop Factor

ET_0 : Evapo Transpiration of Reference Crop

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ET_0 (inches)	4.7	5.0	6.2	5.9	6.4	6.9	7.5	7.6	7.5	6.2	4.3	4.5

iv. Water Requirement for Land Preparation (LP)

Lowland Paddy: 7 inches in 15 days
OFC: 1 1/2 inches in 15 days

v. Effective Rainfall (ER)

The total monthly rainfall (R) which collected by the Study Teams converted into ER using following formula.

ER = 0.67 (R-1), where R is in inches.
ER = 9 inches, when ER is equal to or greater than 9 inches.

vi. Irrigation Duty (ID)

Unlined Canal System, ID = 1.43 X (FWR - ER)
Lined Canal System, ID = 1.11 X (FWR - ER)

(2) Proposed Cropping Pattern

In the formulation of alternative cropping patterns the following principles were applied;

a) The cropping pattern should generate maximum benefits to the farmer.
b) The cropping pattern should be practical in view of the available labour force in the area
c) Maximizing land use through crop diversification
d) The cropping pattern will make optimum utilization of the supplied water resources.

Taking account of above principles, the proposed cropping patterns, in this study stage, are roughly estimated as follows and given in Fig.6.2.2-1 to 4:

a) Liyangastota Scheme

i. WLB Scheme

Command Area: 2,767 ha

Season	Present			Proposed		
	Crops	CI (%)	Benefitted Area (ha)	Crops	CI (%)	Benefitted Area (ha)
Yala	Paddy	60	1,660	Paddy	90	2,490
				OFC	10	277
Maha	Paddy	100	2,767	Paddy	100	2,767
Total		160	4,427		200	5,534

ii. WRB Scheme

Command Area: 3,354 ha

Season	Present			Proposed		
	Crops	CI (%)	Benefitted Area (ha)	Crops	CI (%)	Benefitted Area (ha)
Yala	Paddy	60	2,012	Paddy	90	3,019
				OFC	10	335
Maha	Paddy	90	3,019	Paddy	100	3,354
Total		150	5,031		200	6,708

A total of Liyangastota Scheme Cropping Pattern is shown as follows:

Total Command Area: WLB+WRB= 6,121 ha

Season	Present			Proposed			
	Crops	CI (%)	Benefit Area (ha)	Crops	CI (%)	Benefit Area (ha)	
Yala	Paddy	60	3,672	Paddy	90	5,509	
				OFC	10	612	
Maha	Paddy	94.8	5,786	Paddy	100	6,121	
Total		154.8	9,458		200	12,242	*

Note: * Paddy = 11,630 ha (90%), OFC = 612 ha (10%)

b) Muruthawela Reservoir Scheme

i. LB Main Scheme

Command Area: ∑=1,698 ha

Name of Scheme	Season	Present			Proposed		
		Crops	CI (%)	Benefit Area (ha)	Crops	CI (%)	Benefit Area (ha)
Tract I (415 ha)	Yala	Paddy	50	207	Paddy	70	290
					OFC	30	125
	Maha	Paddy	50	208	Paddy	70	290
					OFC	30	125
Tract II (669 ha)	Yala	Paddy	100	669	Paddy	100	669
	Maha	None	0	0	Paddy	70	468
					OFC	30	201
Tract III (614 ha)	Yala	None	0	0	Paddy	70	430
					OFC	30	184
	Maha	Paddy	100	614	Paddy	100	614
Total			100	1,698		200	3,396

ii. Urubokka Oya Scheme

Command Area: ∑=2,176 ha

Name of Scheme	Season	Present			Proposed		
		Crops	CI (%)	Benefit Area (ha)	Crops	CI (%)	Benefit Area (ha)
Ralwa Nawarathe - Udukiriwela (3 Anicuts, 391 ha)	Yala	Paddy	100	391	Paddy	90	352
					OFC	10	39
	Maha	Paddy	100	391	Paddy	100	391
Wakamulla - Rana (5 Anicuts, 1,380 ha)	Yala	Paddy	50	690	Paddy	90	1,242
					OFC	10	138
	Maha	Paddy	100	1,380	Paddy	100	1,380
High Level Canal (405 ha)	Yala	None	-	0	Paddy	90	365
					OFC	10	40
	Maha	Paddy	100	405	Paddy	100	405
	Total		150	3,257		200	4,352

iii. Kirama Oya Scheme

Command Area: 2,276 ha

Season	Present			Proposed		
	Crops	CI (%)	Benefitted Area (ha)	Crops	CI (%)	Benefitted Area (ha)
Yala	Paddy	50	1,138	Paddy	50	1,138
				OFC	10	228
Maha	Paddy	90	2,048	Paddy	100	2,276
Total		140	3,186		160	3,642

A total of Muruthawela Reservoir Scheme Cropping Pattern is shown as follows

Command Area: ∑=6,149 ha

Name of Scheme	Season	Present			Proposed			
		Crops	CI (%)	Benefit Area (ha)	Crops	CI (%)	Benefit Area (ha)	
LB Main (1,698 ha)	Yala	Paddy	52	876	Paddy	82	1,389	
					OFC	18	309	
	Maha	Paddy	48	822	Paddy	81	1,372	
					OFC	19	326	
Urubokka Oya (2,176 ha)	Yala	Paddy	50	1,081	Paddy	90	1,959	
					OFC	10	217	
	Maha	Paddy	100	2,176	Paddy	100	2,176	
					OFC	0	0	
Kirama Oya (2,276 ha)	Yala	Paddy	50	1,138	Paddy	50	1,138	
					OFC	10	228	
	Maha	Paddy	90	2,048	Paddy	100	2,276	
Total			132	8,141		185	11,390	*

Note: * Paddy = 10,310 ha (91%), OFC = 1,080 ha (9%)

c) Badagiriya Scheme

Command Area: 703 ha

Season	Present			Proposed			
	Crops	CI (%)	Benefit Area (ha)	Crops	CI (%)	Benefit Area (ha)	
Yala	Paddy	34	239	Paddy	70	492	
	OFC	4	28	OFC	30	211	
Maha	Paddy	86	605	Paddy	70	492	
	OFC	2	14	OFC	30	211	
Total		126	886		200	1,406	*

Note: * Paddy = 984 ha (70%), OFC = 422 ha (30%)

d) Kachigala Ara Scheme

Command Area: 516 ha

Season	Present			Proposed		
	Crops	CI (%)	Benefit Area (ha)	Crops	CI (%)	Benefit Area (ha)
Yala	Paddy	20	103	None		
Maha	Paddy	15	77	None		
Total		35	180			

6.2.3 Proposed Water Utilization for each Plan

(1) Liyangastota Scheme

Results of water balance study indicate a total command area of WLB and WRB Scheme can be irrigated by the Main Walawe Ganga discharge under the proposed cropping pattern.

Nevertheless an adequate irrigation water is available for both season, present cropping intensity of Yala is about 60%.

Moreover, all canals are not functioning or are abounded due to deterioration irrigation facilities.

Therefore, it is recommended the existing canal system should be rehabilitated under the proposed cropping pattern.

(2) Muruthawela Reservoir Scheme

i. LB Main and Urubokka Oya Schemes

the main water source under this scheme is the Muruthawela Reservoir on the Urubokka Oya with storage capacity of 48 MCM.

The results of analysis on the Muruthawela Issue Records, it was identified that ID hasn't been issued the full storage capacity of 48 MCM due to constraints of LB Main Canal cross - section which had designed not including Tract I areas.

Moreover, measuring devices on the beginning main canal are not functioning properly due to deterioration.

The issuing water to the whole area of Muruthawela Reservoir Scheme, i.e. LB Main and Urubokka Oya including High Level Canal area, could be possible under the proposed water requirement on the following conditions;

- To utilize Muruthawela storage capacity of 48 MCM itself.
- To reuse irrigation water from the upper reaches of the paddy areas to lower areas. The return flow using ratio adopted 30% (assumed) in this proposed water utilization.

ii. Kirama Oya Scheme

The Study Team recommends to utilize storage capacity of the Muruthawela Reservoir to LB Main Scheme effectively, which has been given priority by ID. Supplemental water to Kirama Oya Scheme, therefore, is not expected from RB Sluice in this Study. In this case, the cropping intensity of 60 % in Yala and 100 % in Maha, shown in para. 6.2.2, are proposed by the Study Team on the conditions which existing anicut structures and canal systems under the Kirama Oya would be rehabilitated and be down water losses minimum.

(3) Badagiriya Scheme

Results of water balance study indicate that a whole command area can be irrigated by the supplementary water from Lunuganwhela reservoir under official agreement.

Therefore it is recommended above water utilization as proposed one's for Badagiriya rehabilitation scheme.

(4) Kachigala Ara Scheme

Compared with the command area of 3,310 ha of Kachigala Ara Scheme, estimated by ID, the Study Team identified the area as 516 ha. The balance area of 2,794 ha is identified as located within the area developed under Udawalawe Scheme. Mahaweli Authority constructed the Maha Jandura anicut at Majandura across Kachigala Ara. Department of Irrigation has already constructed Maha Bemma anicut and Buweliara (Galamuna) anicut is now under construction. These anicuts are planned to prevent and reduce the floods. At present, the area of 516 ha face flood problems caused by the development of Udawalawe Scheme.

Prior to the 516 ha irrigation rehabilitation planning, this flood problem should be considered that it caused an excess water from Udawalawe Scheme. Without the solution of this problems, any rehabilitation plan could not be established in this area. For this reason, the Study Team excluded 516 ha of this irrigation scheme from the plan.

Irrigation Sub-area	Command Area (ha)	
	Estimated by ID	Identified by Study Team
Buweliara Anicut (Galamuna)		132
Mahabenmma Anicut	3,310	222
Hatagala Anicut		162
Total	3,310	516

6.2.4 Rehabilitation Plan for Liyangastota Scheme

(1) Formulation of Concepts

The following items are formulated for rehabilitation plan.

Rehabilitation Items		Concepts of Formulation
i.	Liyangastota Anicut and WLB/WRB Intakes	Achievement of regular utilization from the main Walawe Ganga
ii.	Feeder Canal	Conveyance of design discharge to the Ridiyagama Reservoir
iii.	Ridiyagama Reservoir	Prevention for D/S of reservoir side slope sliding
iv.	Canal systems of WRB and WLB	Restoration of proper water distribution system on the field level.

Note: Command area, WLB= 2,767ha, WRB= 3,354ha

(2) Contents of Rehabilitation

The following rehabilitation Plans should be carried out.

i. Liyangastota Anicut and WLB/WRB Intakes

- Improvement of stop-logs of guide wall pier, replacement of timber planks and attachment of metal fittings on the pier,
- Replacement of opening gates
- Repairs to the RB intake canals with log-way and screen facilities and main structures with gates,
- Construction of an additional intake structure of LB, and
- Construction of Parshall Flumes down stream of RB main and LB feeder canal.

ii. Feeder Canal

- Dredging with restoration of canal profiles,
- Construction of a bathing pond and setting up a barricade for buffalo.

iii. Ridiyagama Reservoir

- Widening of dam crest, earth filling on the down stream slope with a toe - filter and drainage,
- Forming the approach canal for the main spill.

iv. Canal Systems of LB and RB

- Repairing of structures along the canal and improvement or reforming of all canal systems where necessary,
- Canal should be lined with brick in cement mortar.
- Construction of maintenance and agricultural roads.

Target canal length for rehabilitation is summarized as follows (details are shown in Table 6.2.4-2 and 3):

	WLB (2,767ha)	WRB (3,354ha)	Total
Main Canal	51.2 km	8.1 km	59.3 km
D-Level Canal	18.1	22.5	40.6
Total	69.3	30.6	99.9

Note: 1) Target length of main canal with brick lining is same as existing canal length.
2) D-level canal length for rehabilitation adopted 70% of existing canal length.

(3) Cost Estimate

Construction Cost for rehabilitation under Liyangastota Scheme is given in Table 6.2.4-1

6.2.5 Rehabilitation Plan for Muruthawela Reservoir Scheme

(1) Formulation of Concepts

The following items are formulated for rehabilitation plan.

i. LB Main Scheme (A=1,698 ha)

Rehabilitation Items	Concepts of Formulation
Main Canal System	Generating maximum benefits through a whole area including Tract I area by restoration and improvement of main canal system.
Distribution Canal System	Same as above with proper water management by FOs themselves.

ii. Urubokka Oya (A= 2,175 ha) and Kirama Oya (A= 2,276 ha) Scheme

Rehabilitation Items	Concepts of Formulation
Anicut Systems	Revival of easy gate operation.
Main and D Canal System	Restoration of proper water distribution system on the field level.

(2) Contents of Rehabilitation

i. Muruthawela LB Scheme

- Improvement of intake facilities including replacement of gates,
- Reconstruction of LB main canal Parshall Flume and a installment of measuring device for Urubokka Oya main canal,
- Reforming main canal including reconstruction of existing concrete traf structure on the main canal taking account of Tract I water requirement,
- All canal systems should be redesigned and constructed,
- Canal should be lined with brick in cement mortar where necessary, and
- Construction of maintenance and agricultural roads.

ii. Urubokka Oya and Kirama Oya Scheme

- All canal systems should be redesigned and reconstructed,
- peplacement a new steel gate with improvement of stop logs,
- Canal should be lined with brick in cement mortar where necessary, and
- Construction of maintenance and agricultural roads.

Target canal length and rehabilitation anicuts for rehabilitation are summarized as follows (details are shown in Table 6.2.5-2 to 4):

	LB Main	Urubokka Oya	Kirama Oya	Total
Main and D - Canal	17.8 + 25.5	60.6	46.0	149.9 km
Anicut	-	8	17	25 nos

Note: 1) The length of LB Main includes 120 m of a new traf structure.
2) Main and D - canal is with brick lining and length for rehabilitation adopted 70% of existing one's.

(3) Cost Estimate

Construction Cost for rehabilitation under Liyangastota Scheme is given in Table 6.2.5-1

6.2.6 Rehabilitation Plan for Badagiriya Scheme

(1) Formulation of Concepts

The following items are formulated for rehabilitation plan.

Rehabilitation Items	Concepts of Formulation
i. Restoration of abandoned area of 86 ha	Generating maximum benefits through a whole area including abandoned area
ii. Canal Systems	Restoration of proper water distribution system on the field level

(2) Contents of Rehabilitation

- Main canal should be lined with brick in cement mortar 10% of total length and balance be lined with earth,
- D level canal should be lined with brick in cement mortar 50% of the selected D-level canal,
- Replacement and reconstructing of damaged facilities in the DC and FC canal mentioned in Charter 5,
- Reclamation of abandoned area of 80 ha and construction of new canal and drainage systems, and
- Construction of maintenance and agricultural roads.

Target canal length for rehabilitation is summarized as follows (details are shown in Table 6.2.6-2):

Main Canal: 7.5 km (Brick 10% + Earth 90%)
D-Level Canal: 13.1 km (Brick lining)

(3) Cost Estimate

Construction Cost for rehabilitation under Liyangastota Scheme is given in Table 6.2.6-1.

Table 6.2.4.-1 Construction Cost for Rehabilitation Works under Liyangastota Scheme

	Description	Area	Total (Mil.Rs.)	F/C(20%) (Mil.Rs.)	L/C(80%) (Mil.Rs.)	US$/ha
I.	**Construction Cost**					
I-1	Liyangastota Anicut		20.88	4.18	16.70	
I-2	LB Feeder Canal		14.23	7.83	31.32	
I-3	Ridiyagama Tank		39.15	7.83	31.32	
I-4	Walawe Left Bank					
	1. LB Main Canal	340 ha	20.86	4.17	16.69	1.227
	2. NRB	186 ha	17.47	3.49	13.97	1.878
	3. NCB	314 ha	14.20	2.84	11.36	904
	Ridiyagama Unit Sub-total	**840 ha**	**52.53**	10.51	42.02	**1.251**
	4. SLB	495 ha	48.87	9.77	39.10	1.975
	5. SRB	921 ha	38.44	7.69	30.75	835
	6. SCB	512 ha	11.51	2.30	9.21	450
	Bolana Unit sub-total	**1,928 ha**	**98.83**	19.77	79.06	1.025
	Walawe LB Total	**2,768 ha**	**151.35**	30.27	121.08	**1.094**
I-5	Walawe Right Bank					
	1. RB Main Canal	1,488 ha	71.19	14.24	56.95	957
	2. D-1 Canal	987 ha	8.46	1.69	6.77	171
	3. D-2 Canal	81 ha	2.24	0.45	1.79	553
	4. D-3 Canal	798 ha	26.88	5.38	21.50	674
	Walawe RB Total	**3,354 ha**	**108.76**	21.75	87.01	**649**
	Total (I)	**6,122 ha**	**334.38**	71.86	287.43	**1,092**
II.	Land Acquisition (0.5%)		1.67	0.36	1.44	
III.	Engineering Services (8%)		26.75	5.75	22.99	
IV.	Administration (5%)		16.72	3.59	14.37	
V.	Physical Contingency (15%)		50.16	10.78	43.12	
	Total (I~V)		**429.67**	92.34	369.35	
VI.	Price Contingency (10%)		**42.97**	9.23	36.94	
Ground Total			**472.64**	101.57	406.29	**1.544**

Table 6.2.4-2 Liyangastota (WLB) Canal Length - Proposed -

Name of Canal	Existing		Proposed		Lining
	Canal Length (Km)	Command Area (Ha)	Canal Length (Km)	Extent of Rehabilitation	
1. Ridiyagama Unit					
LB Main	12.0	232	12.0	100%	Brick
RB - 1	0.9	108	0.6	70%	do.
(Sub total)	(12.9)	(340)	(12.6)		
NRB	9.2	177	9.2	100%	
FCI of NRB	0.6	9	0.4	0	do.
(Sub total)	(9.8)	(186)	(9.6)		
NCB	2.7	120.2	2.7	100%	
LB1	2.0	68.0	1.4	70%	
RB1	0.8	9.7	0.6	"	
LB2	0.9	32.0	0.6	"	do.
RB2	2.0	51.8	1.4	"	
LB3	1.1	32.8	0.8	"	
(Sub total)	(9.5)	(314.5)	(7.5)		
Ridiyagama Total	(32.2)	(840.5)	(29.7)		
2. Bolana Unit					
SLB	15.4	233.4	15.4	100%	
RB1	0.3	20.0	0.2	70%	
RB2	0.4	13.3	0.3	"	
RB3	0.2	28.1	0.1	"	do.
RB4	1.0	105.5	0.7	"	
Dispensary Ela	1.3	46.2	0.9	"	
Pasala Ela	0.8	48.3	0.6	"	
(Sub total)	(19.4)	(494.8)	(18.2)		
SCB	3.8	355.3	3.8	100%	
19.11 canal	0.6	59.5	0.4	70%	
19.81 canal	0.4	96.7	0.3	"	do.
(Sub total)	(4.8)	(511.5)	(4.5)		
SRB	8.1	347.9	8.1	100%	
LB1	1.7	61.4	1.0	70%	
LB2	0.7	55.3	0.5	"	
LB3	1.0	38.6	0.7	"	
RB1	0.6	21.9	0.4	"	
LB4	2.6	98	1.8	"	do.
LB4A	0.4	16.2	0.3	"	
RB2	0.7	32.4	0.5	"	
LB7	0.4	11.4	0.3	"	
LB8	1.6	104.5	1.1	"	
LB8A	1.0	41	0.7	"	
RB3	2.1	91.9	1.5	"	
(Sub total)	(20.9)	(920.5)	(16.9)		
Bolana Total	(45.1)	(1926.8)	(39.6)		
Walawe LB Total (Rigiyagama+Bolana)	77.3	2767.3	69.3	88%	

Table 6.2.4-3 Liyangastota (WRB) Canal Length - Proposed -

Name of Canal	Existing		Proposed		Lining
	Canal Length (Km)	Command Area (Ha)	Canal Length (Km)	Extent of Rehabilitation	
RB Main and Others	23	1192	23.0	(100%)	Earth (30%) Brick (70%)
Lunama	3	89	2.1	70%	Brick
Dawage	3.2	136	2.2	do	do
D-32	2.6	71	1.8	do	do
(Sub total)	(31.8)	(1488)	(29.1)		
D-1 Canal and others	2	661	1.4	70%	Brick
Walawewatta	1.3	192	0.9	do	do
Jansegama/Robert	1.2	134	0.8	do	do
(Sub total)	(4.5)	(987)	(3.1)		
D-2 canal	1.5	81	1.1	70%	Brick
(Sub total)	(1.5)	(81)	(1.1)		
D-3 canal	8	325	5.6	70%	Brick
Wick	6	189	4.2	do	do
Oluwia	1.3	80	0.9	do	do
Puhul	0.5	16	0.4	do	do
Wata Ela	1.5	188	1.1	do	do
(Sub total)	(17.3)	(798)	(12.2)		
Total	(55.1)	(3354)	(45.5)	83%	

Table 6.2.5-1 Construction Cost for Rehabilitation Works under Muruthawela Reservoir Scheme

	Description		Area	Total (Mil.Rs.)	F/C(20%) (Mil.Rs.)	L/C(80%) (Mil.Rs.)	US$/ha
I.	**Construction Cost**						
I-1	Muruthawela LB						
	1. LB Main Canal			32.50	6.50	26.00	
	2. Branch Canal			12.08	2.42	9.66	
	3. Tract I		415 ha	27.70	5.54	22.16	1,335
	4. Tract II		614 ha	33.60	6.72	26.88	1,094
	5. Tract III		669 ha	23.49	4.70	18.79	702
		sub-total	**1,698 ha**	**129.37**	25.87	103.49	**1,524**
I-2	Urubokka Oya Scheme						
	1. Anicut Scheme	(8 Anicuts)	1,770 ha	87.36	23.60	63.76	987
	2. Tank Scheme	(under High Level Canal)	405 ha	10.70	2.14	8.56	529
		sub-total	**2,175 ha**	**98.06**	25.74	72.32	**902**
I-3	Kirama Oya Scheme	(18 Anicuts)	**2,276 ha**	**114.84**	35.47	79.37	**1,009**
	Total (I)		**6,149 ha**	**342.27**	87.08	255.18	**1,113**
II.	Land Acquisition	(0.5%)		1.71	0.44	1.28	
III.	Engineering Services	(8%)		27.38	6.97	20.41	
IV.	Administration	(5%)		17.11	4.35	12.76	
V.	Physical Contingency	(15%)		51.34	13.06	38.28	
	Total (I~V)			**439.81**	111.90	327.91	
VI.	**Price Contingency**	(10%)		**43.98**	11.19	32.79	
Ground Total				**483.79**	123.09	360.70	**1,574**

Table 6.2.5-2 Muruthawela LB Scheme Canal Length - Proposed -

Name of Canal	Existing		Proposed		Lining
	Canal Length (Km)	Command Area (Ha)	Canal Length (Km)	Extent of Rehabilitation	
1. LB Main canal					
Up to Tract I	5.1	0(415)	5.1	100%	50% Brick
Up to Tract II	10.2	614	10.2	do	51% Earth
Branch canal	5	669	2.5	50%	
(Sub total)	(20.3)	(1,698)	(17.8)		
2. Tract II					
D-1 canal	4.8	131	4.8	100%	Brick
D-2	1.5	36	1.5	"	"
D-3	0.8	36	0.8	"	"
D-4	0.6	49	0.6	"	"
D-5	0.4	24	0.4	"	"
D-6	1.2	65.0	1.2	"	"
D-7	0.7	70.0	0.7	"	"
D-8	1.9	62.0	1.9	"	"
D-9	2.4	141	2.4	"	"
(Sub total)	(14.3)	(614)	(14.3)		
3. Tract III					
D-1 canal	2.7	214	2.7	100%	Brick
D-7	1.7	32.0	1.7	"	"
D-8	0.8	93.0	0.8	"	"
D-9	0.5	37	0.5	"	"
D-2	2.5	117	2.5	"	"
D-3	0.4	44	0.4	"	"
D-4	0.6	24	0.6	"	"
D-5	0.7	33	0.7	"	"
D-6	1.3	75.0	1.3	"	"
(Sub total)	(11.2)	(669)	(11.2)		
4. Tract I	(0)	(415)	(8.3)	adopted 20m/ha	Brick
Total	45.8	3,396	52	92%	

Table 6.2.5-3 Urubokka Oya Scheme Canal Length - Proposed -

Name of Anicut	Existing		Proposed		Lining
	Command Area (Ha)	Canal Length (Km)	Canal Length (Km)	Extent of Rehabilitation	
1. Paluwa Nawarathe	101.2	6.6	4.6	70%	Brick
2. Kinchigune	106.8	4.9	3.4	"	"
3. Udukiriwila	182.1	4	2.8	"	"
4. Wakamulla	248.1	10.2	7.1	"	"
5. Hunnakumbura	168.4	5.6	3.9	"	"
6. Hakuruwela	396.2	13	9.1	"	"
7. Andupelena	375.2	11.7	8.2	"	"
8. Ranna	192.2	9.7	6.8	"	"
Total	1770ha	65.7km	45.9km	70%	

Table 6.2.5-4 High Level Canal Length - Proposed -

Name of Anicut	Existing		Proposed		Lining
	Command Area (Ha)	Canal Length (Km)	Canal Length (Km)	Extent of Rehabilitation	
Low Level Canal	67	1.3	0.9	70%	
High Level Canal		3.8	3.8	100%	
Pothuwewa	23	2.6	1.8	70%	Earth
Ethunnewela	16	1	0.7	"	"
Nugagaha	6	2.4	1.7	"	"
Ranasingha	30	2.8	2	"	"
Pattiyapola	182	4.4	3.1	"	"
Netolpitiya	81	1	0.7	"	"
Total	405ha	19.3km	14.7km	76%	

Table 6.2.5-5 Kirama Oya Canal Length - Proposed -

Name of Anicut	Existing		Proposed	
	Command Area (Ha)	Canal Length (Km)	Canal Length (Km)	Extent of Rehabilitation
1. Hammbumandiya	101.2	8.0	5.6	70%
2. Eth piriya	78.9	2.6	1.8	(Brickn Lining)
3. Uda Debarawa	43.7	4.8	3.4	"
4. Arachchi	133.6	9.7	6.8	"
5. Wijerathne	34.0	1.4	1.0	"
6. Wauwa	117.4	4.0	2.8	"
7. Okewela	141.6	4.3	3.0	"
8. Pansala	42.1	2.5	1.8	"
9. Pattiyawela	143.3	5.9	4.1	"
10. Unnansege	89.0	2.7	1.9	"
11. Kahawatta	89.0	2.7	1.9	"
12. Pinoda	54.6	1.1	0.8	"
13. Liyangedeniya	105.2	2.1	1.5	"
14. Nalagama	321.7	5.7	4.0	"
15. Daranda	72.8	2.1	1.5	
16. Wile	40.5	2.7	1.9	
17. Maha	190.2	3.2	2.2	"
18. Danketiya	202.4	N.A.	-	Included in Thangalu
Total	2001ha	65.5	46.0	70%

Table 6.2.6-1 Construction Cost for Rehabilitation Works under Badagiriya Scheme

	Description		Area	Total (Mil.Rs.)	F/C(20%) (Mil.Rs.)	L/C(80%) (Mil.Rs.)	US$/ha
I.	**Construction Cost**						
I-1	Main Canal			6.98	1.40	5.58	
I-2	D-1 Canal		214 ha	6.71	1.34	5.37	627
I-3	D-3 Canal		105 ha	1.93	0.39	1.54	368
I-4	D-4 Canal		70 ha	3.48	0.70	2.79	995
I-5	FC Canals		228 ha	8.81	1.76	7.05	773
I-6	Proposed Area		86 ha	9.40	1.96	7.44	2,187
	Total (I)		**703 ha**	**37.32**	7.54	29.78	**1,062**
II.	Land Acquisition	(0.5%)		0.19	0.04	0.15	
III.	Engineering Services	(8%)		2.99	0.60	2.38	
IV.	Administration	(5%)		1.87	0.38	1.49	
V.	Physical Contingency	(15%)		5.60	1.13	4.47	
	Total (I~V)			**47.96**	9.69	38.26	
VI.	Price Contingency	(10%)		**4.80**	0.97	3.83	
Ground Total				**52.75**	10.66	42.09	**1,501**

Table 6.2.6-2 Badagiriya Canal Length - Proposed -

Name of Canals	Existing		Proposed		
	Command Area (Ha)	Canal Length (Km)	Canal Length (Km)	Extent of Rehabilitation	Lining
Exis. Irrigable Area					
Main Canal		7.5	7.5	100%	Brick 10%
K1	13.4	0.3			Earth 90%
K2	6.1	0.6			
FC1	34.0	1.8	0.9	50%	Brick
T1	4.0	0.4			
FC2	8.5	1.1			
FC3	3.6	0.2			
FC4	6.1	0.6	0.3	50%	Brick
FC5	10.9	0.2			
FC6	9.7	0.4			
FC7	1.2	0.1			
FC8	14.6	1.1	0.6	50%	Brick
FC9A	12.1	0.6	0.3	do	do
FC9B	14.6	0.7	0.4	do	do
FC10	9.7	0.5			
DC1		1.5	0.8	50%	Brick
FC11	13.4	0.7			
FC12	4.9	0.1			
FC13	7.3	0.4	0.2	50%	Brick
FC14	6.1	0.2			
FC15	9.7	0.9			
FC16	13.4	0.2			
FC17	10.8	0.4			
FC18	13.4	0.9			
FC23	13.4	0.6			
FC24	6.1	0.4			
FC19	41.3	1.5	0.8	50%	Brick
FC21	7.3	0.3			
FC22	18.2	0.7			
FC20	48.6	1.8	0.9	50%	Brick
FC25	12.1	0.5	0.3	do	do
FC26	2.4	0.2	0.1	do	do
FC27	8.5	0.2			
FC28	10.9	1.2			
FC29	9.7	0.5	0.3	50%	Brick
FC30	9.7	0.6			
FC31	3.6	0.1			
DC3	0.0	0.7	0.4	50%	Brick
FC35	38.9	1.0	0.5	do	do
FC36	46.1	1.8			
FC38	17.0	0.4			
FC37	3.6	0.4			
FC39	21.9	1.2	0.6	50%	Brick
DC4	0.0	0.9	0.5	do	do
FC40	17.0	0.8			
FC40A	7.3	0.5			
FC41	19.4	0.8	0.4	50%	Brick
FC42	18.2	1.4	0.7	do	do
FC43	8.5	0.4			
Exis. Irrigable Area Total	617.2	40.3	16.5		
Proposed Area					
DC4		0.7	0.5	0.2 done	Brick
FC44	17	0.8	0.8	100%	"
FC45	13.4	0.4	0.4	do	"
FC46	12.1	0.4	0.4	do	"
FC47	12.1	0.6	0.6	do	"
FC48	8.5	0.6	0.6	do	"
FC49	23.1	0.8	0.8	do	"
Proposed Area Total	86.2	4.3	4.1	do	"
Badagiriya Scheme Total	703.4	44.6	20.6	44%	

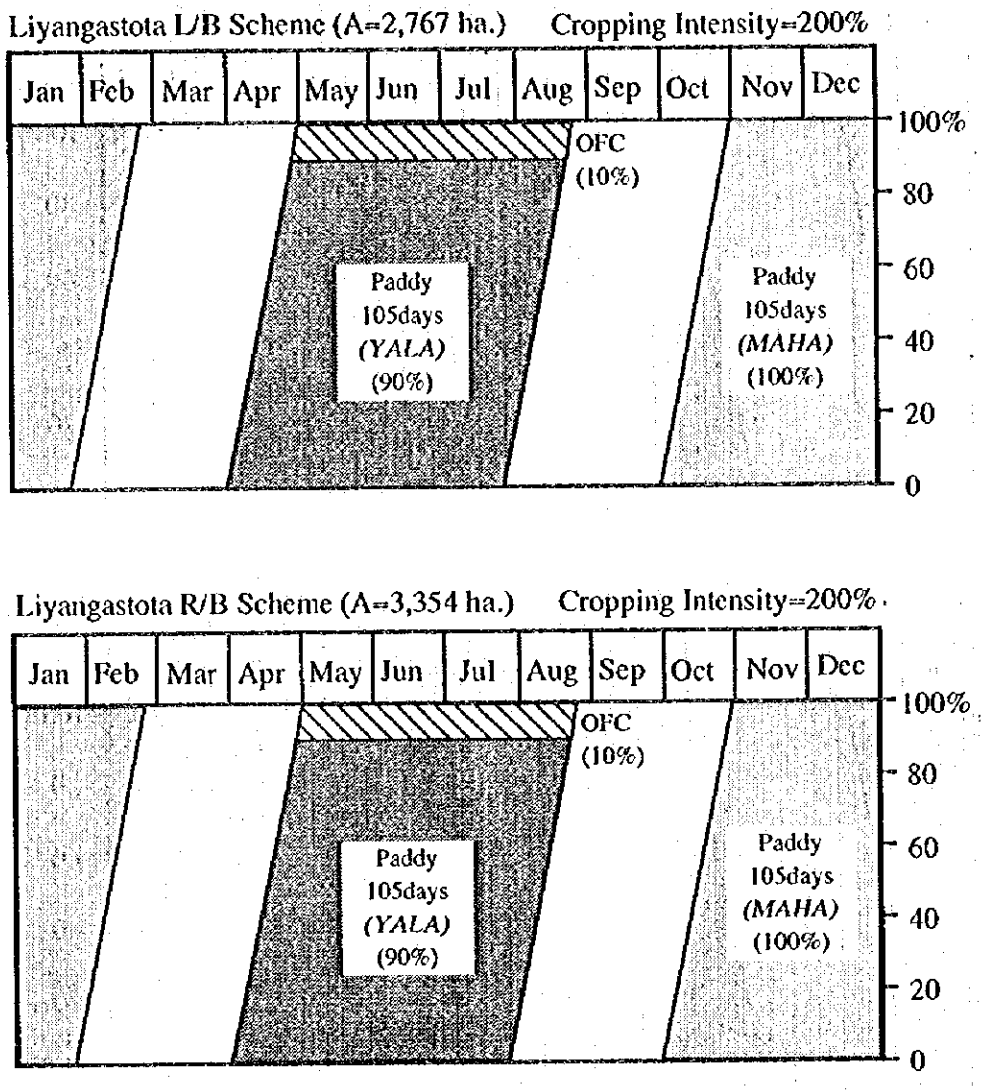

Fig. 6.2.2-1 Proposed Cropping Pattern for Liyangastota Scheme

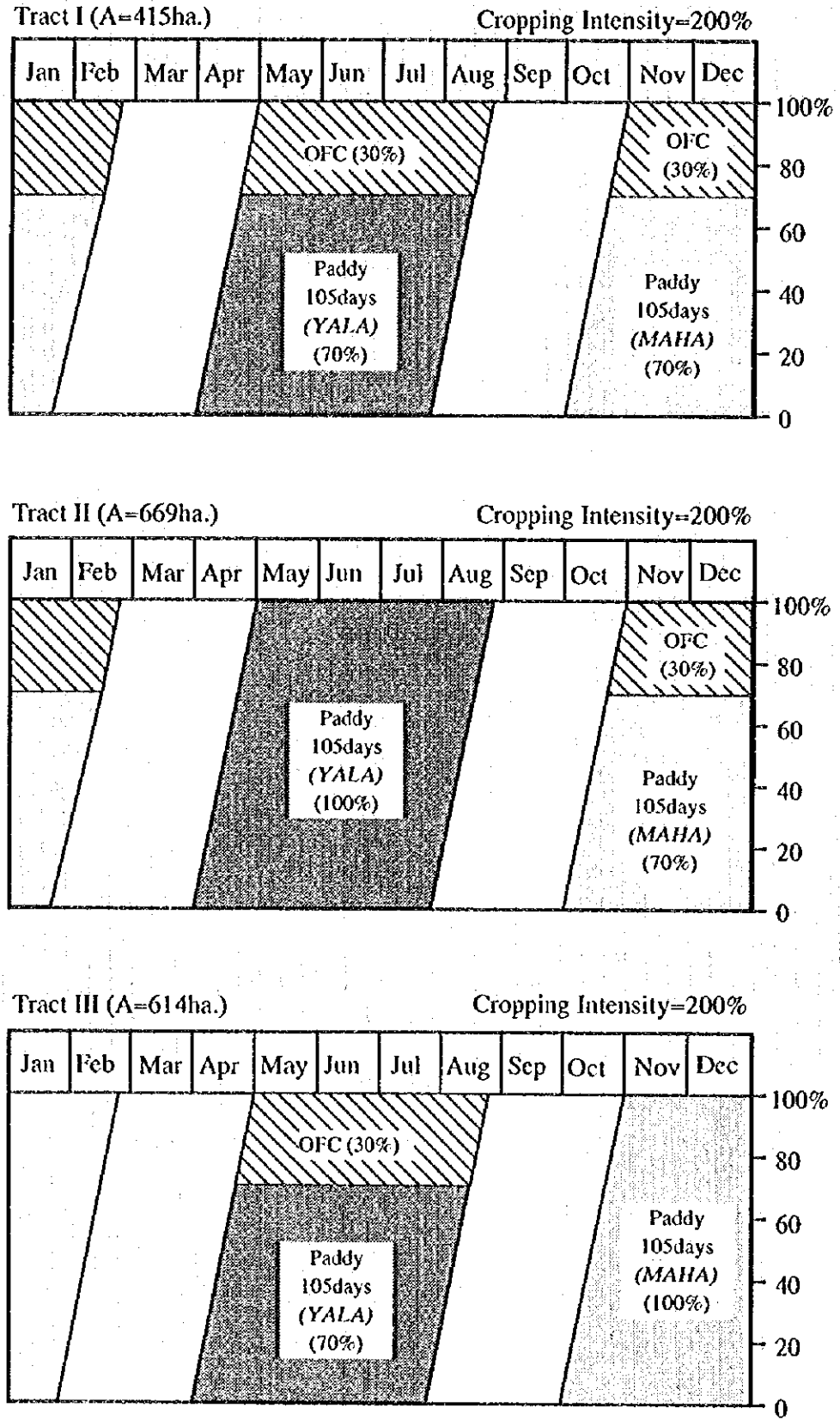

Fig. 6.2.2-2 Proposed Cropping Pattern for Muruthawela L/B Scheme

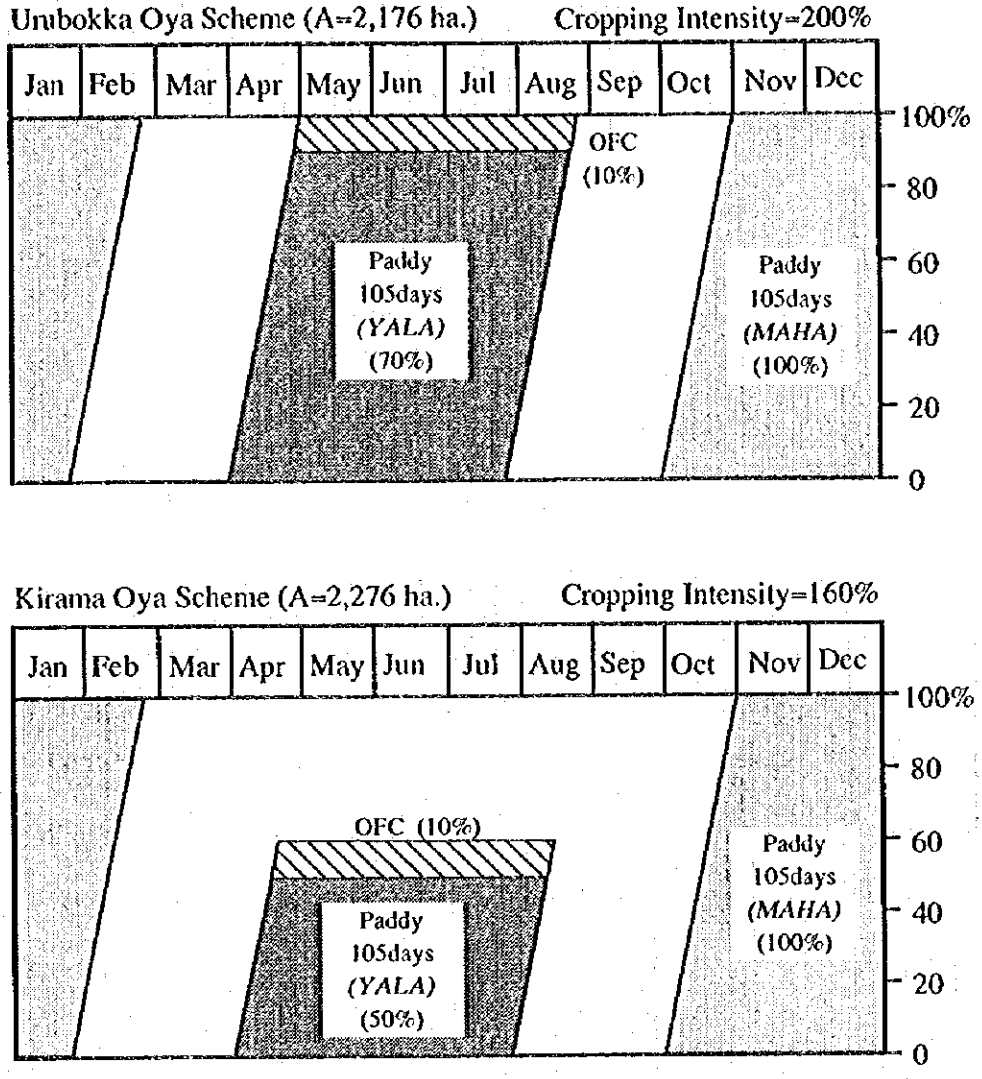

Fig. 6.2.2-3 Proposed Cropping Pattern for Urubokka Oya and Kirama Oya Scheme

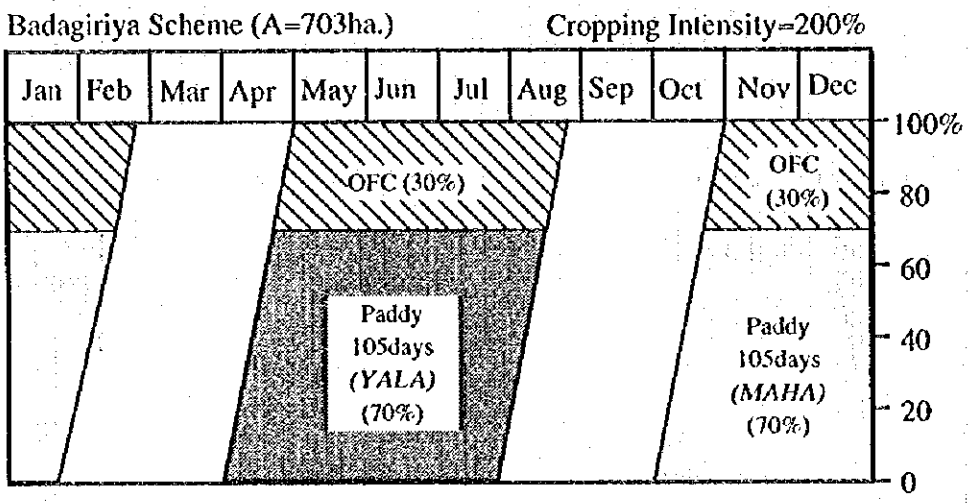

Fig. 6.2.2-4 Proposed Cropping Pattern for Badagiriya Scheme

6.3 Rehabilitation of Drainage Systems

6.3.1 General Concepts and Engineering Approach for Rehabilitation

(1) General Concepts to be Commonly Applied for Target Schemes

a) In formulation of rehabilitation plan for the target schemes, i.e., Benthara Ganga Right Bank Scheme, Polwatte Ganga Scheme and Tangalu Welyaya Scheme, the top priority will be given to improvement of present drainage condition of each scheme by applying gravity drainage method, and introduction of drainage by pumps will be avoided as much as possible so as to minimize project costs as well as costs for O&M of the rehabilitated facilities.

b) Provision of additional structures and lining of the canals shall be avoided as much as possible. However, if it is judged necessary, provision of additional structures and lining the canals may be permitted in the rehabilitation plan. Even in such case, however, the number and kind of the structures and the length of lining shall be limited to minimum extent.

(2) Considerations for Design Criteria prepared by Irrigation Department

Attention was paid to the design criteria titled as " Design of Irrigation Headworks for Small Catchments " prepared by Irrigation Department in May, 1984. The design criteria do not provide necessarily engineering aspects required for design of drainage schemes which have relatively large basin. However, the criteria provide following important information.

1) Zone-wise rainfall intensity with duration vs. return period of 10, 25, 50 and 100 years. Sri Lanka is divided into 6 hydrological zones and the target irrigation and drainage schemes fall in zones 3,4 and 5.

2) The flood tolerance of agricultural crops is given as follows.

Flood Tolerance of Agricultural Crops

Crop Type	Tolerance (in hrs.)
Coconut, Rubber, Oil palm, Orchards	72
Paddy (partial submergence)	72
Paddy (total submergence)	48
Banana, Cocoa, Coffee, Papaya	48
Maize, Sorghum, Pine-apple	24
Tobacco, Vegetables	Very low.

3) Run-off coefficients or relative imperviousness

Run-off coefficients are given according to the slope of catchment as follows.

Catchment Slope in %	Run-off Coefficients
0 to < 2	0.3
2 to < 4	0.4
Above 4	0.5

However, these values are mainly used for design of reservoir.

(3) Other Considerations

Since above-mentioned criteria do not provide any specific design considerations especially design for the drainage scheme with large catchment area, references were made to the design considerations applied in the existing drainage schemes. In addition, following values of specific discharge calculated based on the 5 days rainfall with ten years return period have been considered especially for decision of size and number of pumps required.

Specific Discharge With 10 Years Return Period

(1)	For Benthara Ganga Right Bank Scheme	1.68 $m^3/sec/km^2$.
(2)	For Polwatte Ganga Scheme	1.85 $m^3/sec/km^2$.
(3)	For Tangalu Welyaya Scheme	1.65 $m^3/sec/km^2$.

As a result, in formulation of rehabilitation plan, especially for drainage schemes, 5 days rainfalls with 10 years return period have been basically taken into account for design of the facilities to be rehabilitated. However, construction of large scale flood protection bunds which needs consideration for probable flood discharge with 20 years return period has not been taken into account in the rehabilitation plan. With this background, the following rehabilitation plans have been prepared for each target scheme as follows. Supporting brief engineering papers prepared for formulation of each rehabilitation plan are presented at the end of section 6.3.4.of chapter 6 of the report.

6.3.2 Rehabilitation Plan for Benthara Ganga Right Bank Scheme

(1) Purpose of Rehabilitation

The main purpose for rehabilitation of this scheme is to lower the presently-observed flood levels in the scheme as well as to avoid intrusion of saline water to the scheme as much as possible by applying drainage by gravity and/or drainage by pumps. Accordingly, two rehabilitation plans, i.e., Plan-1 and Plan-2 have been considered as follows.

(2) Rehabilitation Plan

Rehabilitation Plan-I

The basic concept for this plan is to improve the present drainage condition of the scheme by gravity drainage only. And it consists of the following.

a) Area to be drained: 965 ha.

b) Dredging and re-sectioning of selected 12 existing drainage cum irrigation canals.
Total re-sectioning length : 17.3 km.

c) Additional provision of small drainage canals.
Total length of small drainage canals : 6.6 km.

d) Reconstruction of 12 existing SWE structures including, widening the span, lowering the sill level, replacement of 24 nos.of steel-made flap gates and 24 nos of wooden sluice gates. And the remaining other SWE structures will also be rehabilitated or replaced according to the survey results for degree of deterioration of the facilities obtained during the phase-I field survey.

e) Improvement of existing flood protection bunds.

The said rehabilitation plan-I is shown in Figure 6.3.2-1. And cost for rehabilitation plan-I is shown in Table 6.3.2.-1.

Rehabilitation Plan-II

This plan is to further improve the drainage condition by combination of drainage by gravity and by pumps. And it includes the following main components.

a) Rehabilitation items given in the rehabilitation plan-I.

b) Provision of 5 pump stations for supplemental drainage.

The rehabilitation plan-II is shown in Figure 6.3.2-2. And cost for rehabilitation plan-II is shown in Table 6.3.2.-2. As is seen from the Table, cost /ha performance in this plan is very high, accordingly, this rehabilitation plan is not recommended.

6.3.3 Rehabilitation Plan for Polwatte Ganga Scheme

(1) Objectives of Rehabilitation

The main purpose for rehabilitation of this scheme is to lower the presently-observed flood levels and to avoid intrusion of saline water to the scheme. To cope with this purpose, existing Ilwatta anicut needs to be replaced with new one which meets present requirements for flood irrigation.

(2) Rehabilitation Plan

Rehabilitation Plan

The main concept for this rehabilitation plan is to avoid intrusion of saline water by provision of a new anicut as well as to lower the water levels in the scheme by improving the existing SWE structures and the rehabilitation plan consists of the following main components.

a) Replacement of the existing Ilwatta Anicut with new one which will have the following functions. However, reinforced concrete frame of the existing structures will be utilized as much as possible in this plan.

(i) Existing manually operated 3 nos. of steel-made gates in Ilwatta anicut will be replaced with new ones. And the replaced gates shall be operated by 3 nos.of motors run by electricity to properly cope with changes of river water levels as well as sea water levels.

(ii) Considering the need of operation of the gates during floods, steel-made operation deck will be provided at the both sides of the new anicut. The operation deck will have a width of 1.5 m with total span length of about 100 m in total.

(iii) Improvement of 4 nos of existing anicuts along Polwatte Ganga and construction of 3 anicuts.

(iv) Dredging and re-sectioning of the selected existing 5 nos of drainage cum irrigation canals. The total re-sectioning and dredging length will be about 12.5 km.

(v) Additional provision of earthen embankment along the Polwatte Ganga. Top width of the embankment shall be 2.0 m and the required height shall be 1.5 m with side slope of 1 to 2.0.

Based on the above, the said rehabilitation plan for the scheme is shown in Figure 6.3.3-1. And cost for this plan is shown in Table 6.3.3-1.

6.3.4 Rehabilitation Plan for Thangalu Welyaya Scheme

(1) Objectives

The same objectives introduced above is considered for rehabilitation of this scheme. However, since the dominant elevations of the farmlands under the scheme are lower than MSL, introduction of pumps for supplemental drainage of the scheme can not be avoided.

(2) Rehabilitation Plan

This plan is to improve the present drainage condition of the scheme by combination of drainage by gravity and pumps. And it includes the following main components.

a) Provision of 1 unit of pump run by electricity at the location of existing anicuts No.8 or No.9. In this case, mixed-flow type pump is recommended.

b) Replacement of existing No.8 and 9 anicuts with new ones.

c) Provision of 5 nos.of main drainage canals. Total length of the main drainage canals will be 8.6 km.

d) Provision of 14 nos. of supplemental drainage canals. Total length of the supplemental drainage canals will be 9.7 km.

e) Provision of 14 nos. of concrete-made protection works at the junctions of the drainage canals.

f) Re-sectioning and raising of the height of 2 nos of the existing bunds.

g) Dredging at the estuaries of Kirama Oya as well as at Medilla and Kapuhena.

h) Replacement of the existing groins at Medilla and Kapuhena.

i) Provision of 17 nos. of culverts under the existing roads

Based on the above, the said rehabilitation plan is shown in Figure 6.3.4-1. And cost for this plan is shown in Table 6.3.4-1.

"Supporting Brief Engineering Papers for the Said Rehabilitation Planning"

1. General Engineering Concepts Commonly Applied for Preparation of Rehabilitation Plan

1) Considering that this rehabilitation project aims mainly to protect the farmlands under each target scheme from intrusion of saline water and as well as from relatively small scale floods, large scale engineering-planning methodology adopted for formulation of Gin Ganga Regulation Project and Nilwala Ganga Flood Protection has been avoided. Accordingly, in formulation of this drainage plan, emphases have been put on the drainage of farmlands which are already protected by the existing protection facilities by SWE structures and flood protection bunds etc. And, in this rehabilitation plan, protection of the farmlands by construction of large scale flood protection bunds which needs consideration for the probable flood discharge with return period of twenty years has not been taken into account mainly from the economical point of view for the project.

2) To determine the size and number of required structures and pumps, however, computed basic 5 days peak specific discharge with return period of ten years have been basically used. However, since these data are considered to be useful mainly for planning of large scale flood protection and river training projects, modified data have been used in this drainage planning. The computed basic 5 days specific discharge with return period of ten years for each scheme is given below.

For Benthara Ganga Right Bank Scheme	1.68 $m^3/sec/km^2$ (peak)
For Polwatte Ganga Scheme	1.85 $m^3/sec/km^2$.(peak)
For Tangalu Welyaya Scheme	1.65 $m^3/sec/km^2$. (peak)

3) Priority has been given to drainage by gravity by improving the existing SWE structures and canals, however, drainage by pumps has been also considered for such scheme where it is definitely needed to improve the drainage condition of the scheme.

4) Construction of additional structures has been avoided as much as possible to reduce the rehabilitation costs. However, replacement of Ilwatta anicut with new one which will properly respond the change of water levels inside the scheme and sea water levels has been considered. Because the function of existing Ilwatta anicut is too old to protect the farmlands under the scheme from intrusion of saline water.

5) Since 3 target schemes which are mainly considered as drainage schemes are located at the lower end of each river basin, the following expected effects which will contribute to reduction of peak flood discharge have been taken into account.

a) Effect due to temporary storage of peak flood discharge in the paddy fields which occupy large part of the scheme.

b) Effect due to temporary storage of peak flood discharge in the existing tanks as well as in relatively large scale canals.

c) Effect due to reduction of slope of river basin.

d) Effect due to temporary storage of peak flood discharge by the vegetation in each target scheme etc.

6) In addition to the above, attention has been paid to the engineering suggestions provided in the design criteria prepared by Department of Irrigation.

Based on the above-mentioned general concepts, scheme-wise brief engineering studies for rehabilitation planning have been made as follows. It may be mentioned here, however, that since the data,topographic maps with proper scale and contours, information as well as criteria to be referred for making drainage planning are very limited. Accordingly, following studies present only rough engineering considerations taken into account for drainage planning for each scheme.

Brief Engineering Study for Tangalu Welyaya Scheme

In this study, following assumptions have been made.

(1) Area to be drained: 395 ha +1,095 ha (back yard area) = 1,490 ha = 14.9 km2.

(2) Specific peak discharge: $q = 1.65\ m^3/sec/km^2$.

Then, estimated inflow volume during 5 days (V).is calculated as below.

$V = 1.65 \times 14.9 \times 120 \times 3,600 \times 1/2 = 531 \times 10^4\ m^3/5$ days.

Then, average inundation depth (H) is calculated as below.

$$H = 531 \times 10^4\ m^3/395 \times 10^4\ m^2 = 1.34\ m.$$

According to the results of rough analyses for present drainage condition for Tangalu Welayaya Scheme, present drainage systems can drain the volume of about $100 \times 10^4\ m^3$/day, which means water level reduction of 0.25 m/day ($100 \times 10^4\ m^3/395 \times 104\ m^2$) By improvement of existing SWE structures, drainage volume will be increased by $130 \times 10^4\ m^3$/day, which means water level reduction of 0.33 m /day. Then, with 3 day's continuous drainage by gravity, water height will be reduced to 0.35 m (1.34 m - 0.33 m x 3 = 0.35 m). Then required drainage capacity by pump will be (0.35 m - 0.30 m) x $395 \times 10^4\ m^2$/ (72 hr x 3,600) =0.76 m^3/sec. Considering that drainage condition of the scheme will be improved by rehabilitation of the existing SWE structures, drainage by pump should be considered as supplemental in this rehabilitation plan. However, introduction of drainage by pump is necessary for this scheme, because most of the elevations of the farmlands under this scheme are almost equal to or located lower than MSL. Accordingly, installation of a pump with drainage capacity of about 0.5 m^3/sec is recommended. The type of pump to be installed shall be mixed flow type.

Brief Engineering Study for Benthara Ganga Scheme

Study for Plan-I (Drainage by Gravity with Improvement of Existing SWE Structures)

In this study, the following assumptions have been made.

(1) Area to be drained: 11.7 km^2 + 5.3 km^2 (sub drainage area) = 17.0 km^2.

(2) Specific peak discharge : q = 1.68 m^3/sec/km^2.

Then, estimated inflow volume (V) during 5 days is calculated as below.

V = 1.68 x 17.0 x 120 x 3,600 x 1/2 = 620 x 10^4 m^3/5 days.

Then, average inundation depth (H) is calculated as below..

H = 620 x 10^4 m^3/965 x 10^4 m^2 (considering the command area only) = 0.64 m.

According to the results of rough analyses for present drainage condition for Benthara Ganga Right Bank Scheme, present drainage systems can drain the volume of about 170 x 10^4 m^3/day, which means water level reduction of 0.10 m/day (170 x 10^4 m^3/1,700 x 10^4 m^2) is roughly expected. With rehabilitation of the existing SWE structures, total width of SWE structures will be widened 1.2 times the existing ones. Then, the water level can be reduced with the ratio of 0.10 x 1.2 = 0.12 m. Then, at the third day, water depth can be reduced to (0.64 m - 3 x 0.12 m = 0.28 m.
However, some of the command areas will still remain un-drained. However, by improvement of the existing SWE structures, present gravity drainage systems under Benthara Ganga Right Bank Scheme will be much improved. Accordingly, rehabilitation plan-I is recommended for this scheme.

Study for Plan-II (Drainage by Gravity with Improvement of Existing SWE Structures and Installation of Pumps

In this study, following assumptions have been made.

(1) Area to be drained : Considering the introduction of pumps, areas to be drained have been taken more from the economical point of view as follows.

A = 965 ha + 1,000 ha (backyard areas of block No.4) 1,200 ha (backyard areas of block No.5) = 3,165 ha = 31.65 km2.

(2) Specific peak discharge : 1.68 m^3/sec/km^2.

Then, inflow volume (V) during 5 days is calculated as below.

V = 1.68 x 31.65 x 120 x 3,600 x 1/2 = 1,150 x 10^4 m^3/5 days.

Then, average inundation depth (H) is calculated as below.

H = 1,150 x 10^4 m^3/965 x 10^4 m^2 = 1.20 m.

From the results obtained from the study for plan-I, with improvement the existing SWE structures, the improved SWE structures will have a drainage capacity of reduction of water height of 0.12 m/day, which means

reduction of water height of 0.36 m/3 days. Accordingly, water height of 0.54 m (1.2 m - 0.36 m- 0.3 m) must be reduced by pumps within 3 days, allowing inundation depth of 0.3 m. Then, the total drainage capacity to be given to the pumps is calculated as below.

Total drainage capacity required : $Q = 965 \times 10^4 \times 0.54\ m^3/3 \times 24 \times 3,600 = 20\ m^3/sec$. Since the total drainage block is divided into 5 blocks, average required pump capacity per one pump station amounts to 4.0 m^3/sec.

The above study results obviously show that cost for introduction of pumps is very high, accordingly , rehabilitation plan - II should be dropped. As a result, rehabilitation plan-I is recommended for improvement of drainage of Benthara Ganga Scheme, although plan-I does not provide full drainage of the scheme.

Brief Engineering Study for Polwatte Ganga Scheme

In this study, the following assumptions have been made.

1. Area to be drained : 560 ha (command area) + 660 ha (backyard areas on the right bank of Polwatte Ganga) + 670 ha (backyard areas on the left bank of Polwatte Ganga) = 1,890 ha = 18.9 km^2.

2. Specific peak discharge : $q = 1.85\ m^3/sec/km^2$. However, since areas to be drained are almost flat, this specific discharge may be reduced considering reduction factors as follows.

   $q' = 1.85 \times 0.5$ (reduction due to gentle slope of drainage basin) x 0.8 (reduction due to temporary storage effect by the existing tanks and canals) = 0.74 $m^3/sec/km^2$.

Then, estimated inflow volume (V) during 5 days is calculated as below.

$V = 0.74 \times 18.9 \times 120 \times 3,600 \times 1/2 = 300 \times 10^4\ m^3/5$ days.

Then, estimated inundation depth (H) is calculated as below.

$H = 300 \times 10^4\ m^3/560 \times 10^4\ m^2$ (command area) = 0.53 m.

According to the brief study for present drainage capacity of Ilwatta anicut, it can drain the water with the ratio of water level reduction of 0.12 m /day ($65.7 \times 10^4\ m^3/560 \times 10^4\ m^2$) with the condition that the gates installed in the anicut function well, it means the gates are operated according to the change of water levels inside the scheme and sea water levels. In the rehabilitation plan, existing Ilwatta anicut will be replaced with new one which will have such functions mentioned above, the water depth inside the scheme may be reduced within 3 days as follows.

Water depth reduction : H' = (0.53 m - 3 x 0.12 m) = 0.17 m)

And, the proposed new anicut will also have the function of avoiding the free intrusion of saline water to the farmlands under the scheme provided that the gates are operated timely, responding to the change of water levels as well as sea water levels, which is one of the most important aspect for improvement of existing Ilwatta anicut, accordingly, the rehabilitation plan discussed above is recommended.

Table 6.3.2-1 Construction Cost for Rehabilitation Works under Benthara Ganga RB Scheme

Alternative I

	Description		Area	Total (Mil.Rs.)	F/C (Mil.Rs.)	L/C (Mil.Rs.)	US$/ha
I.	**Construction Cost**						
I-1	Replacement of SWE Structures			52.55	10.51	42.04	
I-2	Resectioning of Drainage Canal			5.33	1.07	4.27	
I-3	Provision of Small Drainage Canal			1.79	0.36	1.43	
I-4	Improvement of Bunds			63.09	12.62	50.47	
	Total (I)		**965 ha**	**122.76**	24.55	98.21	**2,544**
II.	Land Acquisition	(0.5%)		0.61	0.12	0.49	
III.	Engineering Services	(8%)		9.82	1.96	7.86	
IV.	Administration	(5%)		6.14	1.23	4.91	
V.	Physical Contingency	(15%)		18.41	3.68	14.73	
	Total (I~V)			**157.75**	31.55	126.20	
VI.	Price Contingency	(10%)		**15.78**	3.16	12.62	
Ground Total				**173.53**	34.71	138.82	**3,596**

Table 6.3.2-2 Construction Cost for Rehabilitation Works under Benthara Ganga RB Scheme

Alternative II

	Description		Area	Total (Mil.Rs.)	F/C (Mil.Rs.)	L/C (Mil.Rs.)	US$/ha
I.	**Construction Cost**						
I-1	Replacement of SWE Structures			52.55	10.51	42.04	
I-2	Resectioning of Drainage Canal			5.33	1.07	4.27	
I-3	Provision of Small Drainage Canal			1.33	0.27	1.07	
I-4	Improvement of Bunds			63.09	12.62	50.47	
I-5	Provision of Pump Stations			495.00	99.00	396.00	
	Total (I)		**965 ha**	**617.30**	123.46	493.84	**12,794**
II.	Land Acquisition	(0.5%)		3.09	0.62	2.47	
III.	Engineering Services	(8%)		49.38	9.88	39.51	
IV.	Administration	(5%)		30.87	6.17	24.69	
V.	Physical Contingency	(15%)		92.60	18.52	74.08	
	Total (I~V)			**793.24**	158.65	634.59	
VI.	Price Contingency	(10%)		**79.32**	15.86	63.46	
Ground Total				**872.56**	174.51	698.05	**18,084**

Table 6.3.3-1 Construction Cost for Rehabilitation Works under Polwatte Ganga Scheme

	Description		Area	Total (Mil.Rs.)	F/C (Mil.Rs.)	L/C (Mil.Rs.)	US$/ha
I.	**Construction Cost**						
I-1	Resectioning and Dredging of Canal			1.02	0.20	0.81	
I-2	Provision of Embakment			2.02	0.40	1.61	
I-3	Improvement of Ilwatte Anicuts			90.00	18.00	72.00	
I-4	Construction of Anicuts			22.59	4.52	18.08	
	Total (I)		**560 ha**	**115.63**	23.13	92.50	**4,130**
II.	Land Acquisition	(0.5%)		0.58	0.12	0.46	
III.	Engineering Services	(8%)		9.25	1.85	7.40	
IV.	Administration	(5%)		5.78	1.16	4.63	
V.	Physical Contingency	(15%)		17.34	3.47	13.88	
	Total (I~V)			**148.59**	29.72	118.87	
VI.	Price Contingency	(10%)		**14.86**	2.97	11.89	
Ground Total				**163.44**	32.69	130.76	**5,837**

Table 6.3.4-1 Construction Cost for Rehabilitation Works under Thangalu Welyaya Scheme

	Description		Area	Total (Mil.Rs.)	F/C (Mil.Rs.)	L/C (Mil.Rs.)	US$/ha
I.	**Construction Cost**						
I-1	Provosion of Drainage Canals			7.38	1.48	5.90	
I-2	Construction of Culvert with Gates			5.67	1.13	4.54	
I-3	Improvement of Drainage Canal			2.02	0.40	1.62	
I-4	Resectiong of Bunds			6.27	1.25	5.01	
I-5	Dredging & Resectioning of Kirama el.			0.31	0.06	0.24	
I-6	New Groynes			12.39	2.48	9.91	
I-7	Replacement of Anicuts			30.50	6.10	24.40	
I-8	Provision of Pump Station			19.00	3.80	15.20	
	Total (I)		**395 ha**	**83.53**	16.71	66.83	**4,230**
II.	Land Acquisition	(0.5%)		0.42	0.08	0.33	
III.	Engineering Services	(8%)		6.68	1.34	5.35	
IV.	Administration	(5%)		4.18	0.84	3.34	
V.	Physical Contingency	(15%)		12.53	2.51	10.02	
	Total (I~V)			**107.34**	21.47	85.87	
VI.	Price Contingency	(10%)		**10.73**	2.15	8.59	
Ground Total				**118.08**	23.62	94.46	**5,979**

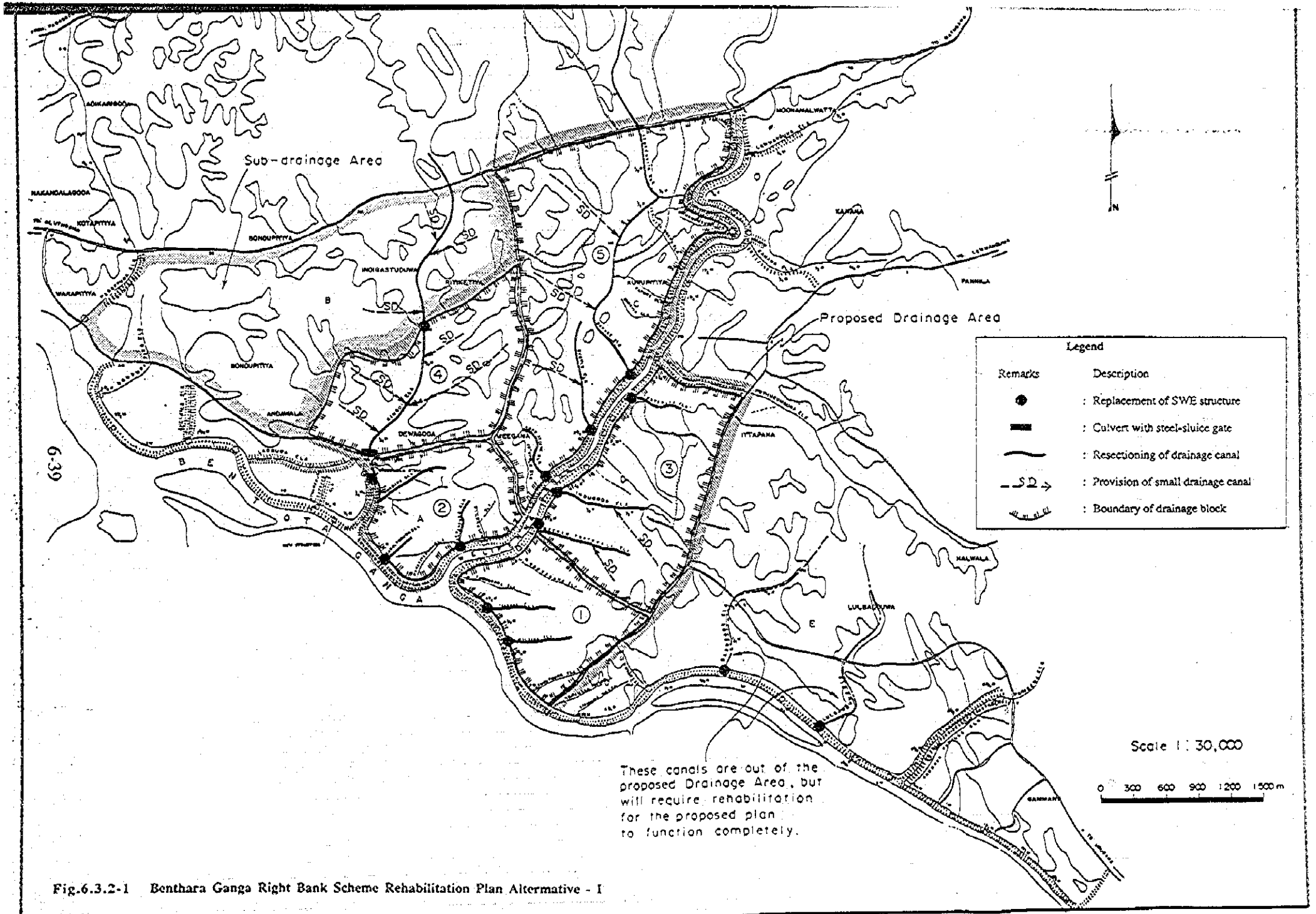

Fig.6.3.2-1 Benthara Ganga Right Bank Scheme Rehabilitation Plan Altermative - I

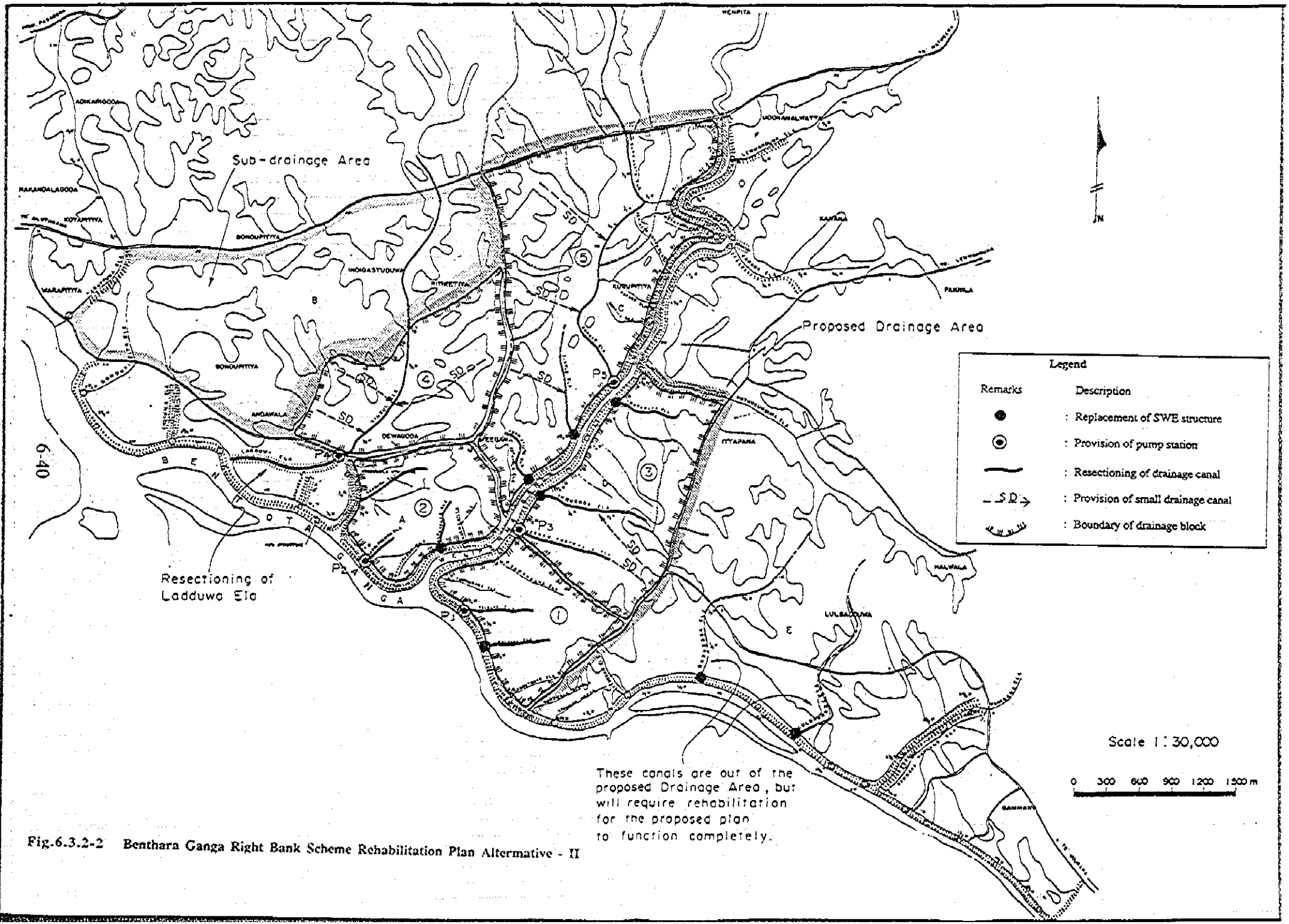

Fig.6.3.2-2 Benthara Ganga Right Bank Scheme Rehabilitation Plan Alternative - II

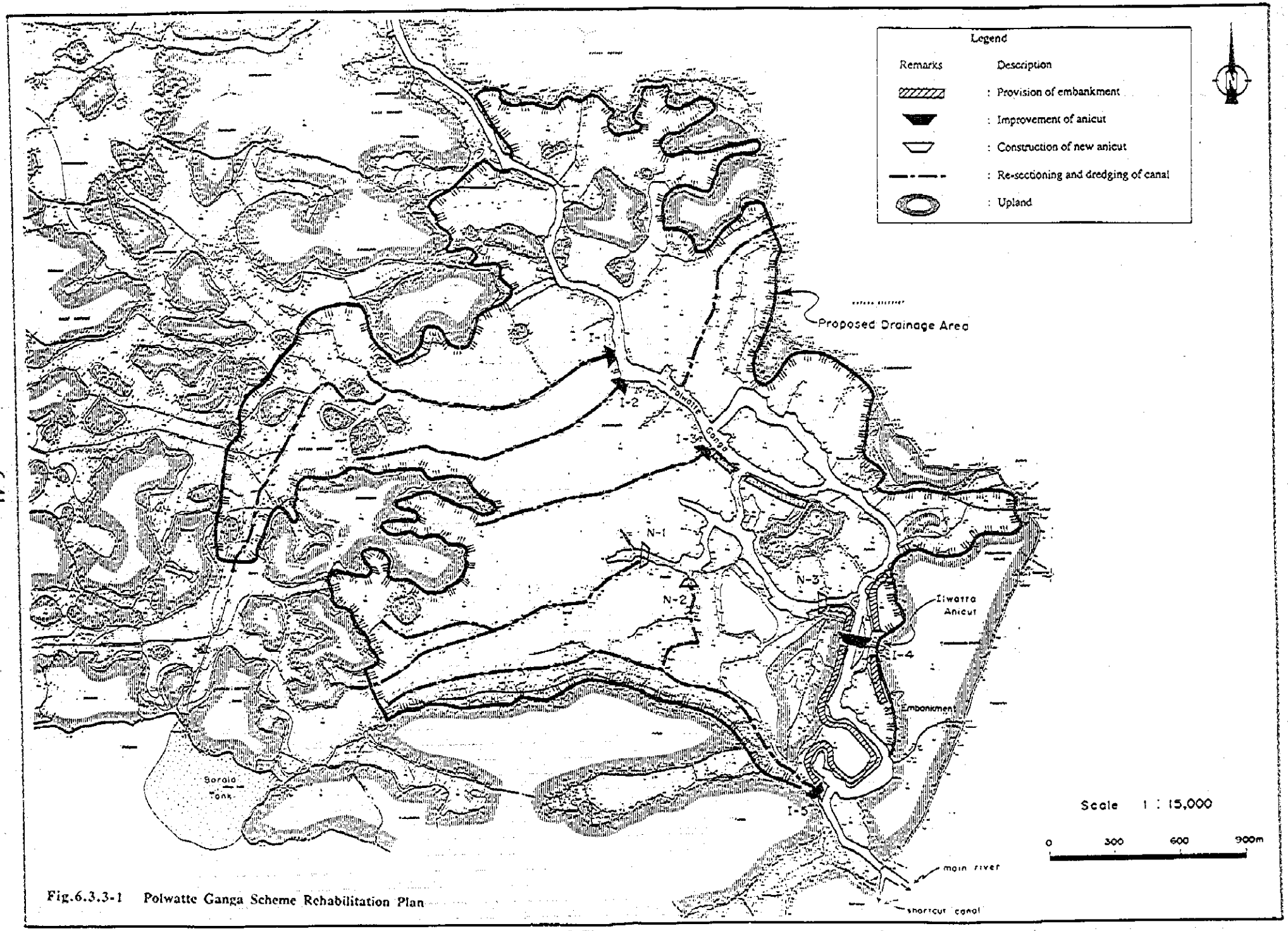

Fig.6.3.3-1 Polwatte Ganga Scheme Rehabilitation Plan

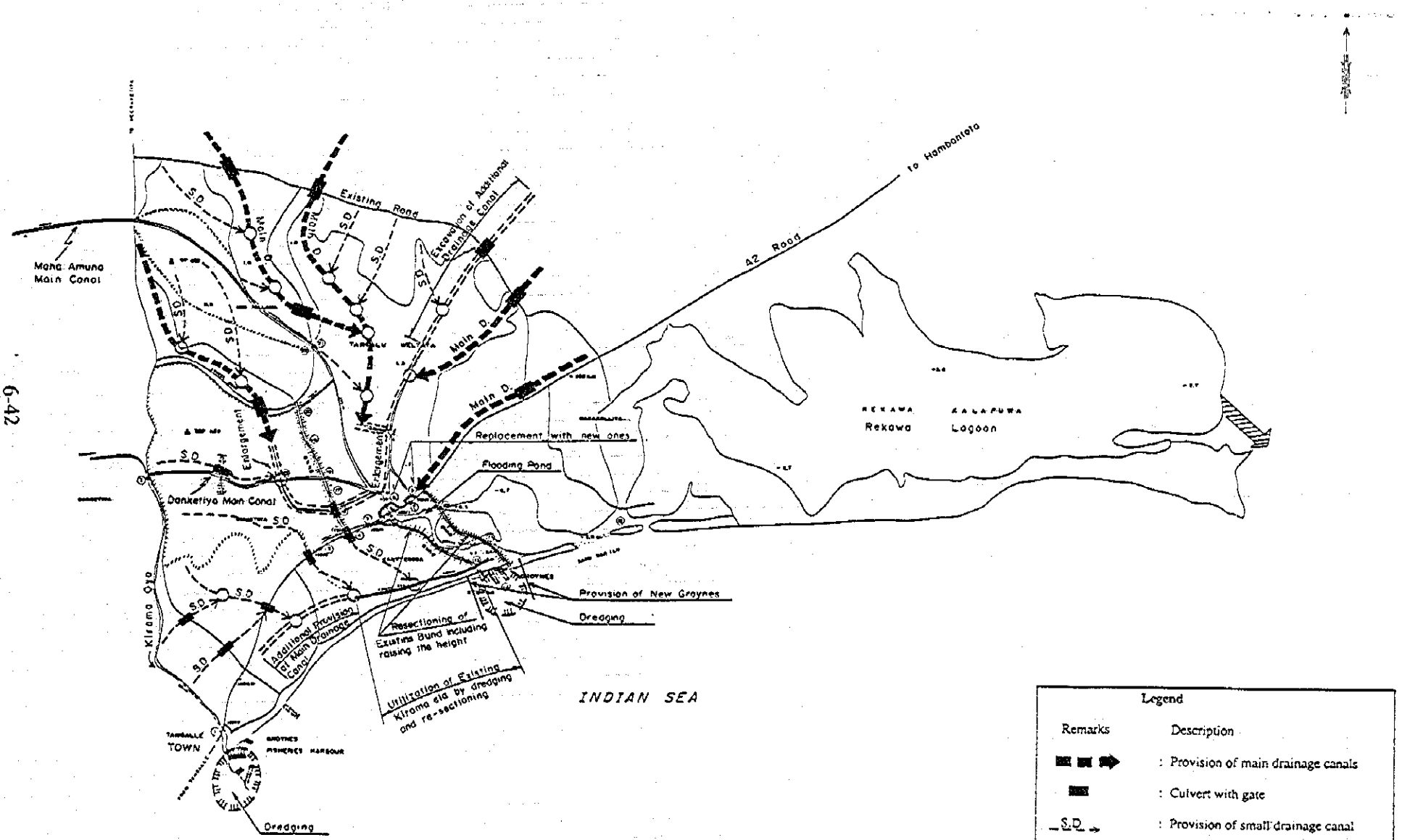

Fig.6.3.4-1 Thangalu Welyaya Scheme Rehabilitation Plan

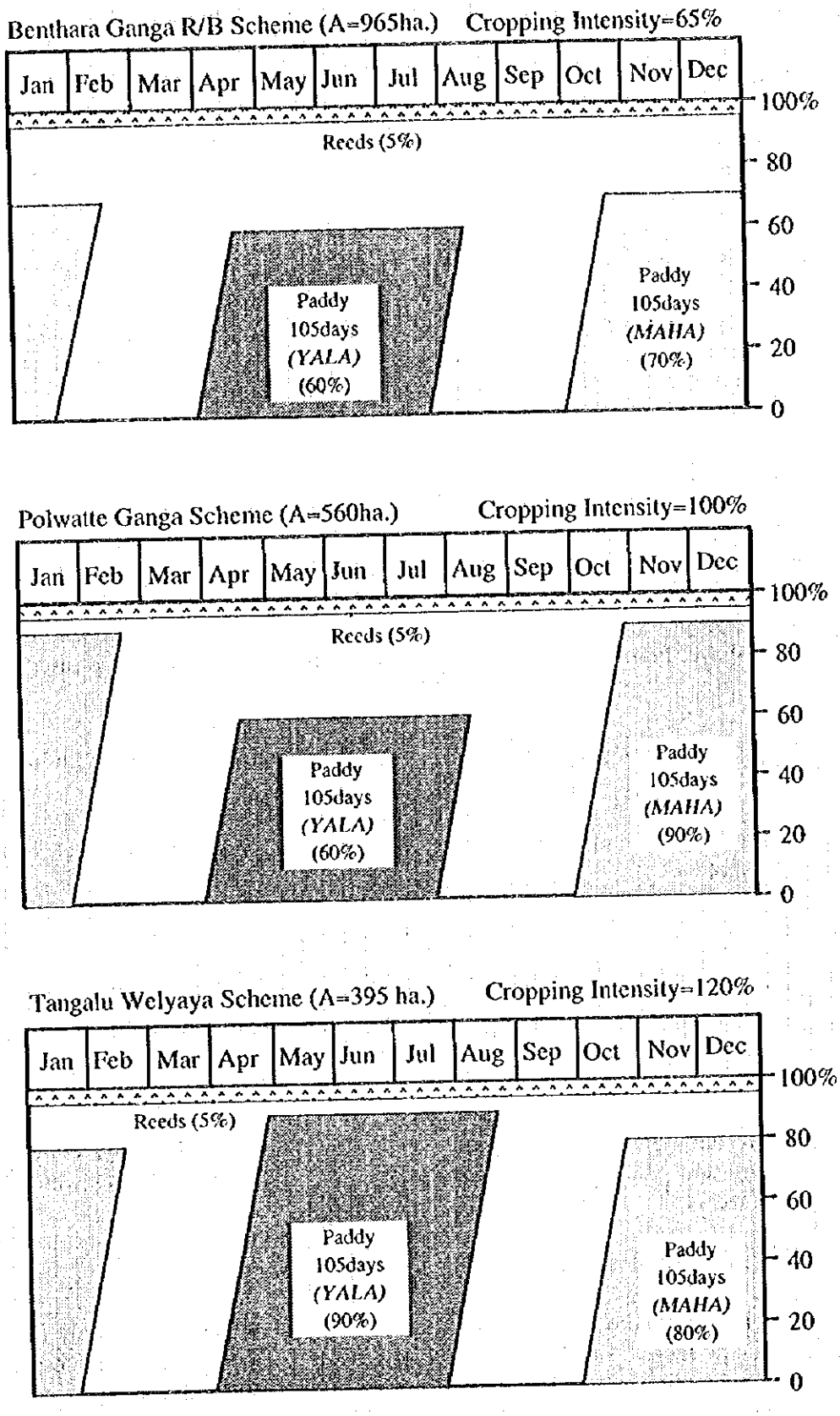

Fig. 6.3.4-2 Proposed Cropping Pattern for Benthara Ganga R/B, Polwatte Ganga and Tangalu Welyaya Scheme